National Aeronautics and Space Administration

Fiscal Year 2010
BUDGET ESTIMATES

National Aeronautics and Space Administration
President's FY 2010 Budget Request Summary

Budget Authority, $ in million								
By Appropriation Account By Theme	FY 2008 Actuals	FY 2009 Enacted	Recovery Act	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Science	**4,733.2**	**4,503.0**	**400.0**	**4,477.2**	**4,747.4**	**4,890.9**	**5,069.0**	**5,185.4**
Earth Science	1,237.4	1,379.6	325.0	1,405.0	1,500.0	1,550.0	1,600.0	1,650.0
Planetary Science	1,312.6	1,325.6		1,346.2	1,500.6	1,577.7	1,600.0	1,633.2
Astrophysics	1,395.6	1,206.2	75.0	1,120.9	1,074.1	1,042.7	1,126.3	1,139.6
Heliophysics	787.6	591.6		605.0	672.6	720.5	742.7	762.6
Aeronautics	**511.4**	**500.0**	**150.0**	**507.0**	**514.0**	**521.0**	**529.0**	**536.0**
Exploration	**3,299.4**	**3,505.5**	**400.0**	**3,963.1***	**6,076.6***	**6,028.5***	**5,966.5***	**6,195.3***
Constellation Systems	2675.9	3033.2	400.0	3505.4	5543.3	5472.0	5407.6	5602.6
Advanced Capabilities	623.5	472.3		457.7	533.3	556.5	558.9	592.7
Space Operations	**5,427.2**	**5,764.7**	**0.0**	**6,175.6**	**3,663.8**	**3,485.3**	**3,318.6**	**3,154.8**
Space Shuttle	3,295.4	2,981.7		3.157.1	382.8	87.8	0.0	0.0
International Space Station	1,685.5	2,060.2		2,267.0	2,548.2	2,651.6	2,568.9	2,405.9
Space and Flight Support	446.2	722.8		751.5	732.7	745.9	749.7	748.9
Education	**146.8**	**169.2**	**0.0**	**126.1**	**123.8**	**123.8**	**123.8**	**125.5**
Education	146.8	169.2		126.1	123.8	123.8	123.8	125.5
Cross-Agency Support	**3,251.4**	**3,306.4**	**50.0**	**3,400.6**	**3,468.4**	**3,525.7**	**3,561.4**	**3,621.4**
Center Management and Operations	2,011.7	2,024.0		2,084.0	2,119.2	2,142.5	2,166.1	2,189.9
Agency Management and Operations	834.1	921.2		961.2	956.9	964.5	972.3	981.5
Institutional Investments	325.5	293.7	50.0	355.4	392.3	418.7	423.0	450.0
Congressionally Directed Items	80.0	67.5		0.0	0.0	0.0	0.0	0.0
Inspector General	**32.6**	**33.6**	**2.0**	**36.4**	**37.0**	**37.8**	**38.7**	**39.6**
NASA FY 2010	**17,401.9**	**17,782.4**	**1,002.0**	**18,686.0**	**18,631.0**	**18,613.0**	**18,607.0**	**18,858.0**
Year to Year Change		2.2%		5.1%	-0.3%	-0.1%	0.0%	1.3%

Following the human spaceflight review, the Administration will provide an updated request for Exploration activities reflecting the review's results.

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National Aeronautics and Space Administration
President's FY 2010 Budget Request Detail

Budget Authority, $ in million

By Appropriation Account By Theme	FY 2008 Actuals	FY 2009** Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Science	**4,733.2**	**4,903.0**	**4,477.2**	**4,747.4**	**4,890.9**	**5,069.0**	**5,185.4**
Earth Science	**1,237.4**	**1,704.6**	**1,405.0**	**1,500.0**	**1,550.0**	**1,600.0**	**1,650.0**
Earth Science Research	*358.3*	*437.4*	*397.5*	*407.5*	*404.2*	*416.8*	*412.1*
Earth Science Research and Analysis	259.4	313.7	281.7	300.3	294.2	304.4	296.5
Computing and Management	98.9	123.7	115.8	107.2	110.0	112.4	115.6
Earth Systematic Missions	*546.1*	*898.9*	*715.5*	*725.4*	*786.4*	*818.8*	*867.6*
Global Precipitation Measurement (GPM)	74.4	157.8	159.5	127.6	137.5	111.2	80.4
Glory Mission	82.3	50.7	27.1	10.1	4.4	1.9	0.0
Landsat Data Continuity Mission (LDCM)	127.3	200.9	120.6	137.4	165.0	90.0	15.0
NPOESS Preparatory Project (NPP)	46.1	57.1	112.8	33.8	5.3	5.2	5.1
Ice, Cloud and Land Elevation Satellite (ICESat-II)	9.6	38.8	39.2	74.6	99.1	126.9	161.7
Soil Moisture Active and Passive (SMAP)	9.6	104.3	70.0	132.2	180.4	135.0	40.0
Decadal Survey Missions	16.8	82.3	0.0	10.9	8.8	161.1	374.6
Other Missions and Data Analysis	180.1	206.9	186.3	198.9	186.0	187.5	190.8
Earth System Science Pathfinder	*106.8*	*118.3*	*63.9*	*128.8*	*114.2*	*121.4*	*119.1*
Aquarius	33.4	44.7	18.3	6.3	4.2	2.8	0.0
Venture Class Missions	0.0	21.0	12.9	79.2	66.5	75.1	75.7
Other Missions and Data Analysis	73.4	52.6	32.8	43.3	43.5	43.5	43.4
Earth Science Multi-Mission Operations	*143.0*	*148.1*	*149.9*	*160.3*	*165.4*	*161.3*	*165.5*
Earth Science Multi-Mission Operations	143.0	148.1	149.9	160.3	165.4	161.3	165.5
Earth Science Technology	*43.0*	*54.1*	*45.9*	*47.2*	*48.2*	*49.5*	*52.7*
Earth Science Technology	43.0	54.1	45.9	47.2	48.2	49.5	52.7
Applied Sciences	*40.2*	*47.8*	*32.2*	*30.7*	*31.5*	*32.2*	*33.1*
Pathways	40.2	47.8	32.2	30.7	31.5	32.2	33.1

Budget Authority, $ in million
By Appropriation Account
By Theme

	FY 2008 Actuals	FY 2009** Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Planetary Science	**1,312.6**	**1,325.6**	**1,346.2**	**1,500.6**	**1,577.7**	**1,600.0**	**1,633.2**
Planetary Science Research	*183.1*	*162.1*	*161.7*	*193.5*	*240.2*	*232.6*	*254.2*
Planetary Science Research and Analysis	133.6	135.0	135.1	144.4	153.2	156.9	160.7
Other Missions and Data Analysis	18.6	19.5	21.4	22.2	22.3	22.7	29.3
Education and Directorate Management	27.7	3.9	1.4	23.1	60.7	49.0	60.1
Near Earth Object Observations	3.3	3.7	3.8	3.8	3.9	4.0	4.1
Lunar Quest Program	*41.3*	*105.0*	*103.6*	*142.6*	*138.6*	*145.5*	*118.7*
Lunar Science	36.2	64.8	33.3	52.4	58.5	64.3	39.4
Lunar Atmosphere and Dust Environment Explorer	5.1	30.2	66.5	73.9	31.1	0.0	0.0
International Lunar Network	0.0	10.0	3.7	16.3	48.9	81.2	79.3
Discovery	*136.4*	*247.0*	*213.2*	*234.6*	*256.8*	*256.5*	*264.3*
Gravity Recovery and Interior Laboratory (GRAIL)	67.0	122.4	124.1	104.8	41.4	4.7	0.0
Other Missions and Data Analysis	69.3	124.6	89.1	129.9	215.4	251.8	264.3
New Frontiers	*115.1*	*263.9*	*264.1*	*239.9*	*294.2*	*239.8*	*249.6*
Juno	95.0	245.0	237.2	174.2	71.4	17.8	18.1
Other Missions and Data Analysis	20.2	19.0	26.9	65.7	222.8	222.0	231.5
Mars Exploration	*709.3*	*381.6*	*416.1*	*494.5*	*405.5*	*514.3*	*536.7*
2009 Mars Science Lab	545.0	223.3	204.0	194.6	67.3	65.0	30.0
MAVEN	1.0	6.7	53.4	168.7	182.6	138.4	30.6
Other Missions and Data Analysis	163.3	151.6	158.7	131.2	155.7	310.9	476.1
Outer Planets	*62.2*	*101.1*	*98.6*	*97.1*	*140.3*	*117.7*	*118.5*
Outer Planets	62.2	101.1	98.6	97.1	140.3	117.7	118.5
Technology	*65.2*	*64.9*	*89.0*	*98.4*	*102.1*	*93.5*	*91.4*
Technology	65.2	64.9	89.0	98.4	102.1	93.5	91.4

National Aeronautics and Space Administration
President's FY 2010 Budget Request Detail

Budget Authority, $ in million By Appropriation Account By Theme	**FY 2008 Actuals**	**FY 2009** Enacted**	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
Astrophysics	**1,395.6**	**1,281.2**	**1,120.9**	**1,074.1**	**1,042.7**	**1,126.3**	**1,139.6**
Astrophysics Research	*102.2*	*135.0*	*151.9*	*160.0*	*165.0*	*177.2*	*188.0*
Astrophysics Research and Analysis	56.9	60.0	61.1	62.5	64.0	66.2	67.8
Balloon Project	24.0	24.6	26.7	28.8	32.4	33.2	35.8
Other Missions and Data Analysis	21.3	50.4	64.1	68.6	68.5	77.9	84.4
Cosmic Origins	*870.1*	*819.2*	*667.2*	*598.9*	*550.3*	*523.8*	*452.3*
Hubble Space Telescope (HST)	244.9	207.7	112.6	101.6	94.6	91.1	93.2
James Webb Space Telescope (JWST)	510.3	446.9	441.4	385.1	354.6	335.6	259.8
Stratospheric Observatory for Infrared Astronomy (SOFIA)	63.8	72.8	72.8	74.0	75.8	77.6	79.1
Other Missions And Data Analysis	51.2	91.7	40.4	38.3	25.3	19.4	20.2
Physics of the Cosmos	*148.9*	*128.3*	*147.7*	*188.5*	*213.9*	*291.4*	*330.3*
Missions and Data Analysis	148.9	128.3	147.7	188.5	213.9	291.4	330.3
Exoplanet Exploration	*156.7*	*68.1*	*46.2*	*57.3*	*86.9*	*123.5*	*167.3*
Missions and Data Analysis	156.7	68.1	46.2	57.3	86.9	123.5	167.3
Astrophysics Explorer	*117.7*	*130.7*	*107.9*	*69.5*	*26.6*	*10.4*	*1.7*
Wide - Field Infrared Survey Explorer (WISE)	72.7	65.2	13.0	5.2	1.6	0.2	0.0
Nuclear Spectroscopic Telescope Array (NuStar)	16.7	38.7	59.9	33.7	6.8	6.4	0.0
Other Missions and Data Analysis	28.3	26.8	35.0	30.6	18.2	3.8	1.7
Heliophysics	**787.6**	**591.6**	**605.0**	**672.6**	**720.5**	**742.7**	**762.6**
Heliophysics Research	*183.3*	*195.9*	*178.6*	*178.1*	*183.1*	*190.6*	*194.3*
Heliophysics Research and Analysis	33.0	31.0	35.4	38.4	39.1	40.1	41.1
Sounding Rocket Operations	51.0	77.4	66.5	67.5	68.9	71.4	73.1
Other Missions and Data Analysis	99.4	87.5	76.7	72.3	75.1	79.1	80.1
Living with a Star	*218.1*	*238.6*	*212.2*	*204.6*	*208.7*	*230.0*	*236.6*
Solar Dynamics Observatory (SDO)	108.1	20.8	34.1	20.2	18.6	16.3	15.6
Radiation Belt Storm Probes (RBSP)	67.8	154.4	137.1	127.9	105.1	22.0	17.3
Solar Probe Plus	13.9	18.0	4.0	16.6	36.7	57.8	81.3
Other Missions and Data Analysis	28.4	45.3	37.0	39.8	48.3	134.0	122.4

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Budget Authority, $ in million By Appropriation Account By Theme	**FY 2008 Actuals**	**FY 2009** Enacted**	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
Solar Terrestrial Probes	*71.9*	*123.1*	*143.0*	*169.1*	*170.6*	*160.8*	*164.3*
Magnetospheric Multiscale (MMS)	43.1	94.6	118.6	149.3	148.8	137.5	143.8
Other Missions and Data Analysis	28.8	28.5	24.4	19.8	21.8	23.3	20.5
Heliophysics Explorer Program	*48.1*	*31.4*	*69.4*	*119.7*	*158.1*	*161.3*	*167.4*
GOLD	0.3	0.5	0.5	10.6	10.9	6.7	0.9
Other Missions and Data Analysis	47.9	30.9	68.9	109.1	147.2	154.6	166.5
New Millennium	*15.0*	*2.7*	*1.8*	*1.1*	*0.0*	*0.0*	*0.0*
New Millennium	15.0	2.7	1.8	1.1	0.0	0.0	0.0
Near Earth Networks	*40.9*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Near Earth Networks	40.9	0.0	0.0	0.0	0.0	0.0	0.0
Deep Space Mission Systems (DSMS)	*210.3*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Deep Space Network	210.3	0.0	0.0	0.0	0.0	0.0	0.0
Aeronautics	**511.4**	**650.0**	**507.0**	**514.0**	**521.0**	**529.0**	**536.0**
Aeronautics	**511.4**	**650.0**	**507.0**	**514.0**	**521.0**	**529.0**	**536.0**
Aviation Safety	*66.5*	*89.3*	*60.1*	*59.6*	*59.2*	*61.7*	*62.5*
Integrated Vehicle Health Management	21.5	22.2	19.8	18.2	18.3	18.9	18.9
Aging Aircraft and Durability	9.1	13.4	11.4	11.2	11.7	12.1	12.1
Integrated Resilient Aircraft Control	21.8	37.3	16.4	17.0	17.6	18.2	18.2
Integrated Intelligent Flight Deck Technologies	14.1	16.3	12.5	13.3	11.6	12.6	13.4
Airspace Systems	*100.1*	*121.5*	*81.4*	*82.9*	*83.9*	*87.2*	*88.3*
NextGen Concepts and Technology Development	83.3	105.3	53.3	54.5	55.3	57.8	58.7
NextGen Systems Analysis, Integration, and Evaluation	16.8	16.2	28.1	28.4	28.5	29.5	29.6
Fundamental Aeronautics	*269.6*	*307.6*	*228.4*	*230.0*	*233.6*	*239.0*	*245.9*
Subsonic - Rotary Wing	30.8	38.9	26.1	26.1	26.3	27.4	27.9
Subsonic - Fixed Wing	119.6	155.2	101.6	103.7	105.4	107.3	110.8
Supersonics	53.0	55.6	40.6	40.0	40.7	42.0	42.8
Hypersonics	66.2	57.9	60.0	60.2	61.1	62.3	64.4

Budget Authority, $ in million By Appropriation Account By Theme	**FY 2008 Actuals**	**FY 2009** Enacted**	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
Aeronautics Test Program	*75.1*	*131.6*	*74.7*	*77.1*	*77.2*	*76.6*	*78.7*
Aero Ground Test Facilities	50.0	100.0	48.6	50.1	50.2	49.8	51.2
Flight Operations and Test Infrastructure	25.1	31.6	26.1	27.0	27.0	26.8	27.5
Integrated Systems Research	*0.0*	*0.0*	*62.4*	*64.4*	*67.1*	*64.4*	*60.5*
Environmentally Responsible Aviation Project	0.0	0.0	62.4	64.4	67.1	64.4	60.5
Exploration	**3,299.4**	**3,905.5**	**3,963.1***	**6,076.6***	**6,028.5***	**5,966.5***	**6,195.3***
Constellation Systems	**2,675.9**	**3,433.2**	**3,505.4**	**5,543.3**	**5,472.0**	**5,407.6**	**5,602.6**
Constellation Systems Program	*2,545.3*	*3,130.2*	*3,466.4*	*5,531.3*	*5,472.0*	*5,407.6*	*5,602.6*
Program Integration and Operations	610.4	645.5	642.5	1,423.9	1,405.4	1,501.5	1,813.9
Crew Exploration Vehicle	889.5	1,387.2	1,383.5	1,938.9	2,056.1	1,931.0	1,751.7
Crew Launch Vehicle	1,030.5	1,067.4	1,415.4	2,143.3	1,985.5	1,950.1	2,012.0
Cargo Launch Vehicle	15.0	30.0	25.0	25.0	25.0	25.0	25.0
Commercial Crew and Cargo	*130.5*	*303.0*	*39.1*	*12.2*	*0.0*	*0.0*	*0.0*
Advanced Capabilities	**623.5**	**472.3**	**457.7**	**533.3**	**556.5**	**558.9**	**592.7**
Human Research Program	*149.6*	*151.9*	*151.5*	*151.9*	*157.4*	*161.4*	*166.2*
Exploration Technology Development	*286.9*	*264.1*	*287.0*	*381.2*	*399.0*	*397.5*	*426.5*
Lunar Precursor Robotic Program	*187.1*	*56.3*	*19.1*	*0.2*	*0.1*	*0.0*	*0.0*

***** ***Following the human spaceflight review, the Administration will provide an updated request for Exploration activities reflecting the review's results. FY 2010 and outyear funding levels for Exploration activities shown here represent the budget request if there were no changes to ongoing activities.***

National Aeronautics and Space Administration
President's FY 2010 Budget Request Detail

Budget Authority, $ in million
By Appropriation Account
By Theme

	FY 2008 Actuals	FY 2009** Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Space Operations	**5,427.2**	**5,764.7**	**6,175.6**	**3,663.8**	**3,485.3**	**3,318.6**	**3,154.8**
Space Shuttle	**3,295.4**	**2,981.7**	**3,157.1**	**382.8**	**87.8**	**0.0**	**0.0**
Space Shuttle Program	*3,295.4*	*2,981.7*	*3,157.1*	*382.8*	*87.8*	*0.0*	*0.0*
Program Integration	516.6	489.6	678.1	152.0	22.7	0.0	0.0
Flight and Ground Operations	1,124.9	1,031.2	1,035.1	109.5	49.1	0.0	0.0
Flight Hardware	1,653.9	1,460.9	1,443.9	121.3	16.0	0.0	0.0
International Space Station	**1,685.5**	**2,060.2**	**2,267.0**	**2,548.2**	**2,651.6**	**2,568.9**	**2,405.9**
International Space Station Program	*1,685.5*	*2,060.2*	*2,267.0*	*2,548.2*	*2,651.6*	*2,568.9*	*2,405.9*
ISS Operations	1,603.2	1,755.4	1,639.0	1,717.3	1,513.9	1,437.8	1,449.0
ISS Cargo Crew Services	82.3	304.8	628.0	830.9	1,137.7	1,131.1	956.9
Space and Flight Support	**446.2**	**722.8**	**751.5**	**732.7**	**745.9**	**749.7**	**748.9**
Space Communications and Navigation	*303.9*	*582.9*	*496.6*	*506.9*	*520.3*	*524.0*	*524.0*
Space Communications Networks	56.5	363.5	427.2	423.0	440.8	431.1	444.3
Space Communications Support	97.4	65.4	43.4	64.9	56.9	79.5	79.7
TDRS Replenishment	150.0	154.0	26.0	19.0	22.6	13.4	0.0
Human Space Flight Operations	*0.0*	*0.0*	*114.7*	*88.5*	*88.6*	*88.7*	*89.0*
Space Flight Crew Operations	0.0	0.0	114.7	88.5	88.6	88.7	89.0
Launch Services	*91.8*	*89.6*	*85.9*	*84.1*	*83.9*	*83.9*	*82.8*
Launch Services	91.8	89.6	85.9	84.1	83.9	83.9	82.8
Rocket Propulsion Test	*41.9*	*41.8*	*45.8*	*44.6*	*44.5*	*44.5*	*44.5*
Rocket Propulsion Testing	41.9	41.8	45.8	44.6	44.5	44.5	44.5
Crew Health & Safety	*8.7*	*8.6*	*8.6*	*8.5*	*8.5*	*8.5*	*8.5*
Crew Health and Safety	8.7	8.6	8.6	8.5	8.5	8.5	8.5

National Aeronautics and Space Administration
President's FY 2010 Budget Request Detail

Budget Authority, $ in million

By Appropriation Account / By Theme	FY 2008 Actuals	FY 2009** Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Education	**146.8**	**169.2**	**126.1**	**123.8**	**123.8**	**123.8**	**125.5**
Education	**146.8**	**169.2**	**126.1**	**123.8**	**123.8**	**123.8**	**125.5**
Higher Ed. STEM Education	*92.0*	*107.7*	*80.6*	*80.6*	*80.6*	*80.7*	*80.7*
STEM Opportunities (Higher Education)	9.0	9.5	11.6	11.6	11.6	11.6	11.6
NASA Space Grant	35.7	40.0	28.4	28.4	28.4	28.4	28.4
Experimental Program to Stimulate Competitive Research	12.8	20.0	10.0	10.0	10.0	10.0	10.0
Minority University Research & Education Program	27.5	28.2	30.7	30.7	30.7	30.7	30.7
Global Climate Change Education	7.0	10.0	0.0	0.0	0.0	0.0	0.0
K-12 STEM Education	*41.3*	*47.5*	*43.3*	*41.0*	*41.0*	*41.0*	*42.7*
STEM Student Opportunities (K-12)	9.6	10.5	14.5	14.5	14.5	14.5	14.5
STEM Teacher Development (K-12)	20.1	21.0	28.9	26.5	26.5	26.5	28.2
K-12 Competitive Educational Grant Program	11.6	16.0	0.0	0.0	0.0	0.0	0.0
Informal STEM Education	*13.5*	*14.0*	*2.1*	*2.1*	*2.1*	*2.1*	*2.1*
Science Museums and Planetarium Grants	7.8	7.0	0.0	0.0	0.0	0.0	0.0
NASA Visitor Centers	5.8	7.0	0.0	0.0	0.0	0.0	0.0
NASA Informal Education Opportunities	0.0	0.0	2.1	2.1	2.1	2.1	2.1
Cross-Agency Support	**3,251.4**	**3,356.4**	**3,400.6**	**3,468.4**	**3,525.7**	**3,561.4**	**3,621.4**
Center Management and Operations	**2,011.7**	**2,024.0**	**2,084.0**	**2,119.2**	**2,142.5**	**2,166.1**	**2,189.9**
Center Management and Operations	*2,011.7*	*2,024.0*	*2,084.0*	*2,119.2*	*2,142.5*	*2,166.1*	*2,189.9*
Center Institutional Capabilities	1,555.6	1,579.0	1,608.6	1,626.1	1,631.7	1,637.2	1,644.5
Center Programmatic Capabilities	456.1	445.0	475.4	493.1	510.8	528.9	545.4
Agency Management and Operations	**834.1**	**921.2**	**961.2**	**956.9**	**964.5**	**972.3**	**981.5**
Agency Management	*353.8*	*390.0*	*412.7*	*417.4*	*422.0*	*426.6*	*431.3*
Agency Management	353.8	390.0	412.7	417.4	422.0	426.6	431.3

Budget Authority, $ in million By Appropriation Account By Theme	**FY 2008 Actuals**	**FY 2009** Enacted**	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
Safety and Mission Success	*171.5*	*179.1*	*183.9*	*186.1*	*188.6*	*190.9*	*193.0*
Safety and Mission Assurance	43.9	42.9	48.3	48.8	49.3	49.7	50.4
Chief Engineer	94.8	87.0	102.2	103.6	105.3	106.8	107.0
Chief Health and Medical Officer	2.3	4.1	3.7	3.7	3.7	3.8	3.8
Independent Verification and Validation	30.5	45.0	29.7	30.0	30.3	30.6	31.9
Agency IT Services	*134.9*	*163.9*	*150.4*	*138.3*	*138.0*	*138.3*	*139.7*
IT Management	17.3	17.3	31.9	25.8	25.1	24.0	23.0
Applications	68.3	67.2	70.2	66.1	66.7	67.1	68.8
Infrastructure	49.3	79.4	48.3	46.4	46.2	47.2	47.9
Innovative Partnerships Program	*146.8*	*160.2*	*184.8*	*184.9*	*185.7*	*186.3*	*187.0*
Technology Infusion	6.7	9.1	13.5	13.1	13.5	13.7	14.0
Small Business Innovative Research	86.9	113.4	124.1	124.1	124.1	124.1	124.1
Small Business Technology Transfer Research	13.2	13.6	14.1	14.1	14.1	14.1	14.1
Innovation Incubator	0.0	0.0	2.5	2.5	2.5	2.5	2.5
Future Centennial Challenges	0.0	0.0	4.0	4.0	4.0	4.0	4.0
Partnership Development	39.9	24.1	23.8	20.2	19.9	19.7	21.3
Innovative Technology	0.0	0.0	2.8	6.8	7.5	8.1	7.0
Strategic Capabilities Assets Program	*27.2*	*28.0*	*29.4*	*30.2*	*30.2*	*30.2*	*30.5*
Simulators	10.9	11.5	11.7	12.1	12.1	12.1	11.9
Thermal Vacuum Chambers	7.7	7.2	8.3	8.4	8.4	8.4	8.7
Arc Jets	8.6	9.3	9.4	9.7	9.7	9.7	9.9
Institutional Investments	**325.5**	**343.7**	**355.4**	**392.3**	**418.7**	**423.0**	**450.0**
Institutional Construction of Facilities	*249.0*	*268.9*	*284.2*	*326.0*	*367.4*	*371.6*	*397.4*
Institutional Construction Of Facilities	249.0	268.9	284.2	326.0	367.4	371.6	397.4
Environmental Compliance and Restoration	*76.5*	*74.8*	*71.2*	*66.3*	*51.3*	*51.4*	*52.6*
Environmental Compliance and Restoration	76.5	74.8	71.2	66.3	51.3	51.4	52.6

National Aeronautics and Space Administration
President's FY 2010 Budget Request Detail

Budget Authority, $ in million By Appropriation Account By Theme	**FY 2008 Actuals**	**FY 2009** Enacted**	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
Congressionally Directed Items	**80.0**	**67.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Congressionally Directed Items	*80.0*	*67.5*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Congressionally Directed Items	80.0	67.5	0.0	0.0	0.0	0.0	0.0
Inspector General	**32.6**	**35.6**	**36.4**	**37.0**	**37.8**	**38.7**	**39.6**
Inspector General	**32.6**	**35.6**	**36.4**	**37.0**	**37.8**	**38.7**	**39.6**
IG Program	*32.6*	*35.6*	*36.4*	*37.0*	*37.8*	*38.7*	*39.6*
Inspector General	32.6	35.6	36.4	37.0	37.8	38.7	39.6
NASA FY 2010	**17,401.9**	**18,784.4**	**18,686.0**	**18,631.0**	**18,613.0**	**18,607.0**	**18,858.0**

** FY 2009 enacted column contains Recovery Act funding of $400M for Science, $150M for Aeronautics, $400M for Exploration, $50M for Cross Agency Support and $2M for Inspector General.

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FY 2010 Budget Request Summary

Message from the Administrator

Today, I am pleased to release NASA's FY2010 budget request in the amount of $18.686 billion to advance Earth science, complete the International Space Station, explore the solar system and conduct aeronautics research. The budget request represents an increase of $903.6 million, about 5 percent, above the amount provided NASA in the FY 2009 Omnibus Appropriations Act.

The FY 2010 budget does a number of things: it supports the Administration's commitment to deploy a global climate change research and monitoring system; it funds a strong program of space exploration involving humans and robots with the goal of returning Americans to the moon and exploring other destinations; and it supports the safe flight of the Space Shuttle to complete assembly of the International Space Station by the Space Shuttle's planned retirement.

With the FY 2010 budget request, we will advance our global climate change research. NASA's investment in Earth science research satellites, airborne sensors, computer models and analysis already has revolutionized scientific knowledge and predictions of climate change and its effects. Using the National Research Council's recommended priorities for space-based Earth science research, we will develop new sensors to support the Administration's goal of deploying a global climate research and monitoring system.

The budget request also renews NASA's commitment to aeronautics research to address aviation safety, air traffic control, noise and emissions reduction, and fuel efficiency. And NASA's diverse portfolio of science, technology, engineering and mathematics educational activities is aligned with the administration's goal of improving American innovation and global competitiveness.

Along with the budget release, the White House also announced the launch of an independent review of NASA's human space flight activities. The Review of United States Human Space Flight Plans will examine our development programs and suggest possible alternatives. The goal is to provide options that will ensure the nation's human space flight program remains safe, innovative and affordable in the years following the space shuttle's retirement. During the review, work on the Constellation Program will continue.

The review team will work closely with NASA and seek input from the Congress, the White House, the public, industry and international partners as it develops these options. The review will be done by a blue-ribbon panel of experts. The panel's results will support an administration decision by August 2009 on how to proceed.

As we move forward into the future, I'm confident that with your expertise and hard work, NASA will continue its record of amazing accomplishments in exploration and research. The President's FY 2010 request represents a major investment in this future.

Christopher J. Scolese
Acting Administrator

FY 2010 Budget Overview

NASA's astronauts and robotic spacecraft have been exploring our solar system and the universe for more than 50 years. NASA's FY 2010 request funds a robust program to continue our missions of space exploration and aeronautics research. NASA's FY 2010 budget request, at $18.686 billion, represents an increase of $903.6 million above the amount provided for NASA in the FY 2009 Omnibus Appropriations Act (P.L. 110-8), a 5% increase.

NASA's FY 2010 budget request supports the Administration's commitment to deploy a global climate change research and monitoring system, funds a robust program of space exploration involving humans and robots with a goal to return Americans to the Moon and explore other destinations, and funds the safe flight of the Shuttle to complete assembly of the ISS through its retirement at the end of 2010. The FY 2010 budget request funds continued use of the ISS to enable the Agency to develop, test, and validate critical exploration technologies and processes and, in coordination with our international partners, to make the ISS available support other government entities, commercial industry and academic institutions to conduct unique research in the microgravity environment of space. It will also stimulate private sector development and demonstration of vehicles that may support NASA's cargo and crew requirements. And it renews NASA's commitment to aeronautics research to address aviation safety, air traffic control, noise and emissions reduction, and fuel efficiency. NASA's diverse portfolio of science, technology, engineering and mathematics (STEM) educational activities is also aligned with the Administration's goal of improving American innovation and global competitiveness.

The Agency will create a new chapter of our legacy as we embark on a renewed program of human exploration to the Moon and other destinations beyond low Earth orbit. In the summer of 2009, NASA will participate in a review of planned U.S. human space flight activities with the goal of ensuring that the nation is on a vigorous and sustainable path to achieving its boldest aspirations in space. The review will examine ongoing Exploration activities as well as alternatives to ensure the Nation is pursuing the best technical solution for future human spaceflight – one that is safe, innovative, and affordable. NASA also will send a broad suite of robotic missions to destinations throughout the solar system and develop a bold new set of astronomical observatories to probe the mysteries of the universe, increasing investment in research, data analysis, and technology development in support of these goals.

With the FY 2010 budget request, NASA advances global climate change research. The NASA investment in Earth science research satellites, airborne sensors, computer models and analysis has revolutionized scientific knowledge and predictions of climate change and its effects. Using the National Research Council's recommended priorities for space-based Earth science research as its guide, NASA will develop new space-based research sensors in support of the Administration's goal to deploy a global climate research and monitoring system. NASA will deploy these new sensors expeditiously while coordinating with other Federal agencies to ensure continuity of measurements that have long-term research and applications benefits.

With the FY 2010 request, NASA will complete the International Space Station (ISS) and advance the development of new space transportation systems and the unique scientific research that can be conducted onboard the ISS. NASA will fly the Space Shuttle to complete the ISS and then retire the Shuttle. NASA is committed to completing the nine remaining scheduled shuttle flights, which we believe can be accomplished by the end of 2010. . Funds freed from the Shuttle's retirement will enable the Agency to support development of systems to deliver people and cargo to the ISS and the Moon and explore other destinations. As part of this effort, NASA will stimulate private-sector development and demonstration of vehicles to support the Agency's human crew and cargo space flight requirements. In addition, the Agency will continue to utilize the ISS, the permanently crewed facility orbiting Earth that enables the Agency to develop, test, and validate critical space exploration technologies and processes, and to conduct microgravity research. NASA also will continue to coordinate with international partners to make this platform available for other government entities, commercial industry, and academic institutions to conduct research.

The FY 2010 budget request renews NASA's commitment to a strong national program of aeronautics research and technology that contributes to the economic well-being and quality of life of American citizens. NASA will renew its commitment to cutting-edge, fundamental research in traditional and emerging disciplines to help transform the Nation's air transportation system and to support future aircraft. NASA research will increase airspace capacity and mobility, enhance aviation safety, and improve aircraft performance while reducing noise, emissions, and fuel consumption.

Finally, consistent with Administration priorities, NASA is developing plans to stimulate innovation and increase investments in technologies for the future while ensuring nearer-term Agency commitments are met.

Budget Authority ($M)	FY 2008	FY 2009	Recovery Act	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Science	**4,733.2**	**4,503.0**	**400.0**	**4,477.2**	**4,747.4**	**4,890.9**	**5,069.0**	**5,185.4**
Earth Science	1,237.4	1,379.6	325.0	1,405.0	1,500.0	1,550.0	1,600.0	1,650.0
Planetary Science	1,312.6	1,325.6		1,346.2	1,500.6	1,577.7	1,600.0	1,633.2
Astrophysics	1,395.6	1,206.2	75.0	1,120.9	1,074.1	1,042.7	1,126.3	1,139.6
Heliophysics	787.6	591.6		605.0	672.6	720.5	742.7	762.6
Aeronautics	**511.4**	**500.0**	**150.0**	**507.0**	**514.0**	**521.0**	**529.0**	**536.0**
Exploration	**3,299.4**	**3,505.5**	**400.0**	**3963.1***	**6076.6***	**6028.5***	**5966.5***	**6195.3***
Constellation Systems	2,675.9	3,033.1	400.0	3,505.4	5,543.3	5,472.0	5,407.6	5,602.6
Advanced Capabilities	623.5	472.3		457.7	533.3	556.5	558.9	592.7
Space Operations	**5,427.2**	**5,764.7**	**0.0**	**6,175.6**	**3,663.8**	**3,485.3**	**3,318.6**	**3,154.8**
Space Shuttle	3,295.4	2,981.7		3,157.1	382.8	87.8	0.0	0.0
International Space Station	1,685.5	2,060.2		2,267.0	2,548.2	2,651.6	2,568.9	2,405.9
Space and Flight Support (SFS)	446.2	722.8		751.5	732.7	745.9	749.7	748.9
Education	**146.8**	**169.2**	**0.0**	**126.1**	**123.8**	**123.8**	**123.8**	**125.5**
Cross-Agency Support	**3,251.4**	**3,306.4**	**50.0**	**3,400.6**	**3,468.4**	**3,525.7**	**3,561.4**	**3,621.4**
Center Management and Operations	2,011.7	2,024.0		2,084.0	2,119.2	2,142.5	2,166.1	2,189.9
Agency Management and Operations	834.1	921.2		961.2	956.9	964.5	972.3	981.5
Institutional Investments	325.5	293.7	50.0	355.4	392.3	418.7	423.0	450.0
Congressionally Directed Items	80.0	67.5		0.0	0.0	0.0	0.0	0.0
Inspector General	**32.6**	**33.6**	**2.0**	**36.4**	**37.0**	**37.8**	**38.7**	**39.6**
NASA FY 2010	**17,401.9**	**17,782.4**	**1,002.0**	**18,686.0**	**18,631.0**	**18,613.0**	**18,607.0**	**18,858.0**
Year to Year Change		*2.2%*		*5.1%*	*-0.3%*	*-0.1%*	*0.0%*	*1.3%*

*Following the human spaceflight review, the Administration will provide an updated request for Exploration activities reflecting the review's results.

Science

NASA's Science Mission Directorate continues to expand humanity's understanding of our Earth, our Sun, the solar system and the universe with 57 science missions in operation and 32 more in formulation or development. The Science budget funds these missions as well as the research of over 3,000 scientists and their students across the nation. NASA's request and plans for FY 2010 – FY 2013 increases funding for Science by $762 million over the FY 2009 request.

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**4,733.2**	**4,903.0**	**4,477.2**	**4,747.4**	**4,890.9**	**5,069.0**	**5,185.4**
Earth Science	1,237.4	1,704.6	1,405.0	1,500.0	1,550.0	1,600.0	1,650.0
Planetary Science	1,312.6	1,325.6	1,346.2	1,500.6	1,577.7	1,600.0	1,633.2
Astrophysics	1,395.6	1,281.2	1,120.9	1,074.1	1,042.7	1,126.3	1,139.6
Heliophysics	787.6	591.6	605.0	672.6	720.5	742.7	762.6
FY 2009 President's Budget Request	**4,706.2**	**4,441.5**	**4,482.0**	**4,534.9**	**4,643.4**	**4,761.6**	**-**
Earth Science	1,280.3	1,367.5	1,350.7	1,250.9	1,264.4	1,290.3	-
Planetary Science	1,247.5	1,334.2	1,410.1	1,537.5	1,570.0	1,608.7	-
Astrophysics	1,337.5	1,162.5	1,122.4	1,057.1	1,067.7	1,116.0	-
Heliophysics	840.9	577.3	598.9	689.4	741.2	746.6	-
Total Change from FY2009 President's Budget Request	**27.0**	**461.5**	**-4.8**	**212.5**	**247.5**	**307.4**	

Reflecting the Administration's commitment to global climate change research, NASA has increased the Earth Science budget for FY 2010 – FY 2013 by $0.9 billion. Including the additional resources provided in the FY 2009 appropriation and the Recovery Act, NASA's Earth Science programs will have been increased by almost $1.2 billion over 5 years, a 19 per cent increase. NASA's 15 Earth Science missions in operation provide a large part of the global observations used for climate change research in the United States and elsewhere. This year, NASA's Earth Science satellites enabled research to understand how changes both in the tropics and in the Arctic sea ice are changing ocean biology globally. NASA also recently conducted the first Ice Bridge aircraft campaign to demonstrate a new airborne laser capability to bridge the gap in time between ICESats I and II. In FY 2010, NASA plans to launch the Glory mission to map atmospheric aerosols and continue the long record of solar influences on climate, and the Aquarius mission to provide the first global measurements of sea surface salinity. NASA will complete development of the NPOESS Preparatory Project and continue development of the Global Precipitation Mission and the Landsat Data Continuity Mission (LDCM), and initiate work on development of a Thermal Infra-Red Sensor (TIRS). The launch vehicle failure of the Orbiting Carbon Observatory (OCO) was a significant loss to the climate science communities, and NASA is assessing options to recover from that loss. NASA is continuing to work aggressively to implement the recommendations of the National Research Council Decadal Survey for Earth Science. The first two new missions the Decadal Survey recommended, SMAP and ICESat-II, will continue formulation in FY2010, with launches expected in late 2013/early 2014 and late 2014/early 2015 respectively. The next two, DESDynI and CLARREO, will be accelerated and transition to formulation. NASA also expects to issue its first Venture-class

Announcement of Opportunity later this year, implementing another decadal survey recommendation.

NASA's Planetary Science missions continue to return images and data from the far reaches of the Solar System. This year, the Mars Phoenix Lander completed its mission, conducting the first chemical test providing evidence of water ice on another planet. MESSENGER returned stunning imagery of portions of the planet Mercury never before seen. The Cassini spacecraft continues to provide un-paralleled science of the Saturnian system; the spacecraft flew within 25km of Enceladus viewing the ejecting plumes and surface, and data from 19 fly-bys of Titan enabled creation of a radar map showing 3-D topography revealing 1,200-meter (4,000-foot) mountain tops, polar lakes, vast dunes, and thick flows from possible ice volcanoes. Development is continuing on the Juno mission to Jupiter for launch in 2011. NASA and ESA jointly announced they will work together on a Europa Jupiter System mission concept as the next outer planets flagship effort. The MER rovers continue to study the Martian surface and have exceeded their fifth year of successful operations. NASA is continuing development of the Mars Science Laboratory (MSL) for launch in 2011 and selected MAVEN, a Mars aeronomy mission, as the next Mars Scout mission for launch in 2013. NASA has integrated its lunar science research program with the Lunar Precursor Robotic Program into a single Lunar Quest Program under the Science Mission Directorate, which includes lunar science missions and a new virtual university research collaboration called the NASA Lunar Science Institute. The Moon Mineralogy Mapper (M3) was launched aboard Chandrayaan-1 and has begun making scientific observations of the Moon's composition. Development is continuing on the GRAIL mission to map the Moon's gravity field for launch in 2011. This year, NASA is releasing Announcements of Opportunity for both the next New Frontiers and Discovery missions. NASA's request for Planetary Science is $1.3 billion for FY 2010.

2009 is the International Year of Astronomy, and NASA's Astrophysics program will deploy exciting new capabilities for studying the cosmic frontier. The Kepler mission, launched in March, is NASA's first mission dedicated to the search for Earth-like planets in our galaxy. ESA will launch the Herschel and Planck missions in May, carrying several NASA instruments, to study the far-infrared sky and the cosmic microwave background. The final Hubble Space Telescope serving mission aboard STS-125, scheduled for launch May 12, will upgrade the observatory to its peak scientific performance. In November, NASA plans to launch the Wide-field Infrared Survey Explorer (WISE) as part of its highly successful Explorer Program, following on the recent successes of the Fermi Gamma-ray Space Telescope (launched as GLAST in July 2008), which has provided the best-ever view of the gamma-ray sky revealing energetic sources in our solar system, our galaxy, and galaxies billions of light-years away. Development is continuing on the James Webb Space Telescope, which passed its Confirmation Review in 2008 and has an Agency commitment to launch in 2014. Development continues on the NuSTAR mission to study black holes for launch in 2011, along with a Soft X-ray Spectrometer to fly on Japan's Astro-H mission in 2013. Development continues on the airborne Stratospheric Observatory for Infrared Astronomy or SOFIA, which will conduct open door flight tests in 2009 and early science flights in 2010, with planned full operational capability in 2014. Formulation is continuing for ambitious future mission concepts to investigate the origins of planets, stars, and galaxies; to search for Earth-like planets around nearby stars; and to examine the nature of dark energy, dark matter, gravity waves, and black holes. These and other mission concepts are currently under consideration by the NRC's decadal survey for Astrophysics, or Astro2010, which will be completed during 2010, and will provide recommendations to NASA on the science community's highest priority science questions and strategic missions for the next decade. NASA's request for Astrophysics is $1.1 billion for FY 2010.

The fleet of NASA Heliophysics missions strategically placed throughout the solar system is providing researchers the first ever solar system-wide view of solar influences on the Earth and other planets, and the dynamic structures of space itself. This virtual “Great Observatory” is in place and functioning for the next solar magnetic activity cycle, and has already detected the first signs of a new solar maximum anticipated for 2011-2012. By early next year, the launch of Solar Dynamics Observatory will add to this fleet the capability to observe the solar atmosphere to a depth of one-third of the Sun’s radius to study the flow of plasmas that generate magnetic fields and the sudden changes that produce coronal mass ejections that we experience as space weather. Also this year, NASA plans to select two Small Explorer (SMEX) missions in response to an Announcement of Opportunity issued in 2008, which could be either Heliophysics or Astrophysics missions depending on the proposals selected. Development of the Radiation Belt Storm Probes mission to study the interactions of space weather events with Earth’s magnetic field is continuing for launch in 2012, as well as the Magnetosphere Multi-Scale mission to observe the processes of magnetic reconnection, energetic particle acceleration, and turbulence in Earth’s magnetosphere for launch in 2014. Finally, NASA is continuing early formulation work on the Solar Probe-Plus mission that will travel into, and sample, the near-Sun environment to probe the origins of the solar wind. NASA’s request for Heliophysics is $0.6 billion in FY 2010.

Aeronautics

Over the past year, NASA's Aeronautics Research Mission Directorate has continued to pursue long-term, innovative, and cutting-edge research that develops revolutionary tools, concepts, and technologies to enable a safer, more flexible, environmentally friendly, and more efficient national air transportation system. NASA Aeronautics Research also plays a vital role in supporting NASA's human and robotic re-entry vehicle research. NASA's request for Aeronautics is $507 million in FY 2010, with an increase of $247 million for FY 2010 – FY 2013. Including the additional resources provide in the FY 2009 appropriation and the Recovery Act, NASA's Aeronautics programs will have been increased by $450 million over 5 years, a 20% increase.

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**511.4**	**650.0**	**507.0**	**514.0**	**521.0**	**529.0**	**536.0**
Aeronautics	511.4	650.0	507.0	514.0	521.0	529.0	536.0
FY 2009 President's Budget Request	**511.7**	**446.5**	**447.5**	**452.4**	**456.7**	**467.7**	**-**
Aeronautics		446.5	447.5	452.4	456.7	467.7	-
Total Change from FY2009 President's Budget Request	**-0.3**	**203.5**	**59.5**	**61.6**	**64.3**	**61.3**	

A primary goal across Aeronautics Research programs is to establish strong partnerships with industry, academia, and other government agencies in order to enable significant advancement in our Nation's aeronautical expertise. NASA has put many mechanisms in place to engage academia and industry, including industry working groups and technical interchange meetings at the program and project level, Space Act Agreements (SAAs) for cooperative partnerships, and the NASA Research Announcement (NRA) process that provides for full and open competition for the best and most promising research ideas. To date, 68 SAAs have been established with industry partners across all programs and 375 NRAs have been awarded to academia, industry and non-profit organizations. NASA Aeronautics has continued to collaborate with the Joint Planning Development Office (JPDO), Federal Aviation Administration (FAA), U.S. Air Force, Army, and other government organizations.

NASA's Airspace Systems Program has partnered with the JPDO to help develop concepts, capabilities and technologies that will lead to significant enhancements in the capacity, efficiency and flexibility of the National Airspace System. A notable accomplishment is the successful completion, by NASA researchers in collaboration with academia and the FAA, of a series of human-in-the-loop experiments that explored advanced concepts and technology for separation assurance, which ensures that aircraft maintain a safe distance from other aircraft, terrain, obstacles, and certain airspace not designated for routine air travel. The technology being developed by NASA and its partners is critical to relieving air-traffic controller workload, a primary constraint on airspace capacity that is expected to increase in coming years. In the future, this Program will continue to develop new technologies to solve important problems such as surface traffic planning and control, and initial algorithms for airport arrival and departure balancing as well as developing traffic flow management concepts for increased efficiencies at the regional and national levels for different planning intervals.

NASA's Fundamental Aeronautics Program conducts research in all aeronautics disciplines that enable the design of vehicles that fly through any atmosphere at any speed. The program has supported the testing of various new concepts that will help enable much improved capabilities for future vehicles. For example, wind-tunnel testing was conducted for several promising powered lift concepts. Powered lift concepts increase lifting force on an aircraft at slow speeds (e.g., at take-off and landing) without increasing drag under cruise conditions. Successful use of the concepts will enable short take-off and landings on runways less than 3000 feet, which will increase next-generation air transportation system capacity through the use of shorter fields and improved low-speed maneuverability in airport terminal areas. Testing was also completed for a Smart Material Actuated Rotor Technology (SMART) helicopter rotor, which offers the potential for significant noise and vibration reduction in rotorcraft. Future work includes technologies and advanced tools to evaluate the trades between noise, emissions, and performance of future aircraft entering service in the 2012-2015 timeframe.

NASA's Aviation Safety Program continues to develop tools and technologies to improve on today's incredibly safe air transportation system, while ensuring that future technologies can be safely incorporated to the system. Examples of advances that support this development include NASA's ongoing and new research into aircraft icing. For example, with current knowledge we cannot extrapolate how ice forms on a straight wing such as found on a turbo-prop to how it will form on a swept wing, or a radically new aircraft configuration. The Aviation Safety Program is tackling this with a combination of computational models and experiments in NASA's Icing Research Tunnel. We are establishing that, in high and cold flight conditions, ice can form deeper in jet engines than previously understood. NASA is working collaboratively with the FAA, industry and international partners, such as the National Research Council of Canada, to conduct tunnel tests of the underlying physics, to fly our instrumented S-3 Viking into such engine icing conditions, and design upgrades to our Propulsion System Lab in which jet engines may be tested in detail. Additional future work in Aviation Safety includes addressing gaps in validation and verification of critical flight software, developing new data-analysis capabilities to mine aviation operational data for safety issues, examining the safety of new vehicle systems and structures, and tackling the biggest human factors issues in the NextGen flightdeck.

NASA's Aeronautics Test Program (ATP) is focused on ensuring a healthy suite of facilities and platforms to meet the nation's testing needs including the development of new test instrumentation and test technologies. As part of its continuous efforts to improve facility operational efficiencies, ATP initiated the National Force Measurement Technology Capability, to address the severe erosion of NASA's capability to utilize strain gage balances in wind tunnel testing. The National Partnership for Aeronautics Testing, a strategic partnership between NASA and the Department of Defense (DOD), recently commissioned a study of government-owned, mid-to-large supersonic facilities necessary to fulfill future air vehicle test requirements. The Program will continue to develop a long-term strategic approach that aligns the NASA and DOD facilities to meet future requirements with the right mix of facilities and appropriate investments in facility capabilities.

NASA's Integrated Systems Research Program (ISRP), a new program effort beginning in FY10, has been organized to support the Environmentally Responsible Aviation (ERA) Project, a "green aircraft initiative," that will conduct system research and experiments of promising vehicle concepts and technologies that will simultaneously reduce fuel burn, noise and emissions. The environmental impacts of noise and emissions are a growing concern and could limit the ability of NextGen to meet the projected growth in demand for air transportation. The integrated system-level research in this program will be coordinated with on-going long-term, foundational research within the three other research programs, and will focus specifically on maturing and integrating technologies in major vehicle systems and subsystems for accelerated transition to practical application.

Exploration

Human space flight is important to America's political, economic, technological and scientific leadership. In the span of a few short years, NASA has taken long strides to formulate strategies and programs key to developing a robust program of space exploration. These critical steps will allow our Nation to build the next-generation spaceflight vehicles that will deliver humans and cargo to the ISS and the Moon, then on to other destinations in our solar system. NASA's FY 2010 budget advances the development of these systems with a $4.0 billion request for Exploration in FY 2010, which is an increase of five percent from the previous plan for FY 2010.

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010*	FY 2011*	FY 2012*	FY 2013*	FY 2014*
FY 2010 President's Budget Request	**3,299.4**	**3,905.5**	**3,963.1**	**6,076.6**	**6,028.5**	**5,966.5**	**6,195.3**
Constellation Systems	2,675.9	3,433.2	3,505.4	5,543.3	5,472.0	5,407.6	5,602.6
Advanced Capabilities	623.5	472.3	457.7	533.3	556.5	558.9	592.7
FY 2009 President's Budget Request	**3,143.1**	**3,500.5**	**3,737.7**	**7,048.2**	**7,116.8**	**7,666.8**	**-**
Constellation Systems	2,471.9	3,048.2	3,252.8	6,479.5	6,521.4	7,080.5	-
Advanced Capabilities	671.1	452.3	484.9	568.7	595.5	586.3	-
Total Change from FY2009 President's Budget Request	**156.3**	**405.0**	**225.4**	**-971.6**	**-1,088.3**	**-1,700.3**	

***Following the human spaceflight review, the Administration will provide an updated request for Exploration activities reflecting the review's results.**

In the summer of 2009 NASA will review ongoing Exploration activities as well as alternatives to ensure the Nation is pursuing the best technical solution for future human spaceflight – one that is safe, innovative, and affordable. The review will develop suitable options for U.S. human space flight activities beyond retirement of the Space Shuttle in 2010, leading to a plan that will be presented to Congress regarding the core transportation elements and related aspects of a U.S.-led human space flight architecture that would support both crew transportation and rescue missions to the International Space Station and missions to the Moon and other destinations beyond low Earth orbit.

The review will be led by an independent, blue-ribbon team of experts, drawing extensively on resources and personnel from NASA. The review will consider architectures that are capable of supporting the two broad mission areas described above and incorporate both government and/or commercial elements. It will examine the appropriate amount of R&D and complementary robotic activities necessary to make human space flight activities affordable and productive over the long term, as well as appropriate opportunities for international participation. It will also evaluate what capabilities would be enabled by the potential architectures under consideration and will assess the implications of operating the International Space Station past 2016. The detailed FY 2010 and outyear funding levels for individual exploration activities presented in this document are placeholders. Following conclusion of the review, the Administration will provide an updated request for exploration that reflects the outcome of the review.

The Constellation Program is working to complete the formulation phase of its projects – in particular Ares I, Orion, and major ground facilities. Development work is underway, contracts are in place, and civil servants and contractors are working hard to accomplish Constellation

Program objectives. The Ares I-X test flight, planned for 2009, will lay the groundwork for maturing the Ares I final design prior to its Critical Design Review (CDR). When launched later this year from NASA's Kennedy Space Center in Florida, the Ares I-X will climb about 25 miles in a two-minute powered test of first stage performance, as well as the separation and parachute recovery system. Work on the Orion project also continues to advance. Later this year, Orion's PA-1 test will take place at White Sands Missile Range, New Mexico. PA-1 will demonstrate the Launch Abort System's ability to carry crew to safety should there be an emergency while the Orion and Ares I stack is on the launch pad.

As part of the Commercial Crew and Cargo Program and its associated Commercial Orbital Transportation Services (COTS) projects, NASA is investing in two funded COTS partners, Space Exploration Technologies Corporation (SpaceX) of El Segundo, California, and Orbital Sciences Corporation of Dulles, Virginia. Recently, SpaceX successfully operated the full complement of the first stage engines of the Falcon 9, the SpaceX launch vehicle. Orbital continues to progress in achieving engineering milestones, and will enter PDR in May. In addition, NASA has two non-funded COTS partners. In FY 2009, an additional $150 million in Recovery Act funds has been committed to begin the development of commercial crew launch capabilities.

The transition of NASA facilities, infrastructure, property, processes and personnel from the Space Shuttle Program to the Constellation Program continues to be a major activity. This joint effort between the Space Operations and Exploration Systems Mission Directorates is focused on leveraging existing Shuttle and Space Station assets for NASA's future Exploration activities.

NASA's Advanced Capabilities activity in the Human Research Program (HRP) and the Exploration Technology Development Program (ETDP) continues to reduce risk for human explorers of the Moon and beyond by conducting research and developing new technologies to aid future explorers. The Lunar Precursor Robotic Program will launch the Lunar Reconnaissance Orbiter (LRO) and the Lunar Crater Observing and Sensing Satellite (LCROSS). LRO will map and image the lunar surface and LCROSS will attempt to identify water in a permanently shadowed crater.

Space Operations

The President's FY 2010 budget funds the safe flight of the Space Shuttle to complete the ISS, and then retire the Shuttle. NASA is committed to completing the nine remaining scheduled shuttle flights, which we believe can be accomplished by the end of 2010. NASA's request for Space Operations is $6.2 billion in FY 2010, an increase of $0.4 billion from FY 2009 enacted.

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**5,427.2**	**5,764.7**	**6,175.6**	**3,663.8**	**3,485.3**	**3,318.6**	**3,154.8**
Space Shuttle	3,295.4	2,981.7	3,157.1	382.8	87.8		
International Space Station	1,685.5	2,060.2	2,267.0	2,548.2	2,651.6	2,568.9	2,405.9
Space and Flight Support (SFS)	446.2	722.8	751.5	732.7	745.9	749.7	748.9
FY 2009 President's Budget Request	**5,526.2**	**5,774.7**	**5,872.8**	**2,900.1**	**3,089.9**	**2,788.5**	**-**
Space Shuttle	3,266.7	2,981.7	2,983.7	95.7			-
International Space Station	1,813.2	2,060.2	2,277.0	2,176.4	2,448.2	2,143.1	-
Space and Flight Support (SFS)	446.3	732.8	612.1	628.0	641.7	645.4	-
Total Change from FY2009 President's Budget Request	**-99.0**	**-10.0**	**302.8**	**763.7**	**395.4**	**530.1**	

NASA and its Russian, Japanese, European, and Canadian ISS partners are working together to realize one of the most inspiring dreams of the last 50 years: the establishment of a station in Earth orbit for the conduct of various types of research. The recent delivery of the Station's final set of solar arrays and other equipment by the crew of STS-119 represents a key step toward this goal. Two significant milestones are now approaching. In May, the ISS will host its first six-person crew. In June, the STS-127 mission will deliver the third and final component of the Japanese *Kibo* laboratory. The addition of *Kibo's* Exposed Facility will join the European *Columbus* module and the U.S. *Destiny* module to complete the three major international science labs on ISS, setting the stage for utilization of ISS as a highly capable microgravity research facility.

The ISS is an unparalleled international cooperative effort and provides a U.S. National Laboratory in orbit. Scientists will be able to conduct biomedical and engineering research from a unique vantage point. Some of the work will increase our knowledge of the effects of long-duration human space flight, which is critical for the design and operation of future human space vehicles, including those being developed under the Constellation Program to return U.S. astronauts to the Moon and explore other destinations. Other research will not be focused on space exploration, but may have significant applications right here on Earth. Medical research, for example, may be applicable to the development of vaccines; NASA's research aboard the Space Shuttle and ISS into salmonella has already increased our knowledge in this area. In the key areas of energy and the environment, the ISS serves as a daily demonstration of "green" technologies and environmental management techniques. The ISS receives 120kW of power from its solar arrays to operate the Station and run experiments. The ISS environmental system is designed to minimize the amount of mass that has to be launched from Earth to support the Station, so recycling is a must. STS-119 supplied ISS with a replacement Distillation Assembly for Station's water recycling system, which is key for supporting a full six-person crew for extended periods of time. Given the central role science and technology play in our society, it is important that the United States maintain a leadership role in these fields. The availability of a research laboratory in the microgravity environment of space will support this aim.

NASA is relying on U.S. industry to develop vehicles to deliver supplies and experiments to the ISS. In December 2008, the Agency awarded two Commercial Resupply Services (CRS) contracts for the provision of this critical capability. Cargo resupply is important for the continued viability and utilization of ISS. In addition, the vendors involved will gain valuable experience in the development and operation of vehicles that can (1) fly to the ISS orbit; (2) operate in close proximity to the ISS and other docked vehicles; (3) dock to ISS; and, (4) remain docked for extended periods of time.

Another important benefit from Space Shuttle missions and ISS research are ultimately reflected in the programs' ability to inspire the next generation of Americans. This was reflected recently in the delighted faces of students who participated in the uplinked phone call between President Obama and the crews of the ISS and STS-119 on March 24. The ISS will support the President's goal of making math and science education a national priority by demonstrating what can be accomplished through science and engineering, and by inspiring both teachers and students.

Space Communications provides the enabling communications services to NASA's human and robotic flight missions and addresses future sustainment/upgrade requirements for all the Agency's communications networks. Launch Services provides safe, reliable, cost-effective, and on-time launch services for NASA and NASA-sponsored payloads using expendable launch vehicles. The Rocket Propulsion Test Program reviews, approves and provides direction on rocket propulsion test assignments. Crew Health and Safety provides support to the provision of medical care for the Astronaut Corps and the Human Space Flight Operations provides trained crew members for all NASA human space flight endeavors.

Education

In FY 2010, NASA will continue its successes in developing a future aerospace workforce, improving the technological competitiveness of our Nation's universities, attracting and retaining students in science, technology, engineering and mathematics (STEM) disciplines, and engaging the public in NASA's missions. NASA will accomplish these goals by offering competitive research grants to universities, providing targeted educational support to Minority Serving Institutions (MSIs), and strengthening curricula at two-year community colleges. NASA's plans to streamline and centralize internship and fellowship application processes will realize cost savings and facilitate student access to information while attracting a wider, more diverse participant base. The Agency is also seeking new opportunities for student involvement in current space and aeronautics research missions and flight projects, including those using high altitude balloons, sounding rocket payloads, airborne sensors, and space satellites. NASA will further these efforts through a new project, Innovation in STEM Education, which will allow the Agency to investigate and offer opportunities for student and faculty to participate in NASA-related research. NASA's request for Education is $126 million in FY 2010.

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**146.8**	**169.2**	**126.1**	**123.8**	**123.8**	**123.8**	**125.5**
Education	146.8	169.2	126.1	123.8	123.8	123.8	125.5
FY 2009 President's Budget Request	**146.8**	**115.6**	**126.1**	**123.8**	**123.8**	**123.8**	-
Education	146.8	115.6	126.1	123.8	123.8	123.8	-
Total Change from FY2009 President's Budget Request	**0.0**	**53.6**	**0.0**	**0.0**	**0.0**	**0.0**	

NASA will further pursue a goal to attract and retain students in STEM disciplines in the upcoming fiscal year. Last year, the Interdisciplinary National Science Program Incorporating Research & Education (INSPIRE) program engaged over 200 high schools in STEM areas, and NASA Explorer Schools conducted instructional and enrichment activities that reached over 105,000 students. The March 2009 STS-119 mission also provided a unique educational opportunity as two Mission Specialists who are science teachers, Joe Acaba and Richard Arnold, were part of the crew. NASA Education continues to provide internships, fellowships, and research opportunities to help students and educators gain hands-on experiences in a range of STEM-related areas. These opportunities provide students with the motivation, inspiration, and experience needed to serve the Nation's current and future workforce needs. In FY 2008, the Agency provided more than 3,000 summer internships, reached 5,331 students through significant research experience or grants, and provided 139 grants to underrepresented and underserved institutions.

NASA will also engage elementary and secondary school and informal education audiences by using Earth and deep space observations, the flight experience of Educator Astronaut Dorothy Metcalf-Lindenburger aboard STS-131, as well as future missions to the Moon and other destinations. New technologies such as social networks, Internet collaborations, a new virtual magnet school, and remote control of science instruments will expand and enhance these efforts. In FY 2010, NASA also plans to provide an online professional development system for students training to become educators, in-service teachers, and informal educators. Additionally, NASA will promote continuous public awareness of its mission and improvement to STEM literacy by partnering with informal education providers, which allows Agency partners to share the excitement of NASA missions with their visitors in meaningful ways.

Cross-Agency Support

NASA Cross-Agency Support provides critical mission support activities that are necessary to ensure the efficient and effective operation and administration of the Agency but cannot be directly aligned to a specific program or project requirement. These important functions align and sustain institutional and program capabilities to support NASA missions by leveraging resources to meet mission needs, establishing Agency-wide capabilities, and providing institutional checks and balances. Cross-Agency Support includes Center Management and Operations, Institutional Investments, and Agency Management and Operations. NASA's request for Cross-Agency Support is $3.4 billion in FY 2010.

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**3,251.4**	**3,356.4**	**3,400.6**	**3,468.4**	**3,525.7**	**3,561.4**	**3,621.4**
Center Management and Ops	2,011.7	2,024.0	2,084.0	2,119.2	2,142.5	2,166.1	2,189.9
Agency Management and Ops	834.1	921.2	961.2	956.9	964.5	972.3	981.5
Institutional Investments	325.5	343.7	355.4	392.3	418.7	423.0	450.0
Congressionally Directed Items	80.0	67.5					
FY 2009 President's Budget Request	**3,242.9**	**3,299.9**	**3,323.9**	**3,363.7**	**3,436.1**	**3,511.3**	**-**
Center Management and Ops	2,013.0	2,045.6	2,046.7	2,088.0	2,155.3	2,211.6	-
Agency Management and Ops	830.2	945.6	945.5	939.8	950.5	961.3	-
Institutional Investments	319.7	308.7	331.7	335.9	330.4	338.3	-
Congressionally Directed Items	80.0						-
Total Change from FY2009 President's Budget Request	**8.5**	**56.5**	**76.7**	**104.7**	**89.6**	**50.1**	

Center Management and Operations funds the ongoing management, operations, and maintenance of nine NASA Centers and major component facilities. NASA Centers continue to provide high-quality support and the technical talent for the execution of programs and projects.

Institutional Investments funds design and execution of non-programmatic revitalization construction of facilities projects, demolition projects for closed facilities, and environmental compliance and restoration activities. The Construction of Facilities Program makes capital repairs and improvements to NASA's critical infrastructure to improve safety and security and improve NASA's operating efficiency by reducing utility usage. NASA continues to right size the infrastructure by demolishing facilities that are no longer needed. Emphasis has been placed on energy and water conservation. NASA currently has 5 buildings certified under the Leadership in Energy and Environmental Design (LEED) criteria, 3 additional buildings that are built and awaiting certification as LEED Silver facilities, and 13 buildings in various stages of design and construction as High Performance Buildings expected to be LEED-certified when completed.

Agency Management and Operations funds the management and oversight of Agency missions, programs, and functions, and performance of NASA-wide activities, through the following five programs:

- Agency Management supports executive-based, Agency-level functional and administrative management requirements. Agency Management provides for the operational costs of

Headquarters as an installation; funding and management of Agency-wide institutional and statutory requirements for centralized Agency functions; assessment and evaluation of NASA program and mission performance; strategic planning; and independent technical assessments of Agency programs.

- Safety and Mission Success funds activities required to strengthen and enable the fundamental and robust cross-checks applied on the execution of NASA's mission, and to improve the likelihood for safety and mission success for NASA's programs, projects, and operations. The engineering, safety and mission assurance, health and medical independent oversight, and technical authority components are essential to NASA's success and were established in direct response to the Challenger and Columbia shuttle accident board recommendations for independent funding of these efforts. Included under Safety and Mission Assurance is the Independent Verification and Validation program.

- Agency Information Technology Services funds cross-cutting services and initiatives in IT management, applications, and infrastructure necessary to enable the NASA Mission and improve security, integration and efficiency of Agency operations. NASA plans significant emphasis on implementation of five Agency-wide procurements to achieve the following: (1) consolidation of IT networks to improve network management, (2) consolidation of desktop/laptop computer services and mobile devices to improve end-user services, (3) data center consolidation to provide more cost-effective services, (4) Agency public web site management to improve access to NASA data and information by the public, and (5) Agency business systems development and maintenance to provide more efficient and effective business systems. NASA will also continue to improve security incident detection, response, and management through the Security Operations Center.

- The Innovative Partnerships Program (IPP) funds leveraged technology investments, dual-use technology-related partnerships, and technology solutions for NASA. IPP implements NASA's Small Business Innovation Research and Small Business Technology Transfer Programs which seek out high-technology small businesses to address key technology needs for NASA, and facilitates the protection of NASA’s rights in its inventions and the transfer of that technology for commercial application and public benefit. IPP is establishing a new Innovative Technology Project that is intended to identify and competitively select low-maturity basic research projects that can enable new and more capable missions in the future. IPP manages a Seed Fund to address technology needs through cost-shared, joint-development partnerships and the Centennial Challenges Program to stimulate innovation and competition in space operations, exploration and aeronautics technologies of value to NASA and the nation through prize contests. Centennial Challenge competitions have spurred the creation of new businesses and products, including innovations in pressure suit gloves and reusable rocket engines. IPP also transfers NASA technology to industry for public benefit; in 2008, 50 new examples of transfer of NASA innovation to the commercial market place were publicized in areas such as health and medicine, transportation, public safety, consumer goods, homes and recreation, environmental and agricultural resources, computer technology, and industrial productivity.

- The Strategic Capabilities Assets Program (SCAP) funds the costs required to sustain key Agency test capabilities and assets, such as an array of flight simulators, thermal vacuum chambers, and arc jets, to ensure mission success. SCAP ensures that assets and capabilities deemed vital to NASA's current and future success are sustained in order to serve Agency and national needs. All assets and capabilities identified for sustainment either have validated mission requirements or have been identified as potentially required for future missions.

Inspector General

The OIG Office of Audits (OA) conducts independent, objective audits and reviews of NASA and NASA contractor programs and projects to improve NASA operations, as well as a broad range of professional audit and advisory services. It also comments on NASA policies and is responsible for the oversight of audits performed under contract. OA helps NASA accomplish its objectives by bringing a systematic, disciplined approach to evaluate and improve the economy, efficiency, and effectiveness of NASA operations.

The OIG Office of Investigations (OI) identifies, investigates, and refers for prosecution cases of crime, waste, fraud, and abuse in NASA programs and operations. The OIG's federal law enforcement officers investigate false claims, false statements, conspiracy, theft, computer crimes, mail fraud, and violations of federal laws, such as the Procurement Integrity Act and the Anti-Kickback Act. Through its investigations, OI also seeks to prevent and deter crime at NASA. NASA’s request for Inspector General is $36.4 million in FY 2010.

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**32.6**	**35.6**	**36.4**	**37.0**	**37.8**	**38.7**	**39.6**
Inspector General	32.6	35.6	36.4	37.0	37.8	38.7	39.6
FY 2009 President's Budget Request	**32.6**	**35.5**	**36.4**	**37.3**	**38.3**	**39.2**	-
Inspector General	32.6	35.5	36.4	37.3	38.3	39.2	-
Total Change from FY2009 President's Budget Request	**0.0**	**0.1**	**0.0**	**-0.3**	**-0.5**	**-0.5**	-

Mission Directorate: Science

Overview

NASA leads the nation on a great journey of discovery, asking profound questions that touch us all:

- What are the origin and destiny of the universe?
- How did the galaxies, stars, and planetary bodies form and evolve?
- How is our planet changing, and what are the consequences?
- How did life originate and evolve?
- Are we alone?

NASA performs scientific exploration enabled by space observatories and space probes, viewing the Earth from space, visiting the Moon and other bodies in the solar system, returning samples from them, and looking out into our Galaxy and beyond.

From space, we can view the Earth as a planet and study it as a complex, interacting dynamic system with diverse components: the oceans, atmosphere, continents, ice sheets, and life itself. We observe and track global-scale changes, and we study regional changes in their global context. We observe the role that human civilization increasingly plays as a force of change. Through partnerships with other agencies that maintain forecast and decision support systems, we improve national capabilities to predict climate, weather, and natural hazards, to manage resources, and to support the development of environmental policy. These activities and other NASA research on our home planet are an essential part of national and international efforts to employ Earth observations and scientific understanding in service to society.

We extend humankind's virtual presence throughout the Solar System via robotic space probes to other planets and their moons, to asteroids and comets, and to icy bodies of the outer solar system. We are completing humankind's first basic reconnaissance of the Solar System by sending one mission to fly by Pluto and another that will visit two world-sized asteroids, Ceres and Vesta. We are in the midst of a large-scale investigation of Mars, launching a series of ever more capable orbiters, landers, and rovers. And we are directing our attention to certain moons of the giant planets where we see intriguing signs of surface activity and of liquid water within, knowing that on Earth, where there is water and an energy source there is also life.

Our solar system is very much governed by the Sun, a main-sequence star midway through its stellar life. Through the eyes of multiple spacecraft, we see the solar system as a "heliosphere," an interconnected system with diverse components. At the center of the heliosphere, solar radiation controls the climate and sustains the biosphere of Earth, causes modifications to the ozone layer, and has effects on radio and radar transmissions, electrical power grids, and spacecraft electronics. We seek to understand how and why the Sun varies, how planetary systems respond, and how human activities are affected. As human presence expands beyond the confines of Earth, this science will enable the space weather predictions necessary to safeguard the outward journeys of human and robotic explorers.

Some of the greatest minds of the last century discovered wondrous things about our astrophysical universe -- the Big Bang and black holes, dark matter and dark energy, and the interrelated nature of space and time. Their theories challenge NASA to use observations from space to test the limits of our understanding. Having measured the age of the universe, we now seek to explore its ultimate extremes -- its birth, the edges of space and time near black holes, and the dark energy filling the entire universe. We seek to understand the relationship between the smallest of subatomic particles and the vast expanse of the cosmos. And having discovered hundreds of planets around other stars, humankind now seeks to find Earth-like planets and understand the diversity of planetary systems.

This is NASA's science vision: to achieve a deep scientific understanding of our planet, other planets and solar system bodies, our star system in its entirety, and the universe beyond.

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**4,733.2**	**4,903.0**	**4,477.2**	**4,747.4**	**4,890.9**	**5,069.0**	**5,185.4**
Earth Science	1,237.4	1,704.6	1,405.0	1,500.0	1,550.0	1,600.0	1,650.0
Planetary Science	1,312.6	1,325.6	1,346.2	1,500.6	1,577.7	1,600.0	1,633.2
Astrophysics	1,395.6	1,281.2	1,120.9	1,074.1	1,042.7	1,126.3	1,139.6
Heliophysics	787.6	591.6	605.0	672.6	720.5	742.7	762.6
FY 2009 President's Budget Request	**4,706.2**	**4,441.5**	**4,482.0**	**4,534.9**	**4,643.4**	**4,761.6**	**--**
Earth Science	1,280.3	1,367.5	1,350.7	1,250.9	1,264.4	1,290.3	--
Planetary Science	1,247.5	1,334.2	1,410.1	1,537.5	1,570.0	1,608.7	--
Astrophysics	1,337.5	1,162.5	1,122.4	1,057.1	1,067.7	1,116.0	--
Heliophysics	840.9	577.3	598.9	689.4	741.2	746.6	--
Total Change from FY 2009 President's Budget Request	**27.0**	**461.5**	**-4.8**	**212.5**	**247.5**	**307.4**	**--**

Note: In all budget tables, the FY 2010 President's Budget Request depicts the September 2008 Operating Plan for the 2008 Actuals and the 2009 Omnibus Appropriations Act (P.L. 111-8) and the American Recovery and Reinvestment Act (P.L. 111-5) for the 2009 enacted. Starting in FY 10, the NEOO project moves from Earth Science to the Planetary Science theme and Astro-H moves from Heliophysics to the Astrophysic theme.

Plans for FY 2010

Science

Earth Science

New Initiatives:

Consistent with the American Recovery and Act of 2009, the FY 2010 Budget request for Earth Science (and its FY 2011-14 runout) reflects a significant commitment to Earth Science on the part of the new Administration. In total, projected Earth Science funding from FY 2009-2013 is increased by approximately $1.2 billion, allowing significant progress towards the goals of identified in the National Research Council's 2007 Decadal Survey report, "Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond", as detailed below.

Major Changes:

The Decadal Survey Tier-1 Soil Moisture Active-Passive (SMAP) and Ice, Cloud and Land Elevation Satellite 2 (ICESat-2) missions have been accelerated to the maximum extent possible, and are planned for launch in late 2013/early 2014 and late 2014/early 2015, respectively.

NASA is initiating a new series of competed "Venture-class" missions. These missions, which may include suborbital payloads, instruments to be flown on non-NASA spacecraft, or small dedicated spacecraft, will be selected via an Announcement of Opportunity. Selection of the first Venture-class mission(s) is planned for FY 2010.

The budget for LDCM, planned for launch in December 2012, now includes the cost of a thermal infrared instrument, consistent with Congressional direction in the FY09 appropriation.

NASA has already begun a new Airborne Science campaign, called IceBridge, to "bridge the gap" between ICESat I and ICESat II data. This activity, focusing on changes in Greenland and arctic ice, will continue in FY 2010 and beyond.

For the first time, all Science missions in development are conservatively budgeted at the "70%" confidence level. Hopefully, this will minimize future overruns and disruptions of the portfolio.

Major Highlights for FY 2010

Besides the acceleration of SMAP and ICESat-2, the other Tier-1 missions -- Deformation, Ecosystem Structure, and Dynamics of Ice (DESDynI) and Climate Absolute Radiance and Refractivity Observatory (CLARREO) -- are preparing to enter formulation phase, towards planned launches in the middle of the next decade. Detailed mission studies and science community workshops for all five Tier-2 missions will prepare them to follow the Tier-1 missions.

NASA will continue to implement five precursor Earth Science missions, Glory, Aquarius, NPOESS Preparatory Project (NPP), Landsat Data Continuity Mapper (LDCM), and Global Precipitation Measurement (GPM) for launch between 2009 and 2014.

The budget will fund operations of approximately 15 on-orbit Earth Science missions in FY2010, while maintaining robust Research and Analysis, Applied Sciences, and Technology Development programs.

NASA is determining how best to meet the lost science contribution after the Orbiting Carbon Observatory (OCO) launch vehicle failure. We have initiated studies to examine both science and hardware considerations. The science study is assessing the current state of carbon cycle science and existing measurements to see what course of action would best address the key science issues. On the hardware side, NASA is examining reflight opportunities, including, but not limited to, flying an OCO-like instrument on a shared platform or as a dedicated mission.

Planetary Science

New Initiatives:

None

Major Changes:

The FY 2010 Budget proposal for Planetary Science includes more conservative estimates for many projects, reflecting a balanced portfolio that fits more realistically within budget constraints. For instance, the Juno mission to Jupiter, and the Gravity Recovery and Interior Laboratory (GRAIL) mission to the Moon, have entered development phase, and consistent with NASA policy, their budgets now reflect independent cost estimates at the 70% confidence level.

Previous cost estimates for the major Outer Planet Flagship (OPF) and Mars Sample Return (MSR) missions have been determined to be unrealistic. Studies of potential future OPF missions will continue, but the start of OPF development will be delayed by several years. We have re-established a balanced Mars exploration program, with a launch at every opportunity (about every 26 months) after 2011; launch of MSR is no longer expected until well after 2020.

Since the release of the FY2009 Budget request, NASA selected the Mars Atmosphere and Volatile EvolutioN (MAVEN) Mars Scout mission, for launch in 2013. The launch of Mars Science Laboratory (MSL) was delayed until late 2011.

A new Lunar Quest program has been established, incorporating activities previously funded under the Planetary Science Research program. Funding for Near Earth Object Observations (NEOO) has been transferred from Earth Science, and is now part of Planetary Science Research.

Major Highlights for FY 2010

Announcements of Opportunity for new missions in the Discovery and New Frontiers programs are planned during FY2009 and early FY2010 respectively, with concept study selections in FY2010. The selected Discovery mission may launch as early as 2014, and the selected New Frontiers mission may launch as early as 2018. Planning will begin for a Mars 2016 mission, with the potential for a cooperative mission with the European Space Agency's (ESA) ExoMars mission.

NASA will continue to implement six Planetary Science missions in development or formulation: MSL, Juno, the Gravity Recovery and Interior Laboratory (GRAIL), the Lunar Atmosphere and Dust Environment Explorer (LADEE), MAVEN, and the first two U.S. landers in the International Lunar Network (ILN).

The budget will fund operations of approximately 13 ongoing Planetary Science missions in FY2010, while maintaining robust Research and Analysis and Technology programs.

Astrophysics

New Initiatives:

None

Major Changes:

In June 2008, NASA selected the High Resolution Soft X-ray Spectrometer (SXS) instrument as an Explorer Mission of Opportunity, and is scheduled to fly on the Japanese Astro-H mission in 2013.

The James Webb Space Telescope (JWST) has entered development phase, and consistent with the new NASA policy, the JWST budget now reflects independent cost estimates at the 70% confidence level.

For the first time, all Science missions in development are conservatively budgeted at the "70%" confidence level. Hopefully, this will minimize future overruns and disruptions of the portfolio.

Major Highlights for FY 2010

The Herschel, Planck, and Kepler missions are expected to be in their first full year of operations, following launch in FY09. The Wide-field Infrared Spectroscopic Explorer (WISE) mission is scheduled for launch in early FY2010. NASA will continue to support seven other Astrophysics missions in development or formulation: JWST, Nuclear Spectroscopic Telescope Array (NuSTAR), SXS, Stratospheric Observatory for Infrared Astronomy (SOFIA), JDEM, the International X-ray Observatory (IXO/Constellation-X), and the Laser Interferometer Space Antenna (LISA).

The budget will fund operations of approximately eight ongoing Astrophysics missions in FY2010, including Fermi, HST, Spitzer Space Telescope, Chandra X-ray Observatory, Swift, Suzaku, Galaxy Evolution Explorer, and Wilkinson Microwave Anisotropy Probe. Early science flights of SOFIA will begin. The budget also maintains robust Research and Analysis and Scientific Balloon programs.

Heliophysics

New Initiatives:

None

Major Changes:

In May 2008, NASA selected six candidate Small Explorer (SMEX) mission proposals for further evaluation. Final selection of up to two missions for development and launch is expected in 2009.

In June 2008, NASA selected the Global-scale Observations of the Limb and Disk (GOLD) instrument, for additional study as a potential Explorer Mission of Opportunity, to be flown on a future commercial satellite. If approved for development and launch, GOLD would help determine how the Earth's outer atmosphere responds to external forces.

NASA selected the Balloon Array for Radiation-belt Relativistic Electron Losses (BARREL) as a new Living With a Star Mission of Opportunity. BARREL seeks to measure the precipitation of relativistic electrons from the radiation belts using multi-balloon campaigns, starting in FY 2012.

For the first time, all Science missions in development are conservatively budgeted at the "70%" confidence level. Hopefully, this will minimize future overruns and disruptions of the portfolio.

The Radiation Belt Storm Probes (RBSP) mission completed preliminary design, and has entered development. Consistent with NASA policy, the RBSP budget reflects independent cost estimates at the 70% confidence level.

Incorporating more conservative budget estimates for RBSP and other missions does not leave sufficient funding to support a Solar Probe mission in 2015; the mission is now scheduled for 2018, which is the next desirable launch window.

Major Highlights for FY 2010

The Solar Dynamics Observatory is expected to launch in October/November of 2009.

NASA will continue to support the RBSP and Magnetospheric Multiscale (MMS) missions, for launch in 2012 and 2014 respectively.

The budget will fund operation and data analysis of approximately 16 ongoing Heliophysics missions in FY2010, while maintaining robust Research and Analysis and Sounding Rocket operations programs.

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Mission Directorate:	Science
Theme:	Earth Science

Theme Overview

NASA's Earth Science Theme supports breakthrough research to advance fundamental knowledge on the most important scientific questions on the global and regional integrated Earth system. NASA's activities encompass the global atmosphere; the global oceans including sea ice; land surfaces including snow and ice; ecosystems; and interactions between the atmosphere, oceans, land, and ecosystems, including humans. NASA's goal is to understand the Earth system and the changing climate and, in association with national and international partners, apply this understanding for the well-being of society. A key strategic element is sustained simultaneous observations to unravel the complexity of the global integrated Earth system.

NASA accomplishes its goals through continuous interactions among its four major elements: Flight Programs develops satellite missions; Research and Analysis redeems the investment in measurements by advancing scientific understanding, while also identifying the foci for the next generation of missions; Technology develops new technology and enables the next generation of effective satellite and airborne instruments; and, Applied Sciences advances the rapid and effective use of ESD measurements and scientific understanding by other Federal, state, local and tribal organizations.

NASA operates fifteen satellite missions that make well-calibrated global observations with high-spatial and high-temporal resolution. NASA aircraft- and surface-based instruments calibrate, complement, and enhance interpretation of satellite measurements. NASA supports state-of-the-art computing capability and capacity for global integrated Earth system modeling. NASA missions produce nearly 4 terabytes of data every day, and NASA maintains the world's largest scientific data and information system for collecting, processing, archiving, and distributing Earth system data to worldwide users.

NASA has five missions in formulation and development. Two Decadal Survey missions have preliminary launch readiness dates of late 2013/early 2014 and late 2014/early 2015, and other Decadal Survey missions are in pre-formulation studies.

Seven in-orbit satellite missions provide data in near-real time to the National Oceanic and Atmospheric Administration for operational forecasts of weather, hurricanes, air quality, and harmful algal blooms. Ten of the in-orbit missions are conducted with fourteen international partners

Mission Directorate:	Science
Theme:	Earth Science

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**1,237.4**	**1,704.6**	**1,405.0**	**1,500.0**	**1,550.0**	**1,600.0**	**1,650.0**
Earth Science Research	358.3	437.4	397.5	407.5	404.2	416.8	412.1
Earth Systematic Missions	546.1	898.9	715.5	725.4	786.4	818.8	867.6
Earth System Science Pathfinder	106.8	118.3	63.9	128.8	114.2	121.4	119.1
Earth Science Multi-Mission Operations	143.0	148.1	149.9	160.3	165.4	161.3	165.5
Earth Science Technology	43.0	54.1	45.9	47.2	48.2	49.5	52.7
Applied Sciences	40.2	47.8	32.2	30.7	31.5	32.2	33.1
FY 2009 President's Budget Request	**1,280.3**	**1,367.5**	**1,350.7**	**1,250.9**	**1,264.4**	**1,290.3**	**--**
Earth Science Research	375.8	380.6	388.2	390.6	400.7	409.3	--
Earth Systematic Missions	530.1	677.9	661.5	583.2	563.6	569.6	--
Earth System Science Pathfinder	113.8	88.6	58.8	37.4	50.0	54.9	--
Earth Science Multi-Mission Operations	167.8	140.5	159.1	157.9	166.5	170.9	--
Earth Science Technology	47.3	46.1	49.2	50.6	51.6	52.8	--
Applied Sciences	45.4	33.8	33.8	31.3	32.1	32.8	--
Total Change from FY 2009 Request	**-42.9**	**337.0**	**54.3**	**249.1**	**285.6**	**309.7**	**--**

Note: Includes $325M of Recovery Act funding in FY09. Starting in FY 10, the NEOO project is in the Planetary theme.

Plans for FY 2010

Earth Science Research

As a result of the funding provided by the American Recovery and Reinvestment Act of 2009, and a significant commitment by the new Administration to Earth Science in FY2010-14, NASA has already begun a new Airborne Science campaign, called IceBridge, to "bridge the gap" between ICESat I and ICESat II data. This activity, focusing on changes in Greenland and arctic ice, will continue in FY 2010 and beyond.

The Science Mission Directorate will issue Research Opportunities in Space and Earth Science 2009 (ROSES-09), a research announcement covering all of the planned research solicitations in Earth Science Research for FY 2009; the FY 2010 budget will fund the competitively selected activities. Roughly a third of the Earth Science Research budget is competed each year through ROSES. The resulting grants are generally funded for three years following the selections. Given the average of a three-year funding cycle, many of the research activities carried out in FY 2010 will be tasks initiated in FY 2008 and FY 2009 based on solicitations included in ROSES-07 and ROSES-08, respectively. Selections based on ROSES 08 solicitations are on-going and are addressing a number of Earth Science research areas, including ocean circulation, the effect of decreasing sea ice cover on climate, energy and water cycle, arctic research of the composition of the troposphere, geodetic imaging, global modeling of the Earth System, hurricane science and biodiversity (first-ever NASA research solicitation). In addition the Research Program develops and tests experimental techniques and algorithms that contribute to future Decadal Survey missions.

Earth Systematic Missions

As a result of the funding provided by the American Recovery and Reinvestment Act of 2009, and a significant commitment by the new Administration to Earth Science in FY 2010-14, significant progress can be made towards the goals identified in the National Research Council (NRC) 2007 report, "Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond". The Soil Moisture Active-Passive (SMAP) and Ice, Cloud, and Land Elevation Satellite (ICESat II) missions will be pursued aggressively, leading to projected launches in late 2013/early 2014 and late 2014/ early 2015 respectively. Studies of the next two Decadal Survey missions, the Climate Absolute Radiance and Refractivity Observatory (CLARREO) and the Deformation, Ecosystem Structure, and Dynamics of Ice (DESDynI), will also intensify.

NASA has also begun development of the Thermal Infrared Sensor (TIRS) instrument, which is now fully funded within the LDCM Project.

The following other activities will be undertaken in FY 2010:

- GPM will complete its Preliminary Design Review followed by Confirmation Review and KDP-C,
- NPP will complete its satellite pre-environmental review,
- Glory will have its Launch Readiness Review, followed by the launch of the spacecraft, and
- LDCM will complete its instrument Critical Design Review and Mission Critical Design Review.

All operating missions will be a part of the 2009 Senior Review, to determine whether extended operations are warranted.

Plans for FY 2010

Earth System Science Pathfinder

Aquarius/SAC-D observatory will have completion of environmental testing, Operational Readiness Review and mission launch. All operating missions will be reviewed during the 2009 Senior Review process to determine whether extended operations are warranted.

NASA is determining how best to meet the lost science contribution after the Orbiting Carbon Observatory (OCO) launch vehicle failure. We have initiated studies to examine both science and hardware considerations. The science study is assessing the current state of carbon cycle science and existing measurements to see what course of action would best address the key science issues. On the hardware side, NASA is examining reflight opportunities, including, but not limited to, flying an OCO-like instrument on a shared platform or as a dedicated mission.

In response to the NRC report, NASA is initiating a new series of competed "Venture-class" missions. These missions, which may include suborbital payloads, instruments to be flown on non-NASA spacecraft, or small dedicated spacecraft, will be selected via an Announcement of Opportunity. Selection of the first Venture-class mission(s) is planned for FY 2010.

Earth Science Multi-Mission Operations

The Earth Science Multi-Mission Operations Program will continue the operation of the Earth Observing System Data and Information System (EOSDIS), the Distributed Active Archive Centers (DAACs) and its accompanying functions, as well as Core System Science Data Processing Systems. The maintenance of these systems is important to the collection of data from Earth Science satellites in orbit, as well as to the continuity of Earth Science research efforts.

Step 1 of the 'Evolution of EOSDIS Elements' (EEE) effort, begun in 2006, is essentially complete. Savings and operational benefits from Step 1 are fully appreciated starting in FY 2009 and beyond. Between now and 2015, NASA plans to continue the support of the EEE to enable a service-oriented architecture (SOA), which allows different applications to exchange data with one another.

Five-year Making Earth Science Data Records for Use in Research Environments (MEaSUREs) Projects began work in 2008 to continue NASA support of the development of multi-instrument Earth System Data Records, including Climate Data Records. A new ACCESS solicitation is being readied for NASA's Research Opportunities in Space and Earth Sciences - 2009 (ROSES-2009). These Cooperative Agreements are proving very valuable for keeping research and modeling communities actively involved with the EOSDIS architecture, and informing core infrastructure evolution decisions.

Earth Science Technology

The Earth Science Technology Program (ESTP) will develop new remote-sensing and information systems technologies for infusion into future science missions to enable, or dramatically enhance, measurements and data system capabilities. Planning will start with measurement priorities established by the science community, leading to systematically developed technology requirements and priorities. Studies may be conducted to assess the most effective ways to meet technology performance requirements. Tasks will be awarded through competed solicitations in the three project areas: Instrument Incubator, Advanced Information Systems, and Advanced Technology Initiatives.

Plans for FY 2010

Applied Sciences

The Applied Sciences Program will continue to work across the range of application areas, with special focus on supporting communities as they plan for and respond to the impacts of climate change.

In October 2008, the NASA Applied Sciences Program completed a comparison study of seven Federal programs that incorporate Earth science data into decision making activities for policy and management. The Applied Sciences Program used this study to identify best practices and to benchmark its approaches on strategic planning, implementation, partnership development, and administration. The study concluded that that Applied Sciences Program is "unique with individual drivers, processes, and expectations." The study suggested that longer-term relationships with users provide a source of innovation in applications; that applied research is often needed to make science results more robust for use in applications; and that diversified funding portfolios, multi-disciplinary staffing, and defined project end-points are keys to successful applications. The Applied Sciences Program has incorporated key findings in its FY2009-2014 Program Plan.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

The 2008 NASA Authorization Act and 2006 National Space Policy charged NASA to develop unique capabilities in global Earth observations and models to discover fundamental scientific knowledge of the integrated Earth system. NASA activities contribute substantially to two Presidential Initiatives ' Integrated Global Earth Observations and Ocean Action Plan; three Congressional Initiatives ' National Oceanographic Partnership Program, Global Change Research Act, and Clean Air Act Amendments; and, two United Nations Assessments ' Intergovernmental Panel on Climate Change and Ozone Depletion. NASA is the largest funding contributor to the 13-agency U.S. Climate Change Science Program.

NASA coordinates with the U.S. Geological Survey on the Landsat Data Continuity Mission and with the Department of Defense and National Oceanic and Atmospheric Administration (NOAA) on the National Polar-orbiting Operational Environmental Satellite System. NASA develops, on a reimbursable basis with NOAA, the Geostationary Operational Environmental Satellite and Polar Orbiting Environmental Satellite programs. In FY 2009, NASA and the French space agency declared the Ocean Surface Topography Mission to be operational and transferred satellite command and control operations to NOAA, marking an important milestone in the transition of a research satellite measurement capability to an operational capability.

Relevance to the NASA Mission and Strategic Goals:

Earth Science supports NASA's achievement of Strategic Plan Sub-Goal 3A: "Study Earth from space to advance scientific understanding and meet societal needs."

This effort is comprised of seven Outcomes:
3A.1: Progress in understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition.
3A.2: Progress in enabling improved predictive capability for weather and extreme weather events.
3A.3: Progress in quantifying global land cover change and terrestrial and marine productivity, and in improving carbon cycle and ecosystem models.
3A.4: Progress in quantifying the key reservoirs and fluxes in the global water cycle and in improving models of water cycle change and fresh water availability.
3A.5: Progress in understanding the role of oceans, atmosphere, and ice in the climate system and in improving predictive capability for its future evolution.
3A.6: Progress in characterizing and understanding Earth surface changes and variability of Earth's gravitational and magnetic fields.
3A.7: Progress in expanding and accelerating the realization of societal benefits from Earth system science.

Earth Science researchers seek to answer how and why the global integrated Earth system is changing, how it supports life, how life impacts the Earth system, and how this information will benefit the Nation.

See FY 2010 Performance Plan for specific annual goals.

Relevance to education and public benefits:

Mission Directorate:	Science
Theme:	Earth Science

NASA develops innovative programs to educate and train scientists in understanding the global integrated Earth system and infuse NASA observations and scientific results in the public and all venues of learning. The DEVELOP program (not an acronym) is a national high school and university student-led, student-run internship activity. ESD's Earth System Science Fellowship Program trains graduate students, while the New Investigator Program targets early-career scientists and engineers. NASA Earth Science discoveries are reported almost daily through the world's media to motivate students and young scientists to pursue challenging careers in Earth science and technology.

NASA Earth Science improves public understanding of the complexity of the global integrated Earth system. Guided primarily by the 2007 National Research Council Decadal Survey, NASA is executing an ambitious plan to answer questions regarding why and how the environment is changing, define the impacts of environmental change on humans, and identify how humans can mitigate the impact of environmental hazards. Through its work with other Federal agencies to improve their operational services, NASA Earth Science advances capabilities in such areas as weather and air quality forecasting, climate prediction, and natural hazard and land use assessment.

Performance Achievement Highlights:

- Arctic Ocean Climate. In September 2007, NASA Aqua satellite measurements revealed that Arctic Ocean sea ice coverage was 23% smaller compared to the previous minimum extent in September 2005. One year later in September 2008, the coverage was the second lowest recorded since 1978, when satellite sea ice observations began with NASA's Nimbus-7 satellite. In 2008, NASA-supported researchers explained the complex causes and impacts of rapid summertime Arctic sea ice depletion. NASA ICESat satellite data revealed Arctic sea ice was becoming thinner, making it easier to melt in summer. Over the western Arctic Ocean where most of the increased melt occurred in 2007, the NASA CloudSat satellite showed decreased cloud cover relative to 2006 and the NASA Aqua satellite measured increased incident solar radiation. The NASA SeaWiFS data-buy product showed that reduced summertime sea ice coverage lengthened the growing season for near-surface ocean phytoplankton, which increased the phytoplankton abundance in the Arctic Ocean.

-Global Air Pollution. NASA Aura satellite measurements tracked air pollutants from their generation sites to assess air quality throughout the world. In 2008, NASA researchers announced the first measurement-based estimate of pollution traveling from East Asian forest fires, urban exhaust and industrial production to North America. About 450 million kilograms of small particle (aerosol) pollution reached the northwest coast of Canada and the United States.

-New Technology. NASA's unmanned aerial system Ikhana, equipped with an innovative NASA Autonomous Modular Sensor instrument, transmitted real-time measurements of visible, infrared and thermal imagery directly to firefighting control centers to monitor and predict the trajectory of California's wildfires. The Secretary of the U.S. Department of Homeland Security and the Governor of California recognized NASA's contributions to prevent loss of life and property.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	NASA Advisory Council (NAC)	05/2008	NASA Advisory Council (NAC) - Review science strategy and implementation strategy for the Earth Science programs	05/2009
Relevance	National Research Council	01/2007	National Research Council - Decadal Survey of effectiveness and quality of the Earth Science programs. First time a Decadal Survey was developed for Earth Science.	2016

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Research

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	358.3	437.4	397.5	407.5	404.2	416.8	412.1
Earth Science Research and Analysis	259.4	313.7	281.7	300.3	294.2	304.4	296.5
Computing and Management	98.9	123.7	115.8	107.2	110.0	112.4	115.6
FY 2009 President's Budget Request	372.5	376.9	384.5	386.8	396.8	405.3	--
Earth Science Research and Analysis	269.3	271.9	279.7	279.4	286.7	293.5	--
Computing and Management	103.1	104.9	104.7	107.3	110.1	111.8	--
Changes from FY 2009 Request	-14.2	60.6	13.1	20.8	7.5	11.6	--

Note: Includes $68.5M of Recovery Act funding in FY09

Program Overview

The Earth Science Research Program advances our knowledge of the global distribution of a range of important environmental parameters related to the Earth's atmosphere, hydrosphere, biosphere, cryosphere, and land surface; to understand the processes that drive and connect them; and to improve our capability to predict the future evolution of the Earth system, including climate, weather, and natural hazards.

Earth Science Research funds basic research and modeling efforts, the Airborne Science Project (which conducts research using airplanes and Uninhabited Air Systems), supercomputing efforts that support a variety of agencies, and education and outreach.

For more information, please see http://science.hq.nasa.gov/earth-sun/index.html.

Plans For FY 2010

The research program portfolio is highly diverse in terms of activities sponsored as described for each project in the following section.

As a result of the funding provided by the American Recovery and Reinvestment Act of 2009, and a significant commitment by the new Administration to Earth Science in FY2010-14, NASA has already begun a new Airborne Science campaign, called IceBridge, to "bridge the gap" between ICESat I and ICESat II data. This activity, focusing on changes in Greenland and arctic ice, will continue in FY 2010 and beyond.

The R&A project constitutes the core of the program and accounts for roughly half of the total budget. It is mostly competed via the Science Mission Directorate Research Opportunities in Space and Earth Science 2009 (ROSES-09), a research solicitation released February 2009. Solicited research in 2009 will generally result in grants funded with FY10 funding and two subsequent years, and includes ocean biology and biogeochemistry, terrestrial ecology, physical oceanography, atmospheric composition, and a hurricane field experiment. It will also continue funding research solicited in ROSES-08 and ROSES-07 as they have progressed in their 2nd and 3rd year, respectively. The research portfolio includes the Interdisciplinary Science project, also competed in ROSES-09 with the focus to continue funding research in interdisciplinary areas, such as sea level change, water and energy cycle impacts of biomass burning and integrated earth system responses to extreme disturbances. Other competitive grant projects are the carbon cycle science team (continued from previous selection) and the Earth science education and outreach activity (also in ROSES-09). The remaining activities include primarily directed funding to NASA Centers for space geodesy (funding the development and operation of the geodetic networks), high end computing, scientific computing and global modeling and data assimilation.

Project Descriptions and Explanation of Changes

Earth Science Research and Analysis

The Earth Science Research Program area consists of multiple projects and science teams which support the overall diverse R&A goals:

Research and Analysis Project:
The Earth Science Research and Analysis (R&A) Project is the core of the R&A Program and funds research in all six Earth Science focus areas: 1) Climate variability and change; 2) Atmospheric composition; 3) Carbon cycle, ecosystems, and biogeochemistry; 4) Water and energy cycles; 5) Weather; and 6) Earth surface and interior. Additionally, the R&A Project addresses the Earth system and the interactions of its components, characterizing them on a broad range of spatial and temporal scales to understand the naturally occurring and human-induced processes that drive the overall system.

Airborne Science:
Airborne Science funds NASA's manned airplanes, and Uninhabited Air Systems (UAS) based Earth science efforts. The project supports the operation of a catalog of NASA-owned and leased aircraft, including the ER-2, DC-8, WB-57, P-3, Twin Otter, B-200, Aerosonde, Global Hawk, and other UAS aircraft. These assets are deployed in campaigns conducted around the world to monitor extreme weather events (e.g., hurricanes), capture data for Earth science modeling activities, and calibrate the instruments flying aboard Earth science spacecraft. As mentioned above, and as a result of the funding provided by the American Recovery and Reinvestment Act of 2009, and a significant commitment by the new Administration to Earth Science in FY2010-14, NASA has already begun a new Airborne Science campaign, called IceBridge, to "bridge the gap" between ICESat I and ICESat II data. This activity, focusing on changes in Greenland and arctic ice, will continue in FY 2010 and beyond.

Interdisciplinary Science:
Interdisciplinary Science funds science teams, as well as calibration and validation activities, that ensure the utility of spaceborne measurements. In addition, it supports focused field work (e.g. airborne campaigns) and specific facility instruments, which are heavily relied upon in fieldwork.

Carbon Cycle Science Team:
The Carbon Cycle Science Team conducts research on the distribution and cycling of carbon among the Earth's active land, ocean and atmospheric reservoirs.

Global Modeling and Assimilation Office:
The Global Modeling and Assimilation Office, located at Goddard Space Flight Center, creates global climate and environmental models using data from Earth science satellites and aircraft. These products can then be used by investigators worldwide to further their research.

Ozone Trends Science:
The Ozone Trends Science project has an overall goal of producing a consistent, calibrated ozone time series that can be used for trend analyses and other studies.

Earth Science Research and Analysis (continued)

Education and Outreach Activity:
The Education and Outreach Activity supports NASA educational outcomes and communicates the results from Earth science missions and research through competitively selected projects. It also continues the worldwide implementation and U.S. coordination of the Global Learning and Observations to Benefit the Environment (GLOBE) Program, in partnership with the National Science Foundation.

Fellowships and New Investigators:
The Fellowships and New Investigators project supports graduate and early-career research, respectively, that is relevant of Earth system research and applied science.

Space Geodesy:
The Space Geodesy Project provides global geodetic positioning and supports the establishment of the needed geodetic reference frames in support of climate change and geohazards research and applications and their associated missions.

Computing and Management

The Computing and Management area consists of three projects:

High-End Computing Capability (HECC):
The High-End Computing Capability (HECC) project at Ames Research Center is focused around the Columbia supercomputer and the associated network connectivity, data storage, data analysis and visualization, and application software support. The Science Mission Directorate currently funds and manages the HECC resources, which serves the supercomputing needs of all NASA Mission Directorates as well as principle investigators at universities. Science Mission Directorate funding supports the operation, maintenance, and upgrade of NASA's supercomputing capability, while the Strategic Capabilities Assets Program exercises the oversight and insight functions. In 2008, a new approximately 40,000 processors supercomputer system "Pleiades" was acquired. The new system,currently ranked the world's third fastest supercomputer, supports NASA's aeronautics, exploration, space operation and science missions.

Scientific Computing:
Scientific Computing funds NASA's Earth Science "Discover" computing system, software engineering, and user interface projects at Goddard Space Flight Center. The Scientific Computing Project's primary purpose is to support Earth science modeling activities based on data collected by Earth science spacecraft.

Directorate Support:
The Directorate Support Project is the institutional budget for the Science Mission Directorate. It funds Headquarters institutional activities that impact the Mission Directorate (i.e. Space Studies Board, NASA Peer Review, printing and graphics, IT budget, NASA Postdoctoral Program, working group support, independent assessment studies, and other administrative tasks with Mission Directorate impact).

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Issue competed, peer-reviewed research awards.	Research and Analysis; Airborne Science (flight opportunities)	None.
Maximize resource utilization (i.e., computing cycles) in supercomputer projects.	Scientific Computing; HECC	None.
Initiate the first-ever competitively selected science team.	Glory Mission of ESM Program; science team will be within R&A Program.	New solicitation in ROSES 2009 subelement.
Competitively selected airborne mission teams.	Tropical photochemistry and Aerosol Airborne Campaign - R&A	Solicitation in ROSES 2009 subelement.
Competitively selected airborne mission teams.	Hurricane Field Experiment - R&A	Solicitation in ROSES 2009 subelement.

Implementation Schedule

Schedule by Fiscal Year: Prior, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22

Project	Phase	Beg	End
R&A, IDS Science, Carbon Cycle Science, Ozone Trends, Global Modeling and Assimilation Office, Space Geodesy, Education and Outreach, and Fellowships & New Investigators (all ongoing research efforts)	Tech		
	Form		
	Dev		
	Ops		
	Res	Jan-90	Dec-20
Airborne Science	Tech		
	Form		
	Dev		
	Ops	Jan-90	Dec-20
	Res		
Scientific Computing	Tech		
	Form		
	Dev		
	Ops	Jan-95	Dec-20
	Res		
HECC	Tech		
	Form		
	Dev	Jan-05	Aug-05
	Ops	Sep-05	Dec-20
	Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

The Earth Science Theme manages the Research Program. GSFC implements Scientific Computing and ARC implements HECC.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
R&A	Earth Science Theme, Science Mission Directorate	Mostly competitive awards	Climate Change Science Program (CCSP) participating agencies and Joint Subcommittee on Ocean Science and Technology (JSOST) participating agencies
Interdisciplinary Science	Earth Science Theme, Science Mission Directorate	Mostly competitive awards	Climate Change Science Program (CCSP) participating agencies and Joint Subcommittee on Ocean Science and Technology (JSOST) participating agencies
Carbon Cycle Science Team	Earth Science Theme, Science Mission Directorate	GSFC, JPL, ARC	Climate Change Science Program (CCSP) participating agencies and Joint Subcommittee on Ocean Science and Technology (JSOST) participating agencies
Ozone Trends Science	Earth Science Theme, Science Mission Directorate	GSFC and LaRC	Climate Change Science Program (CCSP) participating agencies and Joint Subcommittee on Ocean Science and Technology (JSOST) participating agencies.
Airborne Science	Earth Science Theme, Science Mission Directorate	GSFC/Wallops Flight Facility, DFRC, and ARC are the primary Centers involved in this project.	The Federal Aviation Administration, the Department of Defense, the Department of Energy, the National Science Foundation, and the National Oceanic and Atmospheric Administration (Department of Commerce).
High-End Computing Capability	Earth Science Theme, Science Mission Directorate	NASA Advanced Supercomputing, Ames Research Center	Department of Energy and the Department of Defense.
Scientific Computing	Earth Science Theme, Science Mission Directorate	NASA Center for Computational Sciences, Goddard Space Flight Center	Department of Energy and the Department of Defense.
Global Modeling and Assimilation Office (formerly Data Assimilation Office)	Earth Science Theme, Science Mission Directorate	Goddard Space Flight Center	None.
Space Geodesy	Earth Science Theme, Science Mission Directorate	Goddard Space Flight Center and Jet Propulsion Laboratory	None.
Earth Science Education and Outreach Activity	Science Mission Directorate	N/A (various non-NASA organizations)	National Science Foundation's Component of the Global Learning and Observations to Benefit the Environment (GLOBE).
Fellowships and New Investigators	Science Mission Directorate	N/A (various non-NASA organizations)	None.

Acquisition Strategy

The Earth Science Research Program is based on full and open competition. Grants are peer reviewed and selected based on NASA Research Opportunities in Space and Earth Sciences (ROSES)and other related announcements.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	NAC Earth Science Subcommittee	2008	The NASA Advisory Council Science Subcommittee reviews content and progress towards Earth Science sub-goal in the NASA Strategic Plan of at least one Science Focus Area per year. During its 2008 meeting, the ESS reviewed and rated the ESD Science Metrics based on the submitted accomplishments and peer-reviewed publications for FY2008. All six Science Focus Area metrics were rated "green" as documented in the FY2008 Annual Performance Report (APR).	2009

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Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	546.1	898.9	715.5	725.4	786.4	818.8	867.6
Global Precipitation Measurement (GPM)	74.4	157.8	159.5	127.6	137.5	111.2	80.4
Glory Mission	82.3	50.7	27.1	10.1	4.4	1.9	0.0
Landsat Data Continuity Mission (LDCM)	127.3	200.9	120.6	137.4	165.0	90.0	15.0
NPOESS Preparatory Project (NPP)	46.1	57.1	112.8	33.8	5.3	5.2	5.1
Ice, Cloud, and land Elevation Satellite (ICESat-II)	9.6	38.8	39.2	74.6	99.1	126.9	161.7
Soil Moisture Active and Passive (SMAP)	9.6	104.3	70.0	132.2	180.4	135.0	40.0
Decadal Survey Missions	16.8	82.3	0.0	10.9	8.8	161.1	374.6
Other Missions and Data Analysis	180.1	206.9	186.3	198.9	186.0	187.5	190.8
FY 2009 President's Budget Request	530.1	677.9	661.5	583.2	563.6	569.6	--
Global Precipitation Measurement (GPM)	74.4	125.8	161.7	129.8	140.0	113.3	--
Glory Mission	35.2	29.7	9.1	9.8	2.7	0.0	--
Landsat Data Continuity Mission (LDCM)	133.0	139.4	127.1	96.0	11.3	2.7	--
NPOESS Preparatory Project (NPP)	70.0	94.4	46.3	8.6	8.9	9.2	--
Decadal Survey Missions	33.0	103.2	116.2	150.0	250.2	290.7	--
Other Missions and Data Analysis	184.6	185.4	201.1	188.9	150.5	153.7	--
Changes from FY 2009 Request	16.0	221.0	54.0	142.3	222.8	249.2	--

Note: Includes $200.3M in Recovery Act funding in FY09

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions

Program Overview

The Earth Systematic Missions (ESM) Program provides a number of Earth-observing satellites that contribute to the provision of long-term environmental data sets that can be used to study the evolution of the Earth system on a range of temporal scales. This information is used to analyze, model, and improve understanding of the Earth system. Data gathered by these spacecraft will enable improved predictions of climate, weather, and natural hazards. NASA works with the science community to identify science questions on the frontiers of science that have profound societal importance, and to which on-going remote sensing of the Earth can make a defining contribution. These science questions become the foundation of a research strategy, which defines requirements for scientific observations through the vantage point of space. Each of Earth Science's six focus areas has an implementation roadmap that shows what role space-based observations play in meeting overall science objectives. The six Earth Science focus areas are as follows: (1) Climate variability and change; (2) Atmospheric composition; (3) Carbon cycle, ecosystems, and biogeochemistry; (4) Water and energy cycles; (5) Weather; and (6) Earth surface and interior. This effort also provides techniques and technologies that can be employed to predict climate, weather and natural hazards on planets we plan to explore.

For more information, see http://science.hq.nasa.gov/missions/earth.html.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions

Plans For FY 2010

As a result of the funding provided by the American Recovery and Reinvestment Act of 2009, and a significant commitment by the new Administration to Earth Science in FY 2010-14, significant progress can be made towards the goals identified in the National Research Council (NRC) 2007 report, "Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond". The Soil Moisture Active-Passive (SMAP) and Ice, Cloud, and Land Elevation Satellite (ICESat II) missions will be pursued aggressively, leading to projected launches in late 2013/early 2014 and late 2014/early 2015 respectively. Studies of the next two Decadal Survey missions, the Climate Absolute Radiance and Refractivity Observatory (CLARREO) and the Deformation, Ecosystem Structure, and Dynamics of Ice (DESDynI), will also intensify.

Also in response to the NRC report, NASA is initiating a new series of competed "Venture-class" missions. These missions, which may include suborbital payloads, instruments to be flown on non-NASA spacecraft, or small dedicated spacecraft, will be selected via an Announcement of Opportunity. Selection of the first Venture-class mission(s) is planned for FY 2010.

NASA has also begun development of the Thermal Infrared Sensor (TIRS) instrument, which is now fully funded within the LDCM Project.

The following other activities will be undertaken in FY 2010:

- GPM will complete its Preliminary Design Review followed by Confirmation Review and KDP-C,
- NPP will complete its satellite pre-environmental review,
- Glory will have its Launch Readiness Review, followed by the launch of the spacecraft, and
- LDCM will complete its instrument Critical Design Review and Mission Critical Design Review.

Nine of the ten operating spacecraft in the Earth Systematic Mission program were reviewed in 2007 as part of the biennial Senior Review. (Aura is still in its prime mission phase and was not reviewed. The EP/TOMS mission was decommissioned in early 2007 and was not a part of the Senior Review.) All nine missions were extended for the FY 2008 - FY 2009 period, with some modifications to their mission implementation plans. All missions including Aura will be a part of the 2009 Senior Review.

Project Descriptions and Explanation of Changes

Global Precipitation Measurement (GPM) Mission

Extending precipitation measurements beyond the current Tropical Rainfall Measuring Mission (TRMM), GPM will provide: near-global measurements of precipitation, its distribution, and physical processes; rain rates and latent heating measurement; and more frequent and complete sampling of Earth's precipitation. The science focus areas served by GPM will include: climate variability and change; water and energy cycles; and weather. Additional GPM information is available under the Development section.

Glory Mission

Glory will provide measurements of global distribution of natural and anthropogenic aerosols from varying angles, in numerous spectral bands with multiple polarizations, as well as total solar irradiance measurements. The science focus areas served by Glory will include: atmospheric composition; carbon cycle, ecosystems, and biogeochemistry; climate variability and change; and water and energy cycles. Additional Glory information is available under the Development section.

Landsat Data Continuity Mission (LDCM)

Landsat Data Continuity Mission (LDCM) will provide visible and near-infrared images of the Earth surface in approximately nine frequency bands, with 30-meter resolution. LDCM will enable cross-sensor comparison of data from within the Landsat series. The science focus areas served by LDCM will include: carbon cycle, ecosystems, and biogeochemistry; and earth surface and interior. LDCM is being undertaken by NASA as a stand-alone "free-flyer" mission, planned for launch as soon as possible to provide continuity of Landsat data. Additional LDCM information is available under the Development section.

NPOESS Preparatory Project (NPP)

NPP is a preparatory mission for the National Polar-orbiting Operational Environmental Satellite System (NPOESS) and will provide global imagery in a number of visible and infrared frequency bands, collect ozone data, and provide improved measurements of temperature and moisture profiles in the atmosphere. The science focus areas served by NPP will include: atmospheric composition; climate variability and change; carbon cycle, ecosystems, and biogeochemistry; water and energy cycles; and weather. Additional NPP information is available under the Development section.

Ice, Cloud, and land Elevation Satellite (ICESat-II)

ICESat-II, currently in formulation, is the planned follow-on mission to ICESAT. Additional ICESat-II information is available under the Formulation section.

Soil Moisture Active and Passive (SMAP)

The Soil Moisture Active and Passive (SMAP) mission will provide new information on global soil moisture and its freeze/thaw state enabling new advances in hydrospheric science and applications. Direct measurements of soil moisture and freeze/thaw state are needed to improve understanding of regional and global water cycles, terrestrial ecosystems, and the processes that link the water, energy, and carbon cycles. Soil moisture and freeze/thaw information provided by SMAP will lead to improved weather forecasts, flood and drought forecasts, and predictions of agricultural productivity and climate change, as well as improved understanding of the sources and sinks of carbon. Additional SMAP information is available under the Formulation section.

Decadal Survey Missions

This project supports missions that begin formulation in the near future to implement systematic measurements in response to Tier 1 and Tier 2 priorities suggested by the National Research Council's Earth Science Decadal Survey.

Other Missions and Data Analysis

Ocean Surface Topography Mission (OSTM) - OSTM was launched June 20, 2008. The satellite measures sea surface height to an accuracy of less than four centimeters every 10 days. The science focus areas served by OSTM will include: climate variability and change; and water and energy cycles. This mission is a follow-on to Jason, and is currently in its prime phase through June 2011.

Terra - Terra collects global data on the state of the atmosphere, land, and oceans, as well as their interactions with solar radiation and with one another. The science focus areas served by Terra include: atmospheric composition; carbon cycle, ecosystems, and biogeochemistry; climate variability and change; earth surface and interior; water and energy cycles; and weather. Terra is a joint mission with Japan and Canada.

Aqua - Aqua monitors atmospheric, land, ocean, and ice variables for improved understanding of the Earth's water cycle and improved understanding of the intricacies of the climate system. The science focus areas served by Aqua include: atmospheric composition; carbon cycle, ecosystems, and biogeochemistry; climate variability and change; water and energy cycles; and weather. Aqua is a joint mission with Brazil and Japan.

Aura - Aura measures atmospheric chemical composition, tropospheric/stratospheric exchange of energy and chemicals, chemistry-climate interactions, and air quality. The science focus areas served by Aura include: atmospheric composition; climate variability and change; and weather. Aura is a joint mission with the Netherlands, Finland, and the United Kingdom.

Tropical Rainfall Measuring Mission (TRMM) - TRMM measures precipitation, clouds, lightning, and radiation processes over tropical regions. TRMM is one of several spacecraft currently extending the long-term radiation budget record begun in the mid-1980s. The science focus areas served by TRMM include: climate variability and change; water and energy cycles; and weather. TRMM is a joint mission with Japan.

Other Missions and Data Analysis (continued)

Active Cavity Radiometer Irradiance Monitor Satellite (ACRIMSat) - ACRIMSat monitors total solar irradiance. The science focus areas served by ACRIMSat include: climate variability and change; and water and energy cycles. Because ACRIMSAT has continued to operate beyond its original planned base mission, it now provides similar measurements to its operating follow-on mission, SORCE.

Quick Scatterometer (QuickSCAT) - QuickSCAT measures ocean surface wind vectors using the SeaWinds instrument. The science focus areas served by QuikSCAT include: climate variability and change; and weather.

Earth Observing-1 (EO-1) - The EO-1 spacecraft collects data to allow paired scene comparisons between the EO-1 Advanced Land Imager (ALI) and the Landsat-7 Enhanced Thematic Mapper Plus (ETM+). The science focus areas served by EO-1 include: carbon cycle, ecosystems, and biogeochemistry; and earth surface and interior.

Ice, Clouds, and Land Elevation Satellite (ICESat) - ICESat measures elements of ice-sheet mass balance, cloud-top and land-surface topography, and vertical profiles of aerosol and cloud properties. The science focus areas served by ICESat include: climate variability and change; earth surface and interior; and water and energy cycles.

Jason - Jason monitors ocean height to support the study of ocean circulation. The science focus areas served by Jason include: climate variability and change; and water and energy cycles. Jason is a joint mission with France.

Solar Radiation and Climate Experiment (SORCE) - SORCE measures the total and spectral solar irradiance incident at the top of Earth's atmosphere. The science focus areas served by SORCE include: atmospheric composition; climate variability and change; and water and energy cycles.

Instrument Science Teams - Instrument science teams help define the scientific requirements for their respective instruments and generate the algorithms used to process the data into useful data products for the investigations. Additionally, the science teams are responsible for validating their own algorithms and data products. The Earth Systematic Missions Program is supported by the Precipitation Science Team, the Ocean Winds Science Team, and the Landsat Science Project Office.

Earth Systematic Missions Senior Review Competed Science - NASA's Earth Science Division uses Senior Reviews, which are held every two years, to assess the relative science value of missions in operation. These reviews are competitive in nature and serve as the basis for determining whether a mission which has completed its current approved phase should be extended.

Earth Science Program Management - Provides program management support for Earth Science missions, investigations, and activities. Additionally, provides funding for the Earth Systematic Missions (ESM) Program Office and the Earth System Science Pathfinder (ESSP) Program Office, which assist in the overall management and execution of the Earth Science formulation, development, and operating missions.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions

Earth Observation Systems (EOS) Research - The EOS research project funds science for the EOS missions, currently Terra, Aqua, Aura, ICESAT I and Land Cover missions. These individual-investigator, competitively selected research projects analyze data from the missions to address the related science questions, especially focussed on the earth's polar regions. Some funded projects continue algorithm improvement and validation for the EOS Instruments data products, while overall the selected activities focus on science data analyses and the development of Earth System Data Records (ESDRs), including Climate Data Records (CDRs) relevant to NASA's research program. Studies using ICESat I and CryoSat-2 are solicited in the ROSES 2009 sub-element. CryoSat-2 is a European Space Agency satellite that is due to be launched in 2009 and will be operating in the observational gap between ICESat I and ICESat II.

Earth Systematic Missions (ESM) Research - The ESM research project funds science teams for the Earth Systematic missions, currently NPP and Glory missions. These are individual investigator competitively selected research to analyze data from the missions to address the related science questions. In particular, the NPP science investigations are focused on developing climate data records from EOS observations continued by the NPOESS operational observing system. The first science for the Glory mission is solicited in ROSES 2009 sub-element.

Ocean Vector Winds Science Team (OVWST) - This project utilizes scientific data received from the QuikSCAT (Quick Scatterometer) Mission satellite which measures ocean surface wind vectors by sensing ripples caused by winds near the ocean's surface, from which scientists can compute the winds' speed and direction, acquiring hundreds of times more observations of surface wind velocity each day than can ships and buoys. Previously this project was associated with the Earth Systematic Mission area wherein the QuikSCAT mission is managed. Beginning in fiscal year 2010, the Ocean Vector Winds Science Team moves into the Research Program to better align competed science research activities.

Ocean Surface Topography Science Team (OSTST) - This project utilizes scientific data received from the Ocean Surface Topography Mission (OSTM) satellite which measures global sea surface height. Previously this project was associated with the Earth Systematic Mission area wherein the OSTM mission is managed. Beginning in fiscal year 2010, the Ocean Surface Topography Science Team moves into the Research Program to better align competed science research activities.

Precipitation Science Team - This project utilizes scientific data received from the Tropical Rainfall Measuring Mission (TRMM) satellite to improve the forecasting of weather and severe storm events. Previously this project was associated with the Earth Systematic Mission area wherein the TRMM is managed. Beginning in fiscal year 2010, the Precipitation Science Team moves into the Research Program to better align competed science research activities.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Complete planned operations of currently operating missions.	Operating missions	Same
Data collection.	EO-1	Same
Launch 2 additional Earth Systematic Mission (ESM) missions.	Glory	Glory launch is now in 2010 and NPP launch is now in 2011.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions

Implementation Schedule

Project	Phase	Beg	End
Global Precipitation Measurement Mission (GPM)	Tech		
	Form	Jul-02	Oct-08
	Dev	Nov-08	Jun-13
	Ops	Jul-13	Jul-16
	Res		
Glory	Tech		
	Form	Oct-03	Nov-05
	Dev	Nov-05	Jan-10
	Ops	Jan-10	Mar-12
	Res		
Landsat Data Continuity Mission (LDCM)	Tech		
	Form	Oct-03	Feb-05
	Dev	Mar-07	Nov-12
	Ops	Dec-12	Jul-17
	Res		
SMAP	Tech		
	Form	Sep-08	Apr-10
	Dev	Apr-10	Sep-13
	Ops	Oct-13	Mar-16
	Res		
ICESat-II	Tech		
	Form	Jun-09	Aug-12
	Dev	Aug-12	Sep-14
	Ops	Oct-14	Dec-18
	Res		
Ocean Surface Topography Mission (OSTM)	Tech		
	Form	Dec-02	Mar-06
	Dev	Mar-06	Jun-08
	Ops	Jul-08	Jul-11
	Res		
NPOESS Preparatory Project (NPP)	Tech		
	Form	Mar-00	Nov-03
	Dev	Dec-03	Jan-11
	Ops	Jan-11	Jan-16
	Res		
Terra	Tech		
	Form		
	Dev		
	Ops	Oct-99	Sep-11
	Res		Sep-11
Aqua	Tech		
	Form		
	Dev		
	Ops	May-02	Sep-11
	Res		Sep-11
Aura	Tech		
	Form		
	Dev		
	Ops	Jul-04	Jul-10
	Res		Jul-12
Tropical Rainfall Measuring Mission (TRMM)	Tech		
	Form		
	Dev		
	Ops	Nov-97	Sep-11
	Res		Sep-11
Active Cavity Radiometer Irradiance Monitor Satellite (ACRIMSat)	Tech		
	Form		
	Dev		
	Ops	Dec-99	Sep-09
	Res		Sep-11
Quick Scatterometer (QuikSCAT)	Tech		
	Form		
	Dev		
	Ops	Jun-99	Sep-11
	Res		Sep-11

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions

Project	Phase	Start	End
Earth Observing-1 (EO-1)	Tech		
	Form		
	Dev		
	Ops	Nov-00	Sep-11
	Res		
Jason	Tech		
	Form		
	Dev		
	Ops	Dec-01	Sep-11
	Res		
Ice, Clouds, and Land Elevation Satellite (ICESat)	Tech		
	Form		
	Dev		
	Ops	Jan-03	Sep-11
	Res		Sep-11
Solar Radiation and Climate Experiment (SORCE)	Tech		
	Form		
	Dev		
	Ops	Jan-03	Sep-11
	Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

GSFC manages NPP, LDCM, Glory, GPM, Terra, Aqua, Aura, TRMM, EO-1, SORCE, ICESat, and ICESat-II. JPL manages OSTM, ACRIMSat, SMAP, QuikSCAT, and Jason.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
GPM	GSFC	GSFC	JAXA - provides the dual frequency precipitation radar and a launch vehicle for GPM.
Glory	GSFC	GSFC	None.
LDCM	GSFC	GSFC	USGS - provides data processing/distribution and on-orbit operations for LDCM.
ICESat-II	GSFC	GSFC	TBD
SMAP	JPL	JPL/GSFC	TBD
OSTM	JPL	JPL	CNES - provides spacecraft, 2 core instruments, and data processing for OSTM. NOAA provides data processing/distribution, ground stations, and on-orbit operations. EUMETSAT provides a ground station and data processing/distribution.
NPP	GSFC	GSFC	NOAA/IPO - provides 3 of 4 instruments and ground system for NPP.
Terra	GSFC	GSFC	Japan's Ministry of Economy, Trade and Industry (METI) provided the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER). The Canadian Space Agency provided the Measurements of Pollution in The Troposphere (MOPITT) instrument.
Aqua	GSFC	GSFC	The National Space Development Agency (NASDA, now part of the Japan Aerospace Exploration Agency, or JAXA) provided the Advanced Microwave Scanning Radiometer for the Earth Observing System (AMSR-E) instrument. Brazil's Instituto Nacional de Pesquisas Espaciais (INPE, the Brazilian Institute for Space Research) provided the Humidity Sounder for Brazil (HSB) instrument.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Aura	GSFC	GSFC	The National Environmental Research Council of the United Kingdom funded the High Resolution Dynamics Limb Sounder (HIRDLS); the instrument was designed by universities and laboratories in the U.K. and the U.S., including the University of Colorado, Oxford University, the National Center for Atmospheric Research (U.S.), and the Rutherford Appleton Laboratory (U.K.). The University of Edinburgh (U.K.) contributed to data processing algorithms and validation for the Microwave Limb Sounder (MLS). The Ozone Monitoring Instrument (OMI) was built by Dutch Space and TNO TPD in the Netherlands in cooperation with Finnish VTT and Patria Advanced Solutions Ltd. KNMI (Royal Netherlands Meteorological Institute) is the Principal Investigator Institute. Overall responsibility for OMI lies with the Netherlands Agency for Aerospace Programmes (NIVR), with the participation of the Finnish Meteorological Institute (FMI).
TRMM	GSFC	GSFC	The Japan Aerospace Exploration Agency (JAXA) provided the Precipitation Radar (PR) instrument and the launch vehicle (an H-II F6).
ACRIMSat	JPL	JPL	None.
QuikSCAT	JPL	JPL	None.
EO-1	GSFC	GSFC	None.
Jason	JPL	JPL	The French Centre National d'Etudes Spatiales (CNES, the National Center for Space Studies) is responsible for the Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS) instrument; THALES built the instrument, and SMP provided the ground beacons. The CNES is also responsible for the Poseidon-2 nadir-viewing radar altimeter; Alcatel Space Industries was prime contractor for the instrument.
ICESat	GSFC	GSFC	None.
SORCE	GSFC	GSFC	None.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions

Acquisition Strategy

The LDCM instrument was selected through open competition in FY 2007. The Ball Aerospace and Technologies Corporation will build the Operational Land Imaging (OLI) instrument for LDCM. LDCM spacecraft used Rapid Spacecraft Development Office selection, and selected General Dynamics.

NPOESS Preparatory Project (NPP): Spacecraft, ATMS, and CERES were procured competitively. The VIIRS, OMPS, and CrIS were procured competitively via the NPOESS Integrated Program Office. The procurement award for each element was as follows:

Ball Aerospace: Spacecraft and Ozone Mapping Profile Suite Development
NG Electronic Systems: Advanced Technology Microwave Sounder Development
ITT Aerospace: Cross-track Infrared Sounder Development
Raytheon: Visible Infrared Imaging Radiometer Development
NG Space Technology: Clouds and the Earth's Radiant Energy System Development
Raytheon: Ground systems and operations.

The GPM instrument was selected through open competition in FY 2005. The Ball Aerospace and Technologies Corporation will build the GPM Microwave Imager (GMI) instrument for GPM. The GPM Core Spacecraft will be an in-house development at GSFC. The Dual-frequency Precipitation Radar (DPR) instrument and launch vehicle for the Core Spacecraft will be provided by a foreign partner, Japan Aerospace Exploration Agency (JAXA). The Constellation Spacecraft will be acquired by open competition through the GSFC Rapid Spacecraft Development Office. Its launch vehicle will be acquired via competitive process by Kennedy Space Center. The ground systems for both spacecraft will be selected through open competition.

Senior Reviews are held every two years to assess the relative science value of missions in operation. In FY 2007, all operating Earth Systematic Missions other than Aura went through the competitive Senior Review process to determine whether they should enter an extended mission phase after their current missions have been completed. Preparations are underway for the 2009 Senior Reviews in which 13 operating missions will be evaluated.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Senior Review Panel	4/2007	2007 Senior Review- All operating Earth Sytematic Missions except for Aura underwent this review. All missions were extended with modifications to their mission budgets.	04/2009

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Glory Mission

FY 2010 Budget Request

Budget Authority ($ millions)	Prior	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	BTC	LCC TOTAL
FY 2010 President's Budget Request	**218.5**	**82.3**	**50.7**	**27.1**	**10.1**	**4.4**	**1.9**	**0.0**	**0.0**	**395.0**
Formulation	70.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	70.8
Development / Implementation	147.7	82.3	50.7	15.4	0.0	0.0	0.0	0.0	0.0	296.1
Operations / Close-out	0.0	0.0	0.0	11.7	10.1	4.4	1.9	0.0	0.0	28.1
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FY 2009 President's Budget Request	**219.2**	**35.2**	**29.7**	**9.1**	**9.8**	**2.7**	**0.0**	**--**	**0.0**	**305.7**
Formulation	70.8	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	70.8
Development / Implementation	148.4	35.2	25.1	0.0	0.0	0.0	0.0	--	0.0	208.7
Operations / Close-out	0.0	0.0	4.6	9.1	9.8	2.7	0.0	--	0.0	26.2
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0
Changes from FY 2009 Request	**-0.8**	**47.1**	**21.0**	**18.0**	**0.3**	**1.7**	**1.9**	**--**	**0.0**	**89.2**
Formulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0
Development / Implementation	-0.7	47.1	25.6	15.4	0.0	0.0	0.0	--	0.0	87.4
Operations / Close-out	0.0	0.0	-4.6	2.6	0.3	1.7	1.9	--	0.0	1.9
Other	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	-0.1

Explanation of Project Changes

Cost growth since the FY 2009 Budget is related to the launch delay from March 2009 to January 2010. The reasons for the launch delay, and associated cost growth, were addressed in NASA's Glory Project Cost and Schedule Analysis Report (CSAR) to Congress, as required by Section 103(d)(2) of the NASA Authorization Act of 2005.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Glory Mission

Project Purpose

The Glory mission will contribute to NASA's research regarding the atmospheric conditions that influence climate and improve understanding of the natural and man-made factors that contribute to climate change. It will also enable a greater understanding of the seasonal variability of aerosol properties. Both advances are essential components of predicting climate change. Solar radiation is the dominant, direct energy input into the terrestrial ecosystem, affecting all physical, chemical, and biological processes. Aerosols interact with atmospheric conditions in complex ways that can have large effects on climate.

Glory's science objectives are to:
* Determine the global distribution, microphysical properties, and chemical composition of natural and anthropogenic aerosols and clouds with accuracy and coverage sufficient for a reliable quantification of the aerosol direct and indirect effects on climate.
* Continue measurement of the total solar irradiance to determine the Sun's direct and indirect effect on Earth's climate.

For more on the scientific questions addressed by Glory, visit http://glory.gsfc.nasa.gov/.

Project Parameters

The Glory mission will operate two scientific instruments aboard a preexisting NASA spacecraft asset requiring minor modification. The Glory satellite will fly in NASA's low Earth orbit Afternoon, or A-Train, constellation to enhance the utility of the mission data through synergistic observations and measurements from the other satellites. The A-Train constellation currently includes five spacecraft flying in close temporal proximity to each other, providing detailed observations of the Earth system. The Glory spacecraft will be the seventh satellite in the A-Train when it joins the constellation in 2009.

The Aerosol Polarimetry Sensor is an advanced polarimeter which will provide measurements that increase our understanding of black carbon soot and other aerosols as causes of climate change. The APS will provide unprecedented measurements of the global distribution of natural and anthropogenic aerosols and clouds with accuracy and coverage sufficient for a reliable quantification of the aerosol direct and indirect effects on climate. The APS is being developed by Raytheon Space and Airborne Systems, El Segundo, California.

The Total Irradiance Monitor (TIM) instrument provides measurement continuity for the 28-year solar irradiance data record by extending the measurement currently provided by NASA's Solar Radiation and Climate Experiment (SORCE). University of Colorado's Laboratory for Atmospheric and Space Physics is developing the TIM sensor, the instrument's Sun pointing platform, and the TIM science operations center.

Orbital Science Corporation, Dulles, Virginia, is developing the spacecraft and the ground system/mission operations center, and will integrate the instruments. Orbital also provides mission systems engineering support and performs mission operations.

Kennedy Space Center is responsible for Glory launch services. The mission will launch on a Taurus XL from Vandenberg Air Force Base, California.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Glory Mission

Project Commitments

Glory will launch in January 2010 to begin a three-year prime mission (with a five-year goal) to gather scientific measurements of atmospheric aerosols and solar irradiance.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
Aerosol Polarimetry Sensor (APS)	Raytheon	Provide unprecedented measurements of the global distribution of natural and anthropogenic aerosols	Same	Same
Total Irradiance Monitor (TIM)	U of Colorado LASP	Maintain an uninterrupted solar irradiance data record	Same	Same
Spacecraft	Orbital	Refurbishment of the Vegetation Canopy Lidar (VCL) mission bus	Same	Same
Launch vehicle	Orbital	Taurus XL	Same	Same
Ground System Ops, TIM Science Ops, APS Science Ops	Orbital / Colorado University-Boulder LASP /GSFC Institute for Space Studies	Combination of the commercial ground stations and the networks that connect them	Same	Full APS sci. data process. 1 yr, data archival remaining 2 yrs, full TIM sci. data process. 3 yrs
Mission Ops	Orbital	Operations of the spacecraft and the generation of command uplink	Same	Same
Data Archive	GSFC Earth Science Distributed Active Archive Center (GES DAAC)	Archival and distribution of mission data	Same	Same

Schedule Commitments

Glory was confirmed for development on December 13, 2005.

Milestone Name	Confirmation Baseline	FY 2009 PB Request	FY 2010 PB Request
Development			
Mission Confirmation Review	11/2005	12/2005	12/2005
Mission Pre-ship review	8/2008	1/2009	1/2009
Launch	12/2008	3/2009	1/2010

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Glory Mission

Development Cost and Schedule Summary

The base year development cost estimate below is consistent with the revised baseline reported in the Glory Project Cost and Schedule Analysis Report (CSAR) to Congress. At that time, the launch date was estimated to be June 2009. Cost growth since that time is due to the additional delay until November 2009. The Project is making good progress towards the new launch date.

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Glory Mission	2008	259.1	2009	296.1	14	Launch Readiness	6/15/2009	1/23/2010	7

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**259.1**	**296.1**	**37.0**
Aircraft/Spacecraft	31.7	37.5	5.8
Payloads	117.4	138.6	21.2
Systems I&T	3.2	3.8	0.6
Launch Vehicle/Services	55.4	55.4	0.0
Ground Systems	0.9	1.1	0.2
Science/Technology	10.3	12.2	1.9
Other Direct Project Cost	40.2	47.5	7.3

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Glory Mission

Project Management

Goddard Space Flight Center has Project Management responsibility. The Science Mission Directorate Program Management Council has program oversight responsibility.

The Earth Science Division Director is the responsible official for this project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
APS	GSFC	GSFC	None
TIM	GSFC	GSFC	None

Acquisition Strategy

All major procurements for the directed Glory Mission were sole-source awarded to meet the objective for an accelerated mission.

Aerosol Polarimetry Sensor: Raytheon Space and Airborne Systems.
Total Irradiance Monitor: University of Colorado Laboratory for Atmospheric and Space Physics.
Spacecraft/spacecraft support: Orbital Science Corporation.

There are no remaining major procurements, as all instrument and spacecraft contracts are in place.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	NASA HQ	04/2008	DPMC Mission Continuation Review - Directorate review of Project replan (incl. corrective actions, risk mitigations, revised cost estimates). Replan approved May 2008, changing LRD from 12/2008 to 6/2009 (LRD will now be later then 6/2009). 6/2009 is the Flight Operations Review.	06/2009

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
APS Instrument	Instrument contractor poor performance will cause increased cost and possible impact to launch readiness date.	HQ and GSFC implementing DPMC replan of April 2008. The project is monitoring contractor performance trends, and assisting the instrument provider with technical, planning, and management expertise.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	NPOESS Preparatory Project (NPP)

FY 2010 Budget Request

Budget Authority ($ millions)	Prior	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	BTC	LCC TOTAL
FY 2010 President's Budget Request	**542.9**	**46.1**	**57.1**	**112.8**	**33.8**	**5.3**	**5.2**	**5.1**	**6.0**	**814.3**
Formulation	47.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.7
Development / Implementation	495.2	46.1	57.1	112.8	28.8	0.0	0.0	0.0	0.0	740.0
Operations / Close-out	0.0	0.0	0.0	0.0	5.0	5.3	5.2	5.1	6.0	26.6
Other	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0
FY 2009 President's Budget Request	**554.5**	**70.0**	**94.4**	**46.3**	**8.6**	**8.9**	**9.2**	**--**	**11.4**	**803.3**
Formulation	47.7	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	47.7
Development / Implementation	506.8	70.0	94.4	46.3	0.0	0.0	0.0	--	0.0	717.5
Operations / Close-out	0.0	0.0	0.0	0.0	8.6	8.9	9.2	--	11.4	38.1
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0
Changes from FY 2009 Request	**-11.6**	**-23.9**	**-37.3**	**66.5**	**25.2**	**-3.6**	**-4.0**	**--**	**-5.5**	**11.0**
Formulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	--
Development / Implementation	-11.6	-23.9	-37.3	66.5	28.8	0.0	0.0	--	0.0	22.5
Operations / Close-out	0.0	0.0	0.0	0.0	-3.6	-3.6	-4.0	--	-5.4	-11.5
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	-0.1	0.0

Note: The FY 2010 LCC number in the table above is overstated by $14.9M due to the difference in the FY09 enacted bill and the April 2009 initial operating plan. Assuming approval of the initial operating plan, the estimated NPP lifecycle cost will be $799.4M, and the estimated Development cost will be $725.1M.

Explanation of Project Changes

The changes to the NPP budget are due to the launch delay from June 2010 until January 2011, primarily caused by late delivery of the Visible Infrared Imaging Radiometer Suite (VIIRS) instrument.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	NPOESS Preparatory Project (NPP)

Project Purpose

The NPOESS Preparatory Project (NPP) is a joint mission with National Oceanic and Atmospheric Administration and the U.S. Air Force to extend key environmental measurements. The satellite will provide atmospheric and sea surface temperatures, humidity sounding, land and ocean biological productivity, cloud and aerosol properties, and earth radiation budget measurements.

The NPP mission has two objectives: Provide a continuation of global change observations following the Earth Observing System missions Terra and Aqua, and provide the National Polar-orbiting Operational Environmental Satellite System (NPOESS) with risk-reduction demonstration and validation for the critical NPOESS sensors, algorithms, and ground processing.

For more information, visit the following website: http://jointmission.gsfc.nasa.gov

Project Parameters

The NPP spacecraft is based on a modified Ball Commercial Platform 2000 bus with a five-year design life. The NPP orbit is a polar, Sun-synchronous orbit at a nominal altitude of 824 kilometers. Four of the instruments are newly developed sensors based on heritage NASA sensors. The Advanced Technology Microwave Sounder (ATMS) is being developed by NASA, and three of the instruments (Visible/Infrared Imaging Radiometer Suite (VIIRS), Cross-track Infrared Sounder (CrIS), and Ozone Mapping and Profiling Suite (OMPS)) are being developed by the NPOESS Integrated Program Office (IPO). A fifth sensor, the Clouds and the Earth's Radiant Energy System (CERES) was a spare sensor developed by NASA for the Earth Observing System (EOS) program.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	NPOESS Preparatory Project (NPP)

Project Commitments

NPP will launch in January 2011 and undertake the following scientific measurements over its five-year operating life: atmospheric and sea surface temperatures, humidity soundings, land and ocean biological productivity, cloud and aerosol properties, and Earth radiation budget measurements.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
Visible Infrared Imaging Radiometer Suite (VIIRS)	Raytheon SBRS	Provide global imagery in visible and infrared frequency bands: 0.3 to 14 microns / 400 m resolution.	Same	Same
Ozone Mapping and Profiler Suite (OMPS)	Ball Aerospace	Collection of total column and vertical profile ozone data with 300-380 nm / LIMB 290-1000 nm .	Same	Same
Cross-Track Infrared Sounder (CrIS)	ITT Aerospace	Temperature and moisture profiles at 3.9-15.4 microns.	Same	Same
Advanced Technology Microwave Sounder (ATMS)	NG Electronic Systems	Temperature and moisture profiles at 22 channels / 23-183 ghz.	Same	Same
Clouds and the Earth's Radiant Energy System (CERES)	NG Space Technology	Provide Earth radiation budget measurements in shortwave (0.3-5micron) and longwave (8-12 micron) bands		New
Spacecraft	Ball Aerospace	5-year design life, mass is 2228 kg, Power 1400 watts.	Same	Same
Launch vehicle	Boeing	Delta II 7920.	Same	Same
Ground system	Raytheon	Command, Control, and Communication Segment (C3S) and Interface Data Processing Segment (IDPS).	Same	Same

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	NPOESS Preparatory Project (NPP)

Schedule Commitments

The NPP mission completed Mission Confirmation Review (MCR) in November 2003.

Milestone Name	Confirmation Baseline	FY 2009 PB Request	FY 2010 PB Request
Development			
CrIS Flight Model Delivery	Oct 2005	May 2008	May 2008
ATMS Flight Model Delivery	Apr 2005	Oct 2005	Oct 2005
OMPS Flight Model Delivery	Sep 2005	Aug 2008	Aug 2008
VIIRS Flight Model Delivery	Nov 2005	Apr 2009	Nov 2009
CERES Flight Model Delivery	N/A	N/A	Oct 2008
Operations Readiness Review	Jun 2006	Dec 2009	Dec 2009
Launch	Oct 2006	Jun 2010	Jan 2011

Development Cost and Schedule Summary

The VIIRS sensor delivery from NASA's NPOESS partners continues to impact the NPP project. Ongoing issues with the VIIRS sensor development has caused the NPP launch to slip again. The revised NPP launch date is now January 2011 due to the late sensor delivery.

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
NPOESS Preparatory Project (NPP)	2006	592.9	2008	725.1	22	Launch Readiness	4/30/2008	1/31/2011	33

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**592.9**	**725.1**	**132.2**
Aircraft/Spacecraft	160.0	164.3	4.3
Payloads	194.2	162.3	-31.9
Launch Vehicle/Services	72.9	93.3	20.4
Ground Systems	48.2	49.4	1.2
Other Direct Project Cost	117.6	224.3	106.7
Science/Technology	0.0	31.5	31.5

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	NPOESS Preparatory Project (NPP)

Project Management

GSFC is responsible for NPP project management. Agency PMC has program oversight responsibility. NOAA/DOD IPO is responsible for managing development of OMPS, CrIS and VIIRS instruments. Responsible official is the Earth Science Division Director.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Spacecraft	GSFC	None	None
ATMS Development	GSFC	None	None
OMPS Development	NPOESS-IPO	None	NOAA / DoD (NPOESS-IPO)
CrIS Development	NPOESS-IPO	None	NOAA / DoD (NPOESS-IPO)
VIIRS Development	NPOESS-IPO	None	NOAA / DoD (NPOESS-IPO)
CERES Refurbishment	GSFC	LaRC	NOAA
Data archive and storage	GSFC	None	NOAA
Ground Systems and Ops	NPOESS-IPO	None	NOAA / DoD (NPOESS-IPO)

Acquisition Strategy

Spacecraft, ATMS, and CERES were procured competitively. The VIIRS, OMPS, and CrIS were procured competitively via the NPOESS Integrated Program Office.

The procurement award for each element was as follows:
Ball Aerospace: Spacecraft and OMPS Development;
NG Electronic Systems: ATMS Development;
ITT Aerospace: Crls Development;
Raytheon: VIIRS Development;
NG Space Technology: CERES; and
Raytheon: Ground systems and operations.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	NPP IRT	10/2008	Mission Operations Review/Successfully completed.	N/A
Performance	NPP IRT	N/A	Operations Readiness Review	12/2009

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	NPOESS Preparatory Project (NPP)

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Instrument Delivery Delay	Government has taken a hands-on approach to the day-to-day management of VIIRS. The program has installed a Government Program Manager (GPM) at Raytheon to provide oversight and timely decisions. The GPM is an experienced NASA instrument manager.	NASA and NPOESS-IPO team working together to identify further work-arounds to minimize impacts.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Global Precipitation Measurement (GPM)

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	74.4	157.8	159.5	127.6	137.5	111.2	80.4
FY 2009 President's Budget Request	74.4	125.8	161.7	129.8	140.0	113.3	--
Total Change from 2009 President's Budget Request	0.0	32.0	-2.2	-2.2	-2.5	-2.1	--

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Global Precipitation Measurement (GPM)

Project Purpose

The Global Precipitation Measurement (GPM) mission will advance the measurement of global precipitation, making possible high spatial resolution precipitation measurements available at a three-hour or less refresh rate over much of the globe. A joint mission with the Japan Aerospace Exploration Agency (JAXA), GPM will provide the first opportunity to calibrate measurements of global precipitation (including the distribution, amount, rate, and associated heat released) across tropic, mid-latitude, and polar regions.

The GPM mission has the following scientific objectives:

(1) Advance precipitation measurement capability from space through combined use of active and passive remote-sensing techniques. These advanced measurements will be used to calibrate dedicated and operational passive microwave sensors with the goal of achieving global sampling.
(2) Advance understanding of global water/energy cycle variability and fresh water availability. Improved measurements of the space-time variability of global precipitation will substantially close the water/energy budget and elucidate the interactions between precipitation and other climate parameters.
(3) Improve climate prediction by providing the foundation for better understanding of surface water fluxes, soil moisture storage, cloud/precipitation microphysics and latent heat release in the Earth's atmosphere.
(4) Advance Numerical Weather Prediction (NWP) skills through more accurate and frequent measurements of instantaneous rain rates with better error characterizations, and the development of improved assimilation methods.
(5) Improve flood-hazard and fresh-water-resource prediction capabilities through better temporal sampling and wider spatial coverage of high-resolution precipitation measurements, and innovative designs in hydro-meteorological modeling.

For more information see http://science.hq.nasa.gov/missions/earth.html.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Global Precipitation Measurement (GPM)

Project Preliminary Parameters

The GPM Project includes a Core Observatory Spacecraft and the Low-Inclination Observatory Spacecraft. The Core Observatory will leverage passive microwave measurements from other operating and planned "satellites of opportunity" by calibrating their measurements to its own. The exact sampling rate over different areas of the globe will depend on the number and orbits of the satellites of opportunity, but given the prevalence of passive microwave instruments on operational satellite systems, the global sampling will be robust.

The NASA Core Observatory will fly in a 65 degree inclined orbit at an altitude of 407 kilometers; the 65 degree orbit provides improved latitude coverage over TRMM (which is 35 degrees). The Core Observatory includes two scientific instruments which will provide active and passive microwave measurements of precipitation.

The JAXA-supplied Dual-frequency Precipitation Radar (DPR)instrument has cross-track swath widths of 245 km and 120 km, in Ku-band Ka-band, providing three-dimensional observation of rain and an accurate estimation of rainfall rate. The KuPR (13.6 GHz) subsystem of the DPR is an updated version of the highly successful radar flown on TRMM.

The GPM Microwave Imager (GMI)instrument is a conically-scanning radiometer which will provide significantly improved spatial resolution over the TRMM Microwave Imager (TMI).

The NASA Low-Inclination Observatory will fly in a 40 degree inclined orbit to improve real-time monitoring and prediction of hurricanes/typhoons; the satellites of opportunity will fly at multiple altitudes and inclinations.

The Core Observatory Spacecraft will be launched from Tanegashima Space Center, Japan on an H-IIA launch vehicle. NASA's Low-Inclination Observatory Spacecraft will be launched from Cape Canaveral Air Force Station on a Taurus-XL class launch vehicle. The DPR and GMI data will be relayed using the TDRSS multiple access (MA) and single access (SA) service.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Global Precipitation Measurement (GPM)

Estimated Project Deliverables

The GPM Core Observatory is planned for a launch in July 2013 to begin a three-year prime mission (five-year goal), followed by a launch in November 2014 of the NASA Low-Inclination Observatory, a passive microwave spacecraft. When calibrated with existing and planned passive microwave measurements, GPM will provide global measurements of precipitation with a sampling frequency of three hours or less over much of the globe.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
Core Observatory	GSFC	Provides platform for the GMI and JAXA-supplied DPR instruments	Same	Same
Low-Inclination Observatory	GSFC	Provides platform for the second GMI instrument	Same	Same
Dual-frequency Precipitation Radar (DPR)	JAXA	Provides cross-track swath widths of 245 km and 120 km, for the Ku precipitation radar (KuPR) and Ka-band precipitation radar (KaPR).		Same
GPM Microwave Imager (GMI)	GSFC	Provides 13 microwave channels ranging in frequency from 10 GHz to 183 GHz; four high frequency, millimeter-wave, channels about 166 GHz and 183 GHz. 1.2 m diameter antenna	Same	Same
Launch Vehicle	JAXA	H-IIA	Same	Same

Estimated Project Schedule

GPM entered formulation in July 2002. Milestone dates beyond the formulation phase are preliminary estimates pending completion of formulation.

Milestone Name	Formulation Agreement Estimate	FY 2009 PB Request	FY 2010 PB Request
Development			
KDP-C	Dec 2003		May 2009
Core Observatory launch readiness date (LRD)	Nov 2010	Jun 2013	Jul 2013
Low-Inclination Observatory launch readiness date (LRD)		Jun 2014	Nov 2014

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Global Precipitation Measurement (GPM)

Project Management

Goddard Space Flight Center (GSFC) has project management responsibility. The Agency Program Management Council has program oversight responsibility.

The Earth Sciences Division Director is the responsible official for this project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Core Observatory	GSFC	GSFC	None
Core Observatory: GMI	GSFC	GSFC	None
Core Observatory: DPR	GSFC	GSFC	JAXA
Low-Inclination Observatory	GSFC	GSFC	To Be Determined
Low-Inclination Observatory: GMI	GSFC	GSFC	None
Launch vehicle and services: Core Observatory	GSFC	None	JAXA
Launch vehicle and services: Low-Inclination Observatory	GSFC	KSC	None

Acquisition Strategy

The GPM instrument was selected through open competition in FY 2005. The Ball Aerospace and Technologies Corporation will build the GPM Microwave Imager (GMI) instrument for GPM. The GPM core spacecraft will be an in-house development at GSFC. The DPR instrument and launch vehicle for the Core Observatory will be provided by a foreign partner (JAXA). The Low-Inclination Observatory will be acquired by open competition through the GSFC Rapid Spacecraft Development Office (RSDO). Its launch vehicle will be acquired via competitive process by KSC. The ground systems for both spacecraft will be selected through open competition.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	12/2005	Preliminary Design Review (PDR) was successful.	11/2008
Performance	IPAO	11/2008	Critical Design Review (CDR)	10/2009

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Non-NASA Constellation elements	Exact global sampling depends on operations of "spacecraft of opportunity" that are not part of this project.	NASA is developing data algorithms that allow GPM to make the broadest possible use of microwave instruments on other spacecraft; NASA participates in inter-agency and international planning processes for operational Earth observation measurements to maximize the leverage opportunities for GPM.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Landsat Data Continuity Mission (LDCM)

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	127.3	200.9	120.6	137.4	165.0	90.0	15.0
FY 2009 President's Budget Request	133.0	139.4	127.1	96.0	11.3	2.7	--
Total Change from 2009 President's Budget Request	-5.7	61.6	-6.5	41.3	153.7	87.3	--

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Landsat Data Continuity Mission (LDCM)

Project Purpose

Unprecedented changes in land cover and use are having profound consequences for weather and climate change, ecosystem function and services, carbon cycling and sequestration, resource management, the national and global economy, human health, and society. The Landsat data series, begun in 1972, is the longest continuous record of changes in Earth's surface as seen from space and the only satellite system designed and operated to repeatedly observe the global land surface at moderate resolution. Landsat data are available at an affordable cost, providing a unique resource for people who work in agriculture, geology, forestry, regional planning, education, mapping, and global change research.

The purpose of the Landsat Data Continuity Mission (LDCM) is to extend the record of multi-spectral, moderate resolution Landsat-quality data, and to meet U.S. Government operational and scientific requirements for observing land use and land change.

For additional information, visit the LDCM Mission Home Page: http://ldcm.nasa.gov/

Project Preliminary Parameters

LDCM is being formulated for a Launch Readiness Date (LRD) that will minimize a potential data gap in the archive due to the fuel-limited life of Landsat-7. Recent analyses by the USGS and NASA have estimated the Landsat-7 mission should continue to operate through at least the end of 2012. The LDCM mission completed its Initial Confirmation Review, also known as the KDP-B transition review, on September 25, 2008, and is currently planned to be launched in December 2012.

LDCM consists of a single science instrument (the Operational Land Imager), a spacecraft, and a mission operations ground system. The LDCM is in formulation and system level requirements are in development to provide the following system-level performance parameters:

- Earth Spatial-Temporal Coverage: 16-day repeat coverage of the global land mass.

- Spatial Resolution: 30 meters.

- Radiometric Performance: accuracy, dynamic range, and precision sufficient to detect land cover change using historic Landsat data.

- Data: 185-km-cross-track-by-180-km-along-track multi-spectral image of Earth surface.

- Mission Life: five years.

Starting in FY2009, NASA will develop a Thermal Infrared Sensor (TIRS) instrument, to be flown on LDCM or (potentially) some other spacecraft. A decision as to which spacecraft will carry TIRS will be made by summer of 2009. Meanwhile, funding for TIRS (approximately $150-175M) is now carried within the LDCM budget.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Landsat Data Continuity Mission (LDCM)

Estimated Project Deliverables

LDCM will launch in 2012 and operate for a minimum of five years.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
Operational Land Imager (OLI)	Ball Aerospace and Technology Corporation	Provide Landsat-equivalent data to extend the Landsat data of Earth's land surface for five years.	Same	Provider chosen
Spacecraft	General Dynamics	Provide performance and reliability commensurate with OLI data requirements.	Same	Same
Launch Vehicle	ULA	Provide launch service access to space.	Same	Same
Mission operations ground system	Hammers Corporation	Provide capability for command and control, mission scheduling, long-term trending and analysis, and flight dynamics analysis.	Same	Same

Estimated Project Schedule

In FY 2008, the LDCM Project awarded the LDCM spacecraft contract to General Dynamics and the Mission Operations Element (MOE) system development contract (in coordination with the USGS) to the Hammers Corporation, completing the mission complement.

In FY 2009, the LDCM Project will complete the spacecraft and MOE PDR, and the mission PDR. The OLI will undergo critical design and fabrication in FY 2009 and 2010. System integration and test will begin in FY 2011. Observatory integration and testing, as well as environmental testing, will take place in FY 2011, and launch vehicle integration will begin at the start of FY 2012.

Milestone Name	Formulation Agreement Estimate	FY 2009 PB Request	FY 2010 PB Request
Development			
Formulation			
Award OLI contract	June 2007	June 2007	July 2007
Confirmation Review	Jan 2008	Jan 2008	Dec 2009
Critical Design Review (CDR)	Feb 2009	Feb 2009	Apr 2010
PSR	May 2011	May 2011	Jun 2012
Launch	Jan 2011	Jan 2011	Dec 2012

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Landsat Data Continuity Mission (LDCM)

Project Management

Goddard Space Flight Center is responsible for project management. The Science Mission Directorate Program Management Council has program oversight responsibility. The Earth Science Division Director is the responsible official for this project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Operational Land Imager	GSFC	GSFC	None
Spacecraft	GSFC	GSFC	None
Ground System	GSFC	GSFC	U.S. Department of Interior-U.S. Geological Survey
Mission Operations	GSFC	GSFC	U.S. Department of Interior-U.S. Geological Survey

Acquisition Strategy

NASA's acquisition plan includes acquiring separate elements of the LDCM mission through open competition, with GSFC acting as the mission integrator and leading the element source selections. NASA has issued competitively selected contracts for the following major elements: to the Ball Aerospace and Technology Corporation for the development of the Operational Land Imager in July 2007, to the General Dynamics Corporation for the development of the spacecraft in April 2008, and to the Hammers Corporation for the development of the MOE in September 2008.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	HQ and GSFC	9/2008	Systems Requirement Review (SRR) - Successful	N/A
Performance	HQ and GSFC	N/A	Mission Preliminary Design Review	7/2009

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Focal Plane Array (FPA) Development Risk	The technical risk in LDCM is low to moderate. The system component with the greatest associated risk is the Focal Plane Array (FPA). The FPA has proven flight heritage, but intrinsic development risk which could impact the LDCM schedule.	Risk mitigation strategies are based upon proven NASA methodologies that include the required instrument manufacturer risk mitigation strategy implementation and correlated Government expert oversight, an extensive peer-review process, enhanced FPA deliverables and test scenarios, and in-plant expert representation.
Manifest Uncertainty	If direction is given to add a thermal infrared sensor (TIRS) instrument to the LDCM late, the change could significantly impact the mission design, cost, and delivery schedule.	The project office has taken steps to reduce the impact by adding extra capacity to the spacecraft specification to accommodate an extra instrument. The Earth Science Division has authorized engineering and technology risk reduction work on the most probable TIRS instrument approach, so that the instrument could be ready with minimal schedule impact to the LDCM mission.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Ice, Cloud, and Land Elevation Satellite (ICESat II)

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**9.6**	**38.8**	**39.2**	**74.6**	**99.1**	**126.9**	**161.7**
Total Change from 2009 President's Budget Request	**9.6**	**38.8**	**39.2**	**74.6**	**99.1**	**126.9**	**--**

Project Purpose

The Ice, Clouds, and land Elevation Satellite II (ICESat-II) satellite will continue the measurements begun with the ICESat mission, measuring elements of ice-sheet mass balance, cloud-top and land-surface topography, to quantify polar ice sheet contributions to current and recent sea level change and the linkages to climate conditions. In addition, ICESat-II will quantify regional signatures of ice sheet changes to assess mechanisms driving that change and improve predictive ice sheet models. The science focus areas served by ICESat include: climate variability and change; earth surface and interior; and water and energy cycles.

The ICESat-II mission is one of four missions recommended for launch by NASA in the 2010-2013 time frame by the National Research Council (NRC) report entitled, "Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond". The ICESat-II mission will draw heavily from the original ICESat satellite launched in 2003 and still operating at the start of 2009.

For more information see http://nasascience.nasa.gov/missions/icesat2

Project Preliminary Parameters

The ICESat-II observatory employs a dedicated spacecraft with a single nadir pointing surface profiling lidar. It will be launched into a 94 deg, 91 day repeat frozen orbit.

Estimated Project Deliverables

ICESat-II is still in pre-formulation and does not yet have an official launch date; however, the pre-Phase A target launch date is late 2014/early 2015 with a notional 3 year prime mission.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
Spacecraft	TBD	Competitively selected	N/A	New
Lidar Instrument	GSFC	Single beam profiling, nadir pointing	N/A	New
Launch Vehicle	TBD	Competitively selected	N/A	New

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Ice, Cloud, and Land Elevation Satellite (ICESat II)

Estimated Project Schedule

ICESat-II is still in pre-formulation. Milestone dates beyond the formulation phase are preliminary estimates pending completion of formulation.

Milestone Name	Formulation Agreement Estimate	FY 2009 PB Request	FY 2010 PB Request
Formulation			
Formulation			
KDP-A	N/A	N/A	September 2009
Launch readiness date (LRD)	N/A	New	Late 2014/Early 2015

Project Management

The Goddard Space Flight Center (GSFC) has project management responsibility. The Science Mission Directorate Program Management Council has programmatic oversight. The Earth Sciences Division Director is the responsible official for this project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Spacecraft	GSFC	TBD	TBD
Lidar	GSFC	GSFC	None
Mission Operations	GSFC	TBD	TBD
Launch Vehicle	GSFC	TBD	TBD

Acquisition Strategy

The ICESat-II lidar instrument will be built in-house at the GSFC. The spacecraft vendor will be competitively selected. The approach for the mission operations element has not yet been determined. The source and selection method for launch services will be determined later in formulation.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	ICESat-II Independent Review Team	N/A	Mission Concept Review	07/2009

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Soil Moisture Active and Passive (SMAP)

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	9.6	104.3	70.0	132.2	180.4	135.0	40.0
Total Change from 2009 President's Budget Request	9.6	104.3	70.0	132.2	180.4	135.0	--

Project Purpose

The Soil Moisture Active and Passive (SMAP) mission will provide new information on global soil moisture and its freeze/thaw states enabling new advances in hydrospheric science and applications. Direct measurements of soil moisture and freeze/thaw states are needed to improve our understanding of regional and global water cycles, terrestrial ecosystems, and the processes that link the water, energy, and carbon cycles. Soil moisture and freeze/thaw information provided by SMAP will lead to improved weather forecasts, flood and drought forecasts, and predictions of agricultural productivity and climate change, as well as improved understanding of the sources and sinks of carbon. Soil moisture and soil freeze/thaw information is useful for many purposes, so the Mission will contribute to the goals of other Earth Science Focus Areas (Carbon Cycle, Ecosystem, Weather, and Climate).

The SMAP mission is one of four missions recommended for launch by NASA in the 2010-2013 time frame by the U.S. National Research Council (NRC) report entitled, "Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond". SMAP is based on the soil moisture and freeze/thaw mission concept developed under the NASA Earth System Science Pathfinder (ESSP) Program Hydrosphere State (Hydros) project and builds on the Hydros formulation and technology risk mitigation studies conducted in 2003 - 2005.

For more information see http://nasascience.nasa.gov/missions/smap

Project Preliminary Parameters

The SMAP observatory employs a dedicated spacecraft with an instrument suite that will be launched into a near-polar, sun-synchronous orbit on an expendable launch vehicle. The baseline SMAP instrument suite includes a radiometer and a synthetic aperture radar operating in the L-band range (1.20-1.41 GHz) designed to make coincident measurements of soil emission and backscatter and sense the top 5 cm of soil through moderate vegetation cover. These measurements will be analyzed to yield estimates of soil moisture and freeze/thaw state. The measurements will be acquired for a period of three years, and a comprehensive validation program will be used to assess random errors and regional biases in the soil moisture and freeze/thaw estimates.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Soil Moisture Active and Passive (SMAP)

Estimated Project Deliverables

SMAP is planned for a launch in late 2013/early 2014 to begin a three-year prime mission. SMAP will make soil moisture measurements around the entire Earth every 3 days.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
Spacecraft	JPL	Provides platform for the instrument	N/A	New
L-Band Synthetic Aperture Radar (SAR)	JPL	Combined with Radiometer provides soil moisture measurements in the top 5 cm of soil through moderate vegetation cover	N/A	New
L-Band Radiometer	GSFC	Combined with SAR provides soil moisture measurements in the top 5 cm of soil through moderate vegetation cover	N/A	New
Launch Vehicle	TBD	TBD	N/A	New

Estimated Project Schedule

SMAP entered formulation in September 2008. Milestone dates beyond the formulation phase are preliminary estimates pending completion of formulation.

Milestone Name	Formulation Agreement Estimate	FY 2009 PB Request	FY 2010 PB Request
Formulation			
Formulation			
KDP-C	April 2010		December 2010
Launch readiness date (LRD)	March 2013		Late 2013/Early 2014

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Soil Moisture Active and Passive (SMAP)

Project Management

The Jet Propulsion Laboratory (JPL) has project management responsibility for SMAP. The Science Mission Directorate Program Management Council has program oversight responsibility.
The Earth Sciences Division Director is the responsible official.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Spacecraft	JPL	JPL	None
L-Band Synthetic Aperture Radar (SAR)	JPL	JPL	None
L-Band Radiometer	JPL	GSFC	None
Launch Vehicle	JPL	To be determined	To be determined

Acquisition Strategy

The SMAP Spacecraft will be built in-house at JPL. The SMAP instrument, combining the Synthetic Aperture Radar (SAR) and radiometer, will be integrated by JPL. The SAR will be built by JPL. The radiometer will be built by GSFC. The Deployable Antenna/Boom and instrument spin assemblies will be procured through an open competition. The source and selection method for launch services will be determined later in formulation.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SMAP Standing Review Board SRB	06/2008	Mission Concept Review - The SRB deemed that the SMAP project met the success criteria for the MCR.	02/2009
Performance	SMAP Standing Review Board SRB	02/2009	Mission Design Review-successfully completed.	05/2009

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Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	106.8	118.3	63.9	128.8	114.2	121.4	119.1
Aquarius	33.4	44.7	18.3	6.3	4.2	2.8	0.0
Venture Class Missions	0.0	21.0	12.9	79.2	66.5	75.1	75.7
Other Missions and Data Analysis	73.4	52.6	32.8	43.3	43.5	43.5	43.4
FY 2009 President's Budget Request	113.8	88.6	58.8	37.4	50.0	54.9	--
Orbiting Carbon Observatory (OCO)	35.6	25.4	9.0	1.4	0.0	0.0	--
Aquarius	48.6	33.8	27.9	5.1	4.0	2.9	--
Other Missions and Data Analysis	29.6	29.4	21.9	30.8	46.0	52.0	--
Changes from FY 2009 Request	-7.0	29.7	5.2	91.4	64.3	66.5	--

Note: Includes $36.6M in Recovery Act funding in FY09

Program Overview

The Earth System Science Pathfinder Program (ESSP) addresses unique, specific, highly-focused mission requirements in Earth Science research. ESSP includes a series of relatively low-to-moderate cost, small-to-medium sized, competitively selected, Principal Investigator-led missions. These missions, which are built, tested and launched in a short time interval, complement the larger Earth Systematic Missions (ESM). They are capable of supporting a variety of scientific objectives related to Earth science, including studies of the atmosphere, oceans, land surface, polar ice regions, and solid Earth. Investigations include development and operation of remote-sensing instruments and the conduct of investigations using data from these instruments.

ESSP currently has one mission in development (Aquarius) and three operating missions (Gravity Recovery and Climate Experiment [GRACE], CloudSat, and Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations [CALIPSO]). Future ESSP missions will be selected from proposals submitted in response to Announcements of Opportunity.

NASA is determining how best to meet the lost science contribution after the OCO launch vehicle failure. We have initiated studies to examine both science and hardware considerations. The science study is assessing the current state of carbon cycle science and existing measurements to see what course of action would best address the key science issues. On the hardware side, NASA is examining reflight opportunities, including, but not limited to, flying an OCO-like instrument on a shared platform or as a dedicated mission.

ESSP supports missions that complement those of the larger Earth Systematic Missions which are designed to facilitate on-going or operational measurements.

For more information see http://earth.nasa.gov/essp/index.html/.

Plans For FY 2010

The Earth System Science Pathfinder (ESSP) Program plans for FY10 include completion of Aquarius/SAC-D observatory environmental testing, Operational Readiness Review and mission launch. GRACE, CloudSat, and CALIPSO will continue operations as determined by the 2009 Senior Review process. ESSP will also begin the first phase of the Venture Class mission activities.

Project Descriptions and Explanation of Changes

Aquarius

Aquarius will observe and model seasonal and year-to-year variations of sea-surface salinity and how these variations relate to changes in the water cycle and ocean circulation. The science focus areas served by Aquarius will include: climate variability and change; and water and energy cycles. Aquarius is currently in Phase C-D with a planned launch date of May, 2010 and 3 years of prime mission life. Additional detail can be found in the Aquarius section of this document.

Venture Class Missions

"Venture-class" Earth System Science Pathfinder missions have been established in response to the National Research Council's Earth Science Decadal Survey. Venture-class missions will be small, competed science investigations, and may include suborbital payloads; instruments to be flown on non-NASA spacecraft; and small, focused satellites.

Other Missions and Data Analysis

Included in this line item are three operating spacecraft:
- the Gravity Recovery and Climate Experiment (GRACE), launched in 2002, measures Earth's gravity field and its variations with time.
- CloudSat, launched in 2006, measures cloud characteristics to increase understanding of the role of optically thick clouds in Earth's radiation budget.
- The Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) mission, launched in 2006, measures the vertical distribution of clouds and aerosols.

In addition, this line includes the ESSP research project which funds science teams for the ESSP missions. The science teams are comprised of competitively selected individual investigators who analyze data from the missions to address the related science questions.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Senior Review (SR) to make recommendations on mission extensions	GRACE, CloudSat, and CALIPSO	no change

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder

Implementation Schedule

Schedule by Fiscal Year: Prior, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22

Project	Phase	Beg	End
Aquarius	Tech		
	Form	Oct-03	Sep-05
	Dev	Oct-05	Apr-10
	Ops	May-10	May-13
	Res		
Gravity Recovery and Climate Experiment (GRACE)	Tech		
	Form		
	Dev		
	Ops	Mar-02	Sep-11
	Res		
CloudSat	Tech		
	Form		
	Dev		
	Ops	Apr-06	Sep-11
	Res		
Cloud-Aerosol Lidar and Infrared Pathfinder Satellite (CALIPSO)	Tech		
	Form		
	Dev		
	Ops	Apr-06	Apr-09
	Res		Apr-11

- Tech & Adv Concepts (Tech)
- Formulation (Form)
- Development (Dev)
- Operations (Ops)
- Research (Res)
- Represents a period of no activity for the Project

Program Management

The Agency Program Management Council has program oversight responsibility.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Aquarius	JPL	JPL	Argentina's Comision Nacional De Actividades Espaciales (CONAE), National Oceanic and Atmospheric Administration, Naval Research Laboratory, National Center for Atmospheric Research.
Gravity Recovery and Climate Experiment (GRACE)	Earth Science Division	JPL	Deutches Zentrum fur Luft- und Raumfahrt (DLR, the German Aerospace Center); Office National d'Etudes et de Recherches Aerospatiale (ONERA) of France; GeoForschungsZentrum (German National Research Centre for Geosciences); National Oceanic and Atmospheric Administration; National Geospatial-Intelligence Agency.
CloudSat	Earth Science Division	JPL	Canadian Space Agency; U.S. Air Force; Department of Energy.
Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO)	Earth Science Division	LaRC	France's Centre National d'Etudes Spatiales (CNES, the National Center for Space Studies) and Alcatel; SODERN; Institut Pierre Simon Laplace, France.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder

Acquisition Strategy

ESSP program missions are selected competitively via Announcements of Opportunity (AO). The AO process uses peer review for the science content of the proposed missions, as well as thorough independent review of their technical, management, and cost elements.

In FY 2007, GRACE and CloudSat went through the biennial competitive Senior Review process and were approved for continued extended mission operations.

GRACE Project Team: Amarillo Independent School District; Applied Physics Laboratory, Johns Hopkins University; Llano Independent School District, Messalonskee School System; GSFC, Center for Space Research; Univ. of Texas at Austin. Analytical Mechanics Associates; Elizabeth Board of Education, Killeen Independent School District; MIT, Dept of Earth, Atmospheric & Planetary Sciences; Mid-Prairie Community School District; KSC; LaRC; Space Systems Loral; Sunray Independent School District; Texas Space Grant Consortium; Univ. of Colorado, Physics Department; Ohio State Univ., Civil & Environmental Engineering and Geodetic Science; Stanford Telecon; TRW; DJO, DASA, Jena-Optronik, Gm.

CloudSat Project Team: Colorado State Univ. PI and team, E&PO effort; Ball Aerospace ; Cooperative Institute for Research in the Atmosphere (CIRA; Colorado State Univ.) operates Data Processing Center. LaRC Atmospheric Sciences Data Center delivers data products to CIRA. GSFC delivers data products to CIRA. European Centre for Medium-Range Weather Forecasts met forecast data to CIRA. GLOBE program (Boulder, Colorado) prime education partner. USAF Space Test Program conducts mission operations out of Kirtland AFB, Albuquerque, NM.

CALIPSO Project team: LaRC systems engineering, payload mission ops, science data validation, data processing and archiving. Ball Aerospace CALIOP and wide-field camera, payload integration, LV support, science data downlink. Hampton Univ. manages quid pro quo validation effort, E&PO effort, and leads International Science Advisory Pane

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Senior Review Panel	04/2007	GRACE and CloudSat were reviewed as part of the Earth Science biennial Senior Review process. Both missions were ranked very high for data quality and relevance to the NASA Earth Science Theme objectives.	04/2009

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder
Project In Development:	Aquarius

FY 2010 Budget Request

Budget Authority ($ millions)	Prior	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	BTC	LCC TOTAL
FY 2010 President's Budget Request	**148.2**	**33.4**	**44.7**	**18.3**	**6.3**	**4.2**	**2.8**	**0.0**	**0.0**	**257.8**
Formulation	35.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.6
Development / Implementation	112.6	33.4	44.7	15.8	0.0	0.0	0.0	0.0	0.0	206.4
Operations / Close-out	0.0	0.0	0.0	2.5	6.3	4.2	2.8	0.0	0.0	15.8
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FY 2009 President's Budget Request	**149.7**	**48.6**	**33.8**	**27.9**	**5.1**	**4.0**	**2.9**	**--**	**0.0**	**272.0**
Formulation	35.6	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	35.6
Development / Implementation	114.1	48.6	33.8	26.2	0.0	0.0	0.0	--	0.0	222.7
Operations / Close-out	0.0	0.0	0.0	1.7	5.1	4.0	2.9	--	0.0	13.7
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0
Changes from FY 2009 Request	**-1.5**	**-15.2**	**10.9**	**-9.6**	**1.1**	**0.2**	**-0.1**	**--**	**0.0**	**-14.2**
Formulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	--
Development / Implementation	-1.5	-15.2	10.9	-10.4	0.0	0.0	0.0	--	0.0	-16.3
Operations / Close-out	0.0	0.0	0.0	0.8	1.2	0.2	-0.1	--	0.0	2.1
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0

Note: The FY 2010 LCC number in the table above is understated by $2.2M due to the difference in the FY09 enacted bill and the April 2009 initial operating plan. Assuming approval of NASA's Initial Operating Plan for FY 2009, the estimated lifecycle cost of Aquarius will be $260.0M, a reduction of $12.0M from last year's estimate; the estimated Development cost will be $208.6M.

Explanation of Project Changes

The FY 2009 Budget for Aquarius reflected early estimates for the cost of the launch delay from July 2009 to May 2010. While the launch remains planned for May 2010, current cost trends and revised estimates are lower than budgeted last year.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder
Project In Development:	Aquarius

Project Purpose

The Aquarius mission will investigate the links between the global water cycle, ocean circulation, and climate. It will observe and model variations of sea surface salinity, and how these relate to changes in the water cycle and ocean circulation. This will yield an unprecedented view of the oceans' role in climate and weather.

For more information visit: http://aquarius.gsfc.nasa.gov/

Project Parameters

Aquarius is an instrument on Argentina's National Committee of Space Activities (CONAE) spacecraft, Satellite de Aplicaciones Cientificas-D (SAC-D). The combined NASA and CONAE instruments and spacecraft form the Aquarius/SAC-D observatory. This observatory will be launched into a polar, Sun-synchronous orbit that allows global coverage of ice-free ocean surfaces consistent with Aquarius/SAC-D science observational targets. The Aquarius instrument includes an L-band microwave radiometer (1.413 GHz) and scatterometer (1.26 GHz). The radiometer will measure the surface brightness temperature, which is related to the surface emissivity and physical temperature of the seawater. The surface emissivity is determined by the dielectric constant of seawater, which is related to salinity. The scatterometer is required to provide coincident information of sea surface roughness, a critical correction term for retrieval of sea surface salinity.

Project Commitments

Aquarius will launch in May 2010 to begin a three-year prime mission to measure sea surface salinity (SSS) with the precision, resolution, and coverage needed to characterize salinity variations and investigate the linkage between ocean circulation, Earth's water cycle, and climate variability.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
Aquarius Instrument (integrated radiometer/ scatterometer)	JPL	L-band microwave radiometer at 1.413 GHz; scatterometer at 1.26 GHz; SSS measurements with root-mean-sq random errors and systematic biases <= 0.2 psu on 150 km sq scales over ice-free oceans.	Same	Same
Spacecraft	CONAE	SAC-D	Same	Same
Launch Vehicle	Boeing	Delta II	Same	Same
Data Management	GSFC	N/A	Same	Same
Operations	CONAE	Command and telemetry	Same	Same

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder
Project In Development:	Aquarius

Schedule Commitments

The Aquarius mission entered a Risk Mitigation Phase (RMP) in July 2002. Following the RMP, the project was authorized to proceed to a formulation phase in December 2003. The Aquarius mission was authorized by the NASA Science Mission Directorate to proceed to Development on October 12, 2005. In November 2007, the NASA Science Mission Directorate Program Management Council approved a rebaseline of Aquarius, including a launch delay to May 2010.

Milestone Name	Confirmation Baseline	FY 2009 PB Request	FY 2010 PB Request
Development			
Mission Confirmation Review	September 2005	September 2005	September 2005
Mission CDR	August 2007	April 2008	July 2008
Aquarius Instrument Pre-ship Review [FY08 APG]	May 2008	May 2008	May 2009
Launch	March 2009	May 2010	May 2010

Development Cost and Schedule Summary

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Aquarius	2007	192.6	2009	208.6	8	Launch Readiness	7/1/2009	5/1/2010	10

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**192.6**	**208.6**	**16.0**
Payloads	55.4	88.1	32.7
Launch Vehicle/Services	78.9	76.1	-2.8
Ground Systems	5.5	4.3	-1.2
Science/Technology	10.9	9.6	-1.3
Other Direct Project Cost	41.9	30.5	-11.4

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder
Project In Development:	Aquarius

Project Management

The Jet Propulsion Laboratory is responsible for project management. The Science Mission Directorate Program Management Council is responsible for program oversight.

The Earth Science Division Director is the responsible official for this project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Launch Vehicle	KSC	KSC	None
Ground System	JPL	GSFC	None
Aquarius Instrument	JPL	JPL	None
Spacecraft	CONAE	None	CONAE
Radiometer	JPL	GSFC	None
Data management	GSFC	GSFC/JPL	None
Mission operations	CONAE	None	CONAE

Acquisition Strategy

Aquarius was competitively selected from proposals submitted in response to Earth System Science Pathfinder (ESSP) Announcement of Opportunity 3. All elements of the project were included in that selection, and there are no other planned major procurements.

The launch vehicle procurement was awarded to Boeing. Goddard Space Flight Center and the Jet Propulsion Laboratory were selected for the remaining project elements not provided by CONAE.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Aquarius Standing Review Board	7/2008	Mission Critical Design Review (CDR) was successful	N/A
Performance	Aquarius Standing Review Board	N/A	System Integration Review (SIR)	05/2009

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Spacecraft Development Delays	Further delays could impact launch date.	Monitor COMISION NACIONAL DE ACTIVIDADES ESPACIALES (CONAE) Progress and confirm commitments; reassess available schedule reserves.

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Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Multi-Mission Operations

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	143.0	148.1	149.9	160.3	165.4	161.3	165.5
Earth Science Multi-Mission Operations	143.0	148.1	149.9	160.3	165.4	161.3	165.5
FY 2009 President's Budget Request	167.8	140.5	159.1	157.9	166.5	170.9	--
Earth Science Multi-Mission Operations	167.8	140.5	159.1	157.9	166.5	170.9	--
Changes from FY 2009 Request	-24.8	7.5	-9.2	2.4	-1.1	-9.5	--

Note: Includes $7.5M in Recovery Act funding in FY09

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Multi-Mission Operations

Program Overview

The Earth Science Multi-Mission Operations Program acquires, preserves, and distributes observational data to support Earth Science focus areas in conformance with national science objectives. The Earth Science focus areas are as follows: (1) Climate variability and change; (2) Atmospheric composition; (3) Carbon cycle, ecosystems, and biogeochemistry; (4) Water and energy cycles; (5) Weather; and (6) Earth surface and interior. Facilities involved in this undertaking include data-handling, data processing, and archiving systems.

NASA's principal Earth Science information system is the Earth Observing System Data and Information System (EOSDIS), which has been operational since August 1994. EOSDIS acquires, processes, archives, and distributes Earth Science data and information products created from satellite data, which arrive at the rate of more than four trillion bytes (4 terabytes) per day. Having successfully created this system, NASA is using advances in information technology to expand its capabilities while providing continuous service to the user community.

The Evolution of EOSDIS Elements (EEE) effort is increasing efficiency and operability; increasing data usability by the research, application, and modeling communities; providing services and tools needed to enable use of NASA's Earth Science data in next-decadal models, research results, and decision support system benchmarking; and improving support for end users. The evolved system is being phased in -- a process that began in FY 2006 -- with milestones developed through 2008. The budget request for FY 2010 incorporates cost savings that will result from this effort. A system plan for 2015 will guide further improvements. Very modest investments will enable the system to keep technologically current, and incorporate new research data and services.

NASA Earth Science information is archived at eight Distributed Active Archive Centers (DAACs) located across the United States. The DAACs specialize by topic area, and make their data available to researchers around the world. For more information, please see http://eos.nasa.gov/eosdis.

Research opportunities related to EOSDIS are available through the Advanced Collaborative Connections for Earth System Science (ACCESS) at http://access-projects.gsfc.nasa.gov/ and Making Earth System data records for Use in Research Environments (MEaSUREs) at http://measures-projects.gsfc.nasa.gov/ programs. Participants in these programs are solicited through the Research Opportunities in Space and Earth Sciences (ROSES), the NASA Research Announcement soliciting basic and applied research proposals.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Multi-Mission Operations

Plans For FY 2010

The Earth Science Multi-Mission Operations Program will continue operation of EOSDIS, the DAACs and their accompanying functions, as well as Core System Science Data Processing Systems. The maintenance of these systems is important to the collection of data from Earth Science satellites in orbit, as well as to the continuity of Earth Science research efforts.

The Step 1 Evolution of EOSDIS Elements (EEE) effort, begun in 2006, is essentially complete. Savings and operational benefits from the Step 1 are being realized in FY 2009 and beyond. NASA plans to continue the support of the EEE to enable a service oriented architecture between now and 2015.

Five-year MEaSUREs Projects began work in 2008 to continue NASA support of the development of multi-instrument Earth System Data Records, including Climate Data Records. A new Advanced Collaborative Connections for Earth System Science (ACCESS) solicitation is being readied for NASA's Research Opportunities in Space and Earth Sciences - 2009 (ROSES-2009). These Cooperative Agreements are proving very valuable for keeping research and modeling communities actively involved with the EOSDIS architecture, and informing core infrastructure evolution decisions.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Multi-Mission Operations

Project Descriptions and Explanation of Changes

EOSDIS

EOSDIS is the central data handling system for NASA's Earth Science efforts. EOSDIS components funded in the project include:

* Production of standard science data products, using algorithms and software developed by EOS investigators;

* Active archive of data, as well as ordering, distribution, and data management. Also ensures the preservation of data, products, related algorithms, and system-configuration history;

* Information Management, enabling researchers to rapidly locate and retrieve data critical to their work; and

* User Support for research scientists, educators, students, and users in public agencies responsible for operational applications of the data, as well as for the general public.

Nominal EOSDIS development ended in FY 2007. All future development and improvements to the system will be planned through the Evolution of EOSDIS Elements process.

The Precipitation Processing System (PPS) is a measurement-based data and information system at GSFC that evolved from the TRMM Science Data and Information System (TSDIS). PPS continues to support the TRMM Science Team with analyzed rainfall data from TRMM as well as data from other precipitation instruments, and is also developing further to support the upcoming Global Precipitation Mission (GPM) to be launched in 2013.

Earth Science Multi-Mission Operations

This project funds the Elements of EOSDIS Evolution, aimed at improving the efficiency and effectiveness of EOSDIS while reducing the cost, and the Distributed Active Archive Centers, which collect, disseminate, and archive Earth Science data at eight centers across the Nation:

-The Alaska SAR Facility, which collects Synthetic Aperture Radar data, and information on sea ice, polar processes, and geophysics;

-The GSFC Earth Sciences Data and Information Services Center, which collects information on atmospheric composition, atmospheric dynamics, global precipitation, ocean biology, ocean dynamics, and solar irradiance;

-The Langley Research Center DAAC, which collects data on Earth's radiation budget, clouds, aerosols, and tropospheric chemistry;

-The Land Processes DAAC, which collects land processes data;

-The National Snow and Ice Data Center, which collects snow and ice data, as well as information about the cryosphere and climate;

-The Oak Ridge National Laboratory DAAC, which collects data on biogeochemical dynamics, and ecological data for studying environmental processes;

-The Physical Oceanography DAAC, which collects information on oceanic processes and air-sea interactions; and

-The Socioeconomic Data and Applications Center, covering population, sustainability, multilateral environmental agreements, natural hazards, and poverty.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Multi-Mission Operations

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Provide services and tools needed to enable use of NASA's Earth Science data in next-decadal models, research results, and decision support system benchmarking.	EOSDIS and DAACs	None.

Implementation Schedule

Project	Schedule by Fiscal Year (Prior, 08–22)	Phase	Beg	End
EOSDIS and Multi-Mission Operations (including DAACs)		Tech		
		Form		
		Dev		
		Ops	Aug-94	Dec-15
		Res		
Elements of EOSDIS Evolution (phased start-up beginning in FY 2008)		Tech		
		Form	Nov-04	Nov-05
		Dev	Dec-05	Mar-08
		Ops	Apr-08	Dec-20
		Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

The Science Mission Directorate and the Program Management Council have oversight responsibility for this program. The Earth Science Data and Information System Project Office at GSFC has primary responsibility for the program.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Precipitation Processing System (PPS)	GSFC	GSFC	NASA operates and is further developing the PPS to provide analyzed data from the TRMM and GPM missions. Both TRMM and GPM are joint missions of NASA and JAXA, a key stakeholder
ACCESS, MEaSUREs (peer-reviewed data research opportunities)	SMD	NASA Headquarters	None.
Multi-Mission Operations (operations and maint. of Core EOSDIS systems; DAACs, Evolution of EOSDIS)	GSFC	Earth Science Data and Information Systems Office, Goddard Space Flight Center	Key participants in the Multi-Mission Operations project include the space agencies of Europe, Canada, Germany, France, and Japan. Other U.S. agency partners include the National Oceanic and Atmospheric Administration (Department of Commerce), U.S. Geological Survey (Department of the Interior), and the Department of Defense.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Multi-Mission Operations

Acquisition Strategy

The EOSDIS Core System is a high-performance software system that provides science data ingest, archive and distribution capabilities for a multitude of Earth science instruments. Maintenance and operations for this system, utilized by three DAAC's post-Step 1 Evolution of EOSDIS Elements, is performed under contract procured by GSFC. The contract, managed by the ESDIS Project at GSFC, will be recompeted during this year

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	Earth Science Subcommittee	1/2008	The Earth Science Subcommittee reported that they were impressed by the success and clear sense of direction of this program.	TBD
Quality	DAAC Data Priority Workshops	01/2006	DAAC archive holdings peer reviewed for scientific merit. Multiple reviews related to individual research areas, all successful, several recommendations in work.	TBD

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Technology

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	43.0	54.1	45.9	47.2	48.2	49.5	52.7
Earth Science Technology	43.0	54.1	45.9	47.2	48.2	49.5	52.7
FY 2009 President's Budget Request	47.3	46.1	49.2	50.6	51.6	52.8	--
Earth Science Technology	47.3	46.1	49.2	50.6	51.6	52.8	--
Changes from FY 2009 Request	-4.3	8.0	-3.3	-3.3	-3.3	-3.3	--

Note: Includes $8M of Recovery Act funding in FY09

Program Overview

Advanced technology plays a major role in enabling Earth research and applications programs by providing an improved understanding of the total Earth system and its effects of natural and human-induced changes on the global environment. The Earth Science Technology Program (ESTP) provides the Earth Science Division with new capabilities, enabling previously unforeseen and infeasible science investigations, enhancing existing measurement capabilities, and reducing the cost, risk, and development times of Earth science measurements.

The Earth Science Technology Office (ESTO) provides strategic, science-driven technology assessments and requirements development. The program implements a science focused technology program by pursuing promising scientific and engineering concepts through open competition solicitations.

For more information, please see: http://esto.nasa.gov

Plans For FY 2010

ESTP will plan and implement development of new remote-sensing and information systems technologies for infusion into future science missions in order to enable, or dramatically enhance, measurements and data system capabilities. Planning will start with measurement priorities established by the science community, leading to systematically developed technology requirements and priorities. Studies may be conducted to assess measurement options for meeting technology performance requirements. Implementation will be performed through managing awarded tasks from competed solicitations in the three project areas: Instrument Incubator, Advanced Information Systems, and Advanced Technology Initiatives. Ongoing activities in these areas are described in more detail in the project description section below.

For FY2010 new work will only be solicited in the Instrument Incubator area. This FY2010 solicitation is planned to be part of the ROSES-2009 NASA Research Announcement. The solicitation will be a call for Earth science instrument system technology to address the measurements called for in the NRC Decadal Survey.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Technology

Project Descriptions and Explanation of Changes

Instrument Incubator

This project develops new and innovative instruments and measurement techniques at the system level, including laboratory development and airborne validation.

A solicitation for new instrument technologies was released in FY2007 and 21 new awards were made for sensors measuring atmospheric trace gases, aerosols, clouds, gravity fields, ocean topography, tropospheric winds, thermal land imaging, Earth radiation balance, precipitation, ocean color, snow, and vegetation. Instrument technologies include imagers, spectrometers, lidars, microwave sounders, and radars. These projects started in FY2008 and will continue through FY2011.

Some notable recent Instrument Incubator demonstrations include airborne radar measurements of Greenland ice sheet basal topography from high altitude and in two dimensions, the first simultaneous lidar measurements of tropospheric water vapor and aerosols from an aircraft, a ground-based demonstration of the hybrid Doppler wind lidar with simultaneous coherent and direct detection measurements, and airborne Ka-band interferometric synthetic aperture radar (SAR) topography measurements.

Advanced Information Systems Technology

This project develops end-to-end information technologies that enable new Earth-observation measurements and information products. The technologies are used to process, archive, access, visualize, communicate, and understand science data.

A solicitation released in June 2008 awarded 20 additional projects in early FY09, focused on three areas needed to support future Earth science measurements: Sensor System Support (to incorporate autonomy and rapid response in the sensing process and improve the science value of data); Advanced Data Processing (to improve or enhance the information extracted from the data stream); and Data Services Management (to better manage the growing body of Earth science data and allow for efficient exchange).

As examples, one project team deploys a fleet of SnoMote robots to test their mobile sensor network on Mendenhall Glacier in Alaska; the autonomous SnoMotes are designed to gather in-situ science data in dangerous, volatile ice environments to augment remote sensing data with accurate ground-truth measurements. Another task develops an inter-operable sensor architecture system that integrates four satellites, a UAV, and multiple ground sensors, data algorithms, and models, and has been demonstrated as a tool to help manage wildfires.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Technology

Advanced Technology Initiatives

The Advanced Technology Initiatives element provides for the development of critical component and subsystem technologies for the instruments and platforms which support the Earth Science Decadal Survey.

In 2008, the Advanced Technology Program solicited, via ROSES, for technologies such as: space-qualifiable laser transmitters, passive optical technologies, microwave and calibration technologies. Sixteen awards were made, supporting 14 of the 15 NASA Earth Science Decadal Survey missions. Some examples of these awards follow. A corrugated mirror telescope array for lidar will support seven of the Decadal Survey missions and help to enable the measurement of ice, crustal deformation, carbon dioxide and even 3D winds. Another notable technology is a large aperture deployable reflector which will support: soil moisture, ocean and river water dynamics, temperature and humidity soundings and snow accumulation for fresh water assessments. Other awards support measurements of: solar radiance, ozone, aerosols, atmospheric gas columns for air quality and ocean color for coastal ecosystem health and climate emissions.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Annually advance a portion of funded technology developments by one technology readiness level.	ESTP	same
Annually mature several technologies to the point of readiness for demonstration.	ESTP	same
Annually enable or improve one new science measurement capability.	ESTP	same

Program Management

The Earth Science Division within the Science Mission Directorate has oversight responsibility of the program office.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Instrument Incubator	ESTO	GSFC, JPL, LaRC, ARC, GRC	None.
Advanced Info Systems	ESTO	GSFC, JPL, LaRC, ARC, GRC	None.
Advanced Tech Initiatives	ESTO	GSFC, JPL, LaRC, ARC, GRC	None.

Acquisition Strategy

Tasks are procured primarily through full and open competition, such as the Research Opportunities in Space and Earth Sciences (ROSES)announcements.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Technology

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	NAC - Science Committee	10/2008	Technology in support of Decadal Survey missions	10/2010

Mission Directorate:	Science
Theme:	Earth Science
Program:	Applied Sciences

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	40.2	47.8	32.2	30.7	31.5	32.2	33.1
Pathways	40.2	47.8	32.2	30.7	31.5	32.2	33.1
FY 2009 President's Budget Request	45.4	33.8	33.8	31.3	32.1	32.8	--
Pathways	45.4	33.8	33.8	31.3	32.1	32.8	--
Changes from FY 2009 Request	-5.2	14.0	-1.6	-0.6	-0.6	-0.6	--

Note: Includes $4M of Recovery Act funding in FY09

Program Overview

The Applied Sciences Program (http://nasascience.nasa.gov/earth-science/applied-sciences) leverages NASA Earth Science research and observations for practical use, such as resource management and planning, decision-making, and improved predictions and policies. NASA Applied Sciences projects are designed to provide tools for improved decision making, through which the nation can better manage its resources, improve life quality, and strengthen the economy. NASA develops Earth Science applications in collaboration with end-users in public, private, and academic organizations. Examples include improved public health tracking systems for deadly diseases with the Center for Disease Control; advances in prediction of weather conditions for airplane pilots through the National Weather Service and the Federal Aviation Administration; improved tracking of air pollutants with the Environmental Protection Agency for decision-making on biomass burning and industrial practices; improving the Department of Agriculture's Global Economic Forecasting; and providing tools for better disaster management by state and local first responders..

Plans For FY 2010

In FY10, the Applied Sciences Program will continue or initiate projects across a range of application areas, including climate, public health, ecosystems forecasting, air quality, weather, water resources, natural disasters, and agriculture. These projects have been competively selected through NASA's Research Opportunities in Space and Earth Science (ROSES) 2005, 2007, and 2008 research announcements.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Applied Sciences

Project Descriptions and Explanation of Changes

Applied Sciences

In 2010, the Applied Sciences Program will sponsor two types of competitively selected projects across the range of applications described above:

1. "Decision Support through Earth Science Research Results. " These are 3-4 year projects that are carried out collaboratively with end users; the outcome of Decisions projects is to demonstrate and substantiate improvements to the end-users decision making activities.

2. "Earth Science Applications Feasibility Studies." These are short term projects to test the technical or the organizational feasibility of a new application.

The project also includes a small number of activities that crosscut and support the tasks, including cross-cutting projects,workforce development, and outreach.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Issue competed peer reviewed research awards.	Applied Sciences	None
Maximize resource utilization through restructuring and streamlining processes and operations across the program.	Applied Sciences	None

Program Management

Applied Sciences Program responsibility resides within the Earth Science Division of the Science Mission Directorate.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Earth Science Applications	NASA HQ	GSFC, LaRC, SSC, JPL, MSFC, and ARC	EPA, NOAA, USDA, FAA, DOE, DOI, CDC, USAID ; state agencies, and regional organizations such as the Southern Governor's Growth Policy Board, American Water Resources Association, Gulf of Mexcio Alliance. Private sector and universities.

Acquisition Strategy

The Earth Science Applications Program is based on full and open competition. Grants are peer reviewed and selected based on NASA Research Announcements and other related announcements.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Applied Sciences

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	National Research Council	10/2007	The Applied Sciences Program strategy and implementation.	N/A
Relevance	Applied Science Analysis Group	N/A	Applied Sciences program strategy and implementation.	12/2009

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
None at this time.	N/A	

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Mission Directorate:	Science
Theme:	Planetary Science

Theme Overview

Planetary Science is a grand human enterprise that seeks to discover the nature and origin of the celestial bodies among which we live, and to explore whether life exists beyond Earth. The scientific imperative for Planetary Science, the quest to understand our origins, is universal. How did we get here? Are we alone? What does the future hold? These overarching questions lead to more focused, fundamental science questions about our solar system: How did the Sun's family of planets and minor bodies originate? How did the solar system evolve to its current diverse state? What are the characteristics of the solar system that led to the origin of life? How did life begin and evolve on Earth and has it evolved elsewhere in the solar system? What are the hazards and resources in the solar system environment that will affect the extension of human presence into space?

To achieve progress in addressing these six fundamental science questions, NASA relies on a balanced program. There are seven programs within the Planetary Science Theme: Research, Lunar Quest, Discovery, New Frontiers, Mars Exploration, the Outer Planets, and the Technology Programs. Research supports two operating missions with international partners (Rosetta and Hayabusa), as well as Research and Analysis, Sample and Data Curation, data dissemination and analysis. The Lunar Quest Program consists of small robotic spacecraft missions, Missions of Opportunity, the Lunar Science Institute, and Research & Data Analysis. Discovery has two operating spacecraft (MESSENGER and Dawn), one radar instrument operating on an ESA Mars Express mission (ASPERA-3), one mission in its development phase (GRAIL), and four Missions of Opportunities (M3, EPOCH, DIXI, NExT). New Frontiers has one operating spacecraft (New Horizons) and one mission (Juno) currently in its development phase. The Mars Exploration Program has two spacecraft (Odyssey and MRO) and two rovers (Spirit and Opportunity) in operation, one instrument operating on an ESA mission (Mars Express), one mission in development (MSL), one mission in formulation (MAVEN), and project activities for technology, next decade mission design/development, and research. The Outer Planets Program includes research, one operating mission (Cassini) and an Outer Planets Flagship mission under study. Technology Program includes in-space propulsion systems, advanced power generation, and the advanced multi-mission support.

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**1,312.6**	**1,325.6**	**1,346.2**	**1,500.6**	**1,577.7**	**1,600.0**	**1,633.2**
Planetary Science Research	183.1	162.1	161.7	193.5	240.2	232.6	254.2
Lunar Quest Program	41.3	105.0	103.6	142.6	138.6	145.5	118.7
Discovery	136.4	247.0	213.2	234.6	256.8	256.5	264.3
New Frontiers	115.1	263.9	264.1	239.9	294.2	239.8	249.6
Mars Exploration	709.3	381.6	416.1	494.5	405.5	514.3	536.7
Outer Planets	62.2	101.1	98.6	97.1	140.3	117.7	118.5
Technology	65.2	64.9	89.0	98.4	102.1	93.5	91.4
FY 2009 President's Budget Request	**1,247.5**	**1,334.2**	**1,410.1**	**1,537.5**	**1,570.0**	**1,608.7**	**--**
Planetary Science Research	242.1	270.8	315.8	355.6	373.2	382.6	--
Discovery	153.0	247.0	258.3	256.0	326.1	140.5	--
New Frontiers	132.2	263.9	250.3	232.3	227.7	236.9	--
Mars Exploration	553.5	386.5	299.6	344.5	341.1	413.8	--
Outer Planets	81.9	101.1	216.7	279.4	230.6	362.0	--
Technology	84.8	64.9	69.3	69.6	71.3	73.0	--
Total Change from FY 2009 Request	**65.2**	**-8.6**	**-63.8**	**-36.8**	**7.7**	**-8.7**	**--**

Note: The human space flight review being undertaken during the summer of 2009 may result in changes to the International Lunar Network and robotic lunar exploration program. NASA will notify Congress if there are any changes to the request. Starting in FY 2010, the NEOO project is budgeted in the Planetary theme.

Plans for FY 2010

Planetary Science Research

Two new changes are included in the Planetary Science Research Program FY 2010 budget; Lunar Science transferred to the Lunar Quest Program (LQP), and the Near Earth Objects Observations (NEOO) project transferred from Earth Science to Planetary Science. The Research and Analysis program will continue to release research announcements and make selections. The Planetary Data System will continue to archive and release planetary science data to the science community in a timely manner for further scientific analysis. The Astromaterial Curation project will continue its efforts on curation and distribution of solar system samples (Astromaterials) returned by NASA planetary missions such as Stardust and Genesis. The Rosetta project will continue to support fly-by of Asteroid Lutetia (November 2010), and Hayabusa (MUSES-C) will continue to provide navigation, Deep Space Network tracking and science analysis support to JAXA to support an Earth Return in 2010. NEOO will continue to detect impact hazards to the Earth.

Lunar Quest Program

The Lunar Quest Program (LQP), previously the Lunar Science Project, is now moved to its own stand-alone budget and program line. Project elements under LQP includes the Lunar Atmosphere and Dust Environment Explorer (LADEE) and the International Lunar Network (ILN) missions, and the Lunar Science Research. LADEE will complete its preliminary design review in 2009 and will enter Implementation Phase (KDP-C) in FY 2010. The ILN mission will complete Phase A (KDP-A) by the end of FY 2010. Research Announcement for Lunar Research & Analysis will be released annually, followed by selections and awards. The human space flight review being undertaken during the summer of 2009 may result in changes to the International Lunar Network and robotic lunar exploration program. NASA will notify Congress if there are any changes to the request.

Discovery

Having completed its third fly-by of Mercury, MESSENGER will prepare for Mercury orbit insertion (currently planned for March 2011) while it continues its operations and return of valuable data from the three flybys. The Dawn spacecraft will be cruising from a Mars gravity assist in February 2009 in preparation for its Vesta encounter in 2011. ASPERA-3 will complete collection of data on its extended mission of Mars Express. The M3 instrument will continue to collect its science measurements in 2010 and perform data analysis. The EPOXI mission will be approaching its target, comet Hartley 2, in November 2010. GRAIL will complete its Critical Design Review in first quarter FY 2010 and begin Assembly, Test, and Launch Operations (ATLO) by the end of 2010. With the release of the Announcement of Opportunity (AO) for the next Discovery mission in late CY 2009, concept study selection will be made in 2010.

New Frontiers

Juno will deliver instruments and hardware in preparation for ATLO in FY 2010. The New Horizons mission will continue on its course toward Pluto and its moons, with periodic spacecraft and instrument checkouts as it cruises. Following the Announcement of Opportunity (AO) release in 2009, the New Frontiers 3 concept studies will be selected in FY 2010.

Mars Exploration

The Mars Science Laboratory (MSL) launch date has moved from 2009 to 2011. During FY 2010 MSL will complete remaining hardware and software development, and will start to conduct the Rover System Environmental Test Program. In September 2008, NASA selected the Mars Atmosphere and Volatile EvolutioN (MAVEN) spacecraft as the next Mars Scout mission. By the end of FY 2010 MAVEN will successfully complete the Preliminary Design Review (PDR). ExoMars will have an extended Phase B in FY 2010. Odyssey will be in a new orbit with an expected improved sensitivity to detect minerals on the surface. The Mars Reconnaissance Orbiter (MRO) and (if technically possible) both Spirit and Opportunity rovers (MER) will continue to operate and perform data analysis throughout FY 2010. Concept studies with ESA for partnership missions in 2016/2018 will continue.

Plans for FY 2010

Outer Planets

In February 2009 NASA down-selected the Outer Planets Flagship (OPF) from three science targets to focus on the Europa Jupiter System. In addition to further definition study and technology development efforts for the Europa Jupiter System Mission (EJSM) throughout FY 2010, NASA will also continue to negotiate the details of a potential partnership with the European Space Agency (ESA) and other international partners. NASA Cassini will continue its historic operations and data analysis.

Technology

While there are no major changes to the Technology Program, some funds were added to the program to allow for a completion of the NASA's Evolutionary Xenon Thruster (NEXT) electric propulsion life validation and to start the build for the Advanced Stirling Radioisotope Generator (ARSG) proto-flight unit that would support a flight in the 2013-2014 timeframe. The Technology Program FY 2010 budget will also provide for the Advanced Multi-Mission Operation System (AMMOS) effort in its continuation in the development of multi-mission software tools for spacecraft navigation and mission planning.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

The Planetary Science Program is guided by U.S. National Space Policy and follows NASA's tradition of establishing its priorities through consultation with world-class experts. Planetary Science relies on two advisory bodies for scientific assessments and decadal surveys: the NASA Advisory Council and the National Research Council's (NRC) Space Studies Board. The NRC's decadal surveys help NASA prioritize missions and scientific objectives.

Planetary Science seeks to achieve both near and long-term science goals by studying solar system objects and phenomena in situ. Planets and satellites of the solar system and the ancient icy bodies far from the Sun are "Rosetta stones" that can tell unique stories about the evolution of the solar system. As researchers learn more about the origins of living organisms on Earth and about the solar system's planets and moons, they may learn that life has arisen in places beyond Earth.

Robotic explorers gather data to help scientists understand how the planets formed, what triggered different evolutionary paths among planets, and how Earth formed, evolved, and became habitable. To search for evidence of life beyond Earth, scientists use this data to map zones of habitability, study the chemistry of alien worlds, and unveil the processes that lead to conditions necessary for life.

Robotic exploration will generate knowledge about our solar system needed to identify the most promising human exploration missions. This knowledge will also help enable safe human space exploration in the forbidding environments they will encounter.

Relevance to the NASA Mission and Strategic Goals:

Planetary Science supports NASA's achievement of Strategic Plan Sub-goal 3C: Advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space.

This effort is comprised of four Outcomes:
3C.1: Progress in learning how the Sun's family of planets and minor bodies originated and evolved.
3C.2: Progress in understanding the processes that determine the history and future of habitability in the solar system, including the origin and evolution of Earth's biosphere and the character and extent of prebiotic chemistry on Mars and other worlds.
3C.3: Progress in identifying and investigating past or present habitable environments on Mars and other worlds, and determining if there is or ever has been life elsewhere in the solar system.
3C.4: Progress in exploring the space environment to discover potential hazards to humans and to search for resources that would enable human presence.

See FY 2010 Performance Plan, under Management and Performance, for specific annual goals for this Theme.

Relevance to education and public benefits:

Mission Directorate:	Science
Theme:	Planetary Science

The Planetary Science Theme uses its missions, research programs, and the human resources of the space science community to enhance the quality of American science, mathematics, and technology education, particularly at the pre-college level. The innovative nature of planetary science projects creates an impetus for new techniques and technologies that later benefit the public. The FIRST Robotics project is a concrete example of the Planetary Science Theme's contribution to education. The Planetary Theme is dedicated to sharing the excitement of discoveries and knowledge generated by space science missions and research, with the public, and thus contributing to educating and inspiring the next generation of scientists and technical workers needed for the 21st century.

Public benefits from Planetary Science include a growing understanding of the solar system and Earth's significance within it. NASA's robotic science missions are paving the way for understanding the origin and evolution of the solar system and working to identify past and present habitable locations. The Theme also enables human space exploration by studying and characterizing alien environments and identifies possible resources that will enable safe and effective human missions to the Moon and beyond.

Performance Achievement Highlights:

After landing on May 25, 2008, Phoenix studied soil with a chemistry laboratory, a microscope, a conductivity probe and cameras. Laboratory tests performed by NASA's Phoenix Mars Lander identified water in a Martian soil sample. The lander's robotic arm delivered the soil sample to an instrument that heats the sample and then identifies the resulting vapors. Besides confirming the 2002 Mars Odyssey finding of water ice near the surface, the science team has tried to determine whether the water ice ever thaws enough to allow biological process and if carbon-containing chemicals and other raw materials necessary for life are present.

Phoenix confirmed that a significant amount of water exists on the surface of arctic Mars, a potential resource for future human exploration. Phoenix also discovered a class of compounds called perchlorates in the soil. Although a few biological forms on Earth use perchlorates as an energy source, they are generally toxic to most life forms if consumed. However, perchlorates are routinely used as the oxidizer in rocket fuel, also a potential resource. The lander's meteorological station documented a temperature range in the Martian polar north of approximately -20 to -115 degrees Fahrenheit during the summer, after which temperatures fell sharply. These conditions pose challenges to human exploration of the Martian polar regions.

The Cassini spacecraft performed a flyby of Saturn's moon Enceladus, coming within 50 kilometers of the moon's surface. During the flyby, the spacecraft collected samples that may provide evidence of a water ocean and organics. The flyby also provided images of the surface that are providing data on the difference between the north and south poles, which is critical to understanding the moon's geological evolution. Furthermore, there is evidence of some complex organic chemicals and several other conditions that scientists believe to be the pre-conditions for life. Future flybys and possibly future missions will provide more pieces in this intriguing puzzle.

On the first of its passes by Mercury, the MESSENGER spacecraft provided new insights into the origin and evolution of the solar system's smallest planet. MESSENGER confirmed that Mercury has a dipolar internal magnetic field, created an inventory of the heavy ions in the planet's magnetosphere, and detected two current sheet boundaries that may indicate a planetary ion boundary layer.

In 2008, NASA Selected GRAIL, a lunar gravity mapping mission, as the Discovery 11 mission and MAVEN, a Mars aeronomy mission, as the Mars Scout 2nd mission. The Juno mission, which will conduct an in-depth study of Jupiter, completed its Preliminary Design Review and moved into implementation to support an August 2011 launch.

The Lunar Science Program's LADEE lunar dust mission completed studies and moved into formulation phase. The Program also established the NASA Lunar Science Institute.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	NASA Advisory Council	02/2007	Reviews science and program implementation strategies and relevancies to the NASA strategies and goals. Findings from the 2007 review included, NASA has made significant progress toward implementing the recommendations of the NRC's decadal survey and Mars Architecture report. NASA's current planetary exploration program is highly productive, carrying out exciting missions and making fundamental discoveries.	12/2010
Relevance	National Research Council	12/2003	Decadal Survey of Planetary Science priorities/Published Decadal Report entitled "New Frontiers and the Solar System: An Integrated Exploration Strategy". Work on the next Decadal Survey began in 2008.	09/2013

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Planetary Science Research

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	183.1	162.1	161.7	193.5	240.2	232.6	254.2
Planetary Science Research and Analysis	133.6	135.0	135.1	144.4	153.2	156.9	160.7
Other Missions and Data Analysis	18.6	19.5	21.4	22.2	22.3	22.7	29.3
Education and Directorate Management	27.7	3.9	1.4	23.1	60.7	49.0	60.1
Near Earth Object Observations	3.3	3.7	3.8	3.8	3.9	4.0	4.1
FY 2009 President's Budget Request	245.4	274.5	319.6	359.5	377.1	386.6	--
Planetary Science Research and Analysis	127.8	142.4	145.1	150.4	155.2	159.0	--
Other Missions and Analysis	41.8	124.5	143.4	162.2	172.3	174.6	--
Education and Directorate Management	72.4	3.9	27.4	43.1	45.7	49.0	--
Near Earth Object Observations	3.4	3.7	3.8	3.8	3.9	4.0	--
Changes from FY 2009 Request	-62.3	-112.4	-157.9	-166.0	-137.0	-154.0	--

Program Overview

The Planetary Science Research Program supports the development of theoretical tools and laboratory data needed to analyze flight data, makes possible new and better instruments to fly on future missions, and analyzes the data returned. These capabilities allow Planetary Science to answer specific questions and develop an increased understanding of the origin and evolution of the solar system. This program represents an essential complement to flight missions, providing the scientific research and the theoretical foundation to allow the nation to fully utilize the unique data sets returned from the missions exploring the solar system. It is also NASA's primary interface with university faculty and graduate students in this field as well as the research community in general. The Research Program achieves this goal by supporting research grants which are solicited annually and subjected to a careful peer review before being awarded.

The changes in the table above do not reflect a reduction, but instead reflect a transfer of Lunar Science Research (carried within Planetary Science Research in the FY 2009 Request) to the new Lunar Quest Program in the FY 2010 Request.

For further information see: http://nasascience.nasa.gov/planetary-science

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Planetary Science Research

Plans For FY 2010

Release Research Announcements soliciting Research and Analysis proposals and make selections.

Continue planetary science data archiving and releasing of this data to the science community in a timely manner for further scientific analysis.

Continue curation and distribution of solar system samples (Astromaterials) returned by NASA planetary missions such as Stardust.

Support the Rosetta fly-by of Asteroid Lutetia (November 2010).

Continue to provide for Hayabusa (MUSES-C) navigation and Deep Space Network Tracking and coordinating Science Analysis to support an Earth Return in 2010.

Continue to support Near Earth Objects Observations (NEOO) to detect impact hazards to the Earth.

Project Descriptions and Explanation of Changes

Planetary Science Research and Analysis

The scope of Research and Analysis (R&A) is wide because the effort must provide new theories and instrumentation that enable the next generation of flight missions. R&A also provides the foundation for the formulation of new scientific questions and strategies. Discoveries and concepts developed in the R&A Project are the genesis of scientific priorities, missions, instrumentation, and investigations. R&A supports research tasks in areas such as: astrobiology and cosmochemistry; the origins and evolution of planetary systems; and the atmospheres, geology, and chemistry of the solar system's planets (other than Earth). R&A provides for instrument and measurement concepts, and supports the initial definition and development of instruments for future Discovery, New Frontiers, or Mars missions. A new and fully competed call for missions' studies will identify a range of outer planets science targets and mission options that could be achieved at various budget levels, creating a "menu" of mission options that NASA could pursue in the future. Lunar science research has been moved to the Lunar Quest Program.

Other Missions and Data Analysis

Rosetta, a European Space Agency/NASA comet rendezvous mission in operations phase, launched in March 2004 and will arrive at comet Churyumov-Gerasimenko in 2014. The prime scientific objective of the Rosetta mission is to study the origin of comets, the relationship between cometary and interstellar material, and the implications of comets with regard to the origin of the solar system. The Rosetta spacecraft will be the first to undertake the long-term exploration of a comet at close quarters. It comprises a large orbiter, which is designed to operate for a decade at large distances from the Sun, and a small lander. Each of these carries a large complement of scientific experiments designed to complete the most detailed study of a comet ever attempted. Rosetta will allow scientists to look back 4600 million years to an epoch when no planets existed and only a vast swarm of asteroids and comets surrounded the Sun.

Hayabusa (MUSES-C), in operations phase, is a joint Japanese/NASA mission to rendezvous with near-Earth asteroid and return samples. The spacecraft launched in May of 2003 and landed on the Asteroid Itokawa in September 2005. In April 2007, the spacecraft began its return to Earth bringing with it an asteroid sample. Hayabusa will arrive at Earth in 2010. Hayabusa observed Itokawa's shape, geographical features, reflectance, mineral composite, and gravity from an altitude of 3 to 20 km, and clarified the Itokawa's structure as a "pile of rubble." Science published seven Hayabusa-related essays, the first time for the magazine to feature a Japanese asteroid probe project. The Hayabusa project also received a "Space Pioneer Award" from the National Space Society of the United States at the International Space Development conference held in Los Angeles in May.

The Planetary Data Systems (PDS) and Astromaterials Curation Projects provide funds for data archives, sample-holding facilities, and analysis tools needed to perform research. PDS is the active data archive for NASA's Planetary Science Theme. The Astromaterials Curation Facility, at Johnson Space Center, provides services for all returned planetary materials that do not require planetary protection laboratories.

Education and Directorate Management

The Education and Directorate Management projects include Science Mission Directorate-wide management reserve. It is used to support unforeseen administrative and programmatic requirements that cannot and/or should not be funded by other programs and projects.

For Inspiration and Recognition of Science and Technology (FIRST) is a non-profit organization dedicated to increasing interest in science, technology, engineering and mathematics among youth in the United States. There are annual activities and events to expose students to challenging applications of engineering and science. The FIRST Robotics competition consists of national contests in which high school students team with engineers from government, industry, and universities to get hands-on experience and mentoring from engineering and technical professionals.

Near Earth Object Observations

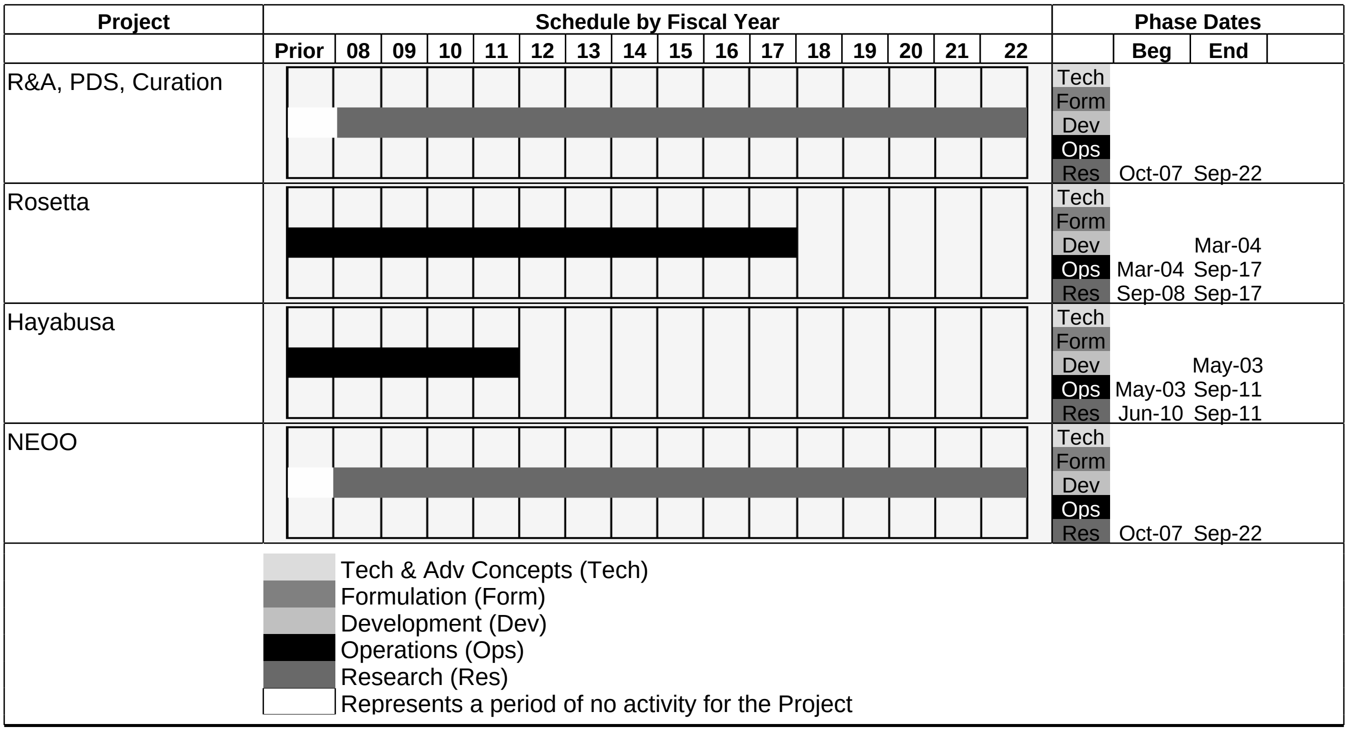
The Near Earth Object Observations (NEOO) was transfered from the Earth Science Division beginning in FY 2010. Its objective is to detect and track at least 90 percent of the Near Earth Objects, asteroids, and comets that come within 1.3 Astronomical Units of the Sun, and to find those which have any potential to collide with Earth and do significant damage at the surface. A network of existing ground-based telescopes and modifications to existing space-based sensors, and supporting data processing and analysis infrastructure, will be funded to achieve this objective.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Release of Research Announcements soliciting R&A proposals (annual selections)	Research & Analysis (R&A)	Same
Meeting commitments to the International Partners as agreed to in the MOU.	Rosetta and Hayabusa	Same
Archive and release mission data to the science community within 6 months of downlink.	Planetary Data System (PDS)	Same
Store new samples of Astromaterials and distribute them as requests are approved by CAPTEM.	Astromaterials Curations	Same
Continue search for hazardous NEOs, asteroids, and comets down to 140 meters in size that may pose an impact threat.	NEOO	Same

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Planetary Science Research

Implementation Schedule



Program Management

NASA HQ is responsible for R&A; JPL is responsible for Rosetta and Hayabusa operations and the NEOO Program Office; GSFC is responsible for PDS project management; and JSC is responsible for Astromaterials Curation project management Program Office.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Research & Analysis	HQ	Multiple (NASA Centers, Universities, industries, etc.)	None
Rosetta	JPL	JPL	The European Space Agency (ESA) built the spacecraft, provided the launch vehicle, and operates the spacecraft.
Hayabusa (Muses -C)	JPL	JPL	Japan Aerospace Exploration Agency (JAXA) responsibilities include the spacecraft, launch vehicle, and operations.
Planetary Data System (PDS)	GSFC	JPL and other Discipline Nodes	None
Astromaterials Curation	JSC	JSC	NSF and Smithsonian Institution for Antarctic meteorites
NEOO	JPL	JPL	None

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Planetary Science Research

Acquisition Strategy

The R&A FY 2010 budget will fund competitively selected activities from the ROSES-07 (Research Opportunities in Space and Earth Science) Omnibus NRA. All major acquisitions for Rosetta, Hayabusa, Planetary Data System (PDS), Astromaterial Curation, and Near Earth Object Observation are in place. The following institutions operate the PDS nodes: Atmospheres Node (NMSU); Engineering Node (JPL); Geosciences Node (Wash U St. Louis); HiRISE Data Node (UAZ); Human Interface Design (ARC); Imaging Node (USGS Flagstaff); Navigation Ancillary Information Facility (NAIF at JPL); Planetary Plasma Interactions Node (UCLA); Radio Science (SETI); Rings Node (SETI); Small Bodies Node (U of MD); JPL, and ARC.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Panel of scientists	10/2008	Curation and Analysis Planning Team for Extraterrestrial Materials (CAPTEM) reviews ongoing curation activities and future plans. Curation of Genesis, Stardust, and Apollo lunar samples are on track and meeting distribution requests. The Curation Project is performing well overall. They reviewed and approved numerous samples for distribution to scientists and reviewed plans for the upgrade of JSC curation facilities and efforts to work with Constellation on curation of samples on the Moon.	03/2009

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	41.3	105.0	103.6	142.6	138.6	145.5	118.7
Lunar Science	36.2	64.8	33.3	52.4	58.5	64.3	39.4
Lunar Atmosphere and Dust Environment Explorer	5.1	30.2	66.5	73.9	31.1	0.0	0.0
International Lunar Network	0.0	10.0	3.7	16.3	48.9	81.2	79.3
Changes from FY 2009 Request	41.3	105.0	103.6	142.6	138.6	145.5	--

Note: The human space flight review being undertaken during the summer of 2009 may result in changes to the robotic lunar exploration program. NASA will notify Congress if there are any changes to the request.

Program Overview

The Lunar Quest Program (LQP) goal is to conduct science exploration of the Moon through research and analysis, and through the development of a series of small-medium satellite and surface missions. The LQP answers the National Research Council report, "The Scientific Context for Exploration of the Moon" (SCEM) and fits within NASA's Space Exploration Policy to scientifically explore our Solar System. The LQP complements other lunar missions sponsored by NASA and international agencies.

The goal of the LQP is to provide small robotic lunar science investigations and lunar research and analysis addressing prioritized science objectives. LQP objectives include:
- Re-establish lunar science and a lunar science community;
- Facilitate the application of enhancing or enabling technologies to support flight missions; and
- Enhance science opportunities in the implementation of NASA's lunar exploration goals.

In order to achieve LPQ goals and objectives, the program currently exists as a loosely coupled, multi-element science program with both flight and research opportunities. The projects will be independent but will also have interrelated objectives and a common management and funding structure. The LQP program element includes two classes of flight opportunities for lunar science investigations: small robotic science spacecraft or landers and a Mission of Opportunity (MoO). The Lunar Atmosphere and Dust Environment Explorer (LADEE) and the International Lunar Network (ILN) are two small robotic orbiter and lander missions currently under formulation as part of the LQP. The LQP also includes a Lunar Science Research and Analysis (R&A) element that will enhance participation and collaboration within the lunar science community. This science participation will provide near-term activity stimulating and reinvigorating the broad scientific community enticing international collaboration for mutual leverage in accomplishing lunar goals and objectives.

In the FY 2009 Request, funding for these efforts was carried under the Planetary Science Research Program. The human space flight review being undertaken during the summer of 2009 may result in changes to the robotic lunar exploration program. NASA will notify Congress if there are any changes to the request.

Plans For FY 2010

Confirm LADEE for Implementation Phase (KDP-C).

Complete ILN Phase A (KDP-A) by the end of CY 2010.

Release Research Announcement soliciting Research & Analysis proposals and make selections. The human space flight review being undertaken during the summer of 2009 may result in changes to the robotic lunar exploration program. NASA will notify Congress if there are any changes to the request.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Lunar Quest Program

Project Descriptions and Explanation of Changes

Lunar Science

Lunar Research & Analysis (R&A) will enhance participation and collaboration within the lunar science community. It is composed of competed research and analysis opportunities such as: National Lunar Science Institute (NLSI) - a virtual institute of geographically dispersed researchers and institutions, directed by the Ames Research Center for management and implementation; Lunar Advanced Science and Exploration Research (LASER) - a lunar-only element in the Research Opportunities in Space and Earth Science (ROSES) NASA Research Announcement (NRA); Lunar Data Competed Studies - research and analysis of existing and new lunar science data procured under other ROSES elements.

After one year of operation to accomplish Exploration objectives, Lunar Reconnaissance Orbiter (LRO) will be transitioned to SMD/Planetary Science in August 2010 to start a two-year lunar science mission as identified by the NRC (Decadal Survey and Scientific Context for Exploration of the Moon [SCEM] report). The LRO Science Mission will give the scientific community a unique opportunity to concentrate the capabilities of the 7 LRO instruments on focused lunar science investigations identified from the data obtained in the "mapping" mission. The focused investigations will allow us to quantify our understanding of the origin and evolution of the Moon.

Lunar Program Management provides management and oversight of the Lunar Quest selected flight missions. This line also provides for independent panel reviews and selections process efforts.

Lunar Atmosphere and Dust Environment Explorer (LADEE)

Currently in Phase A, LADEE, the first LQP mission, is a cooperative effort between Ames Research Center (ARC) and Goddard Space Flight Center (GSFC). The LADEE mission objective is to address high priority science goals as identified by the NRC report, to determine the global density, composition, and time variability of the fragile lunar atmosphere before it is further perturbed by future human activity. LADEE's measurements will also determine the size, charge, and spatial distribution of electrostatically transported dust grains and assess their likely effects on lunar exploration and lunar-based astronomy. Additionally, LADEE will carry the optical laser communications package to be provided by the Space Operations Mission Directorate (SOMD). The optical laser will technically demonstrate high bandwidth communication from the Moon. The orbiter is currently planned for a launch in May 2012. The nominal science mission is 100 days in length, with an option for an additional year of laser communications demonstrations.

International Lunar Network (ILN)

Currently in Pre-Phase A, the ILN Anchor Nodes will be the backbone of a lunar geophysical network, providing global coverage by involving US and international landed missions as individual stations working together - the first US robotic lunar landers since 1968! The ILN Anchor Nodes project is a cooperative effort between Marshall Space Flight Center (MSFC) and the Johns Hopkins University Applied Physics Laboratory (APL). The ILN mission will deliver and will operate geophysical instrument packages at different places on the lunar surface. The nominal mission length is for six years concurrent of surface operations, including operating the instruments through lunar night. The human space flight review being undertaken during the summer of 2009 may result in changes to the International Lunar Network and the robotic lunar exploration program. NASA will notify Congress if there are any changes to the request.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Lunar Quest Program

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Conduct scientific investigations to achieve SMD lunar science goals and objectives in the "Scientific Context for Exploration of the Moon" (SCEM, 2007).	Lunar Quest Program	New Program

Implementation Schedule

Schedule by Fiscal Year: Prior, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22

Project	Phase	Beg	End
Lunar Atmosphere and Dust Environment Explorer (LADEE)	Tech		
	Form	Mar-08	Jun-10
	Dev	Jun-10	May-12
	Ops	Jun-12	Sep-13
	Res		
International Lunar Network (ILN) 1 & 2	Tech		
	Form	Mar-08	Sep-12
	Dev	Oct-12	Dec-16
	Ops	Jan-17	Jan-23
	Res		
Research	Tech		
	Form		
	Dev		
	Ops		
	Res	Oct-08	Sep-22
Lunar Reconnaissance Orbiter (LRO) Science Mission	Tech		
	Form		
	Dev		
	Ops		
	Res	Aug-10	Sep-13

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

Scientific mission priorities and assignment responsibilities reside with SMD. MSFC has Lunar Quest program management responsibility.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
LADEE	MSFC	ARC, GSFC, KSC	N/A
International Lunar Network (ILN)	MSFC	MSFC, APL, KSC, GRC, DOE	TBD
Research & Analysis	HQ	ARC, GSFC, MSFC, JPL, JSC	N/A

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Lunar Quest Program

Acquisition Strategy

The LQP acquisition strategy is to direct development of flight projects including the spacecraft bus to NASA centers, competitively select instruments and science team participation through the Research Opportunities in Space and Earth Science (ROSES) NASA Research Announcement (NRA) and the Stand Alone Missions of Opportunity (SALMON) AO processes.

Major acquisitions for the LADEE (ARC and GSFC) and ILN (MSFC) projects are in place. NASA has selected ARC and GSFC to provide the spacecraft for LADEE, and MSFC to provide the spacecraft for ILN. Three science instruments have been selected for LADEE (Neutral Mass Spectrometer [NMS], UV Spectrometer [UVS], and Lunar Dust EXperiment [LDEX], and an optical communication package. The NMS instrument will be provided by GSFC, ARC will provide UVS, University of Colorado/LASP will provide LDEX, and SOMD selected MIT/LL and GSFC to provide its LLCD contribution.

Science instruments and research and analysis of existing and new lunar science data are to be procured under the Research Opportunities in Space and Earth Science (ROSES) NASA Research Announcement (NRA). Mission of opportunity (MO) are to be selected via the Stand Alone Missions of Opportunity (SALMON) AO.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	NA	Standing Review Board (SRB) will be assigned to first perform a Program Acceptance Review (PAR) assessing the Program's readiness to enter implementation. Following approval to enter implementation, the SRB will thereafter conduct biannual Program Implementation Reviews (PIRs) throughout implementation to assure the program is operating according to the program plan and that it is successfully meeting program objectives.	04/2009

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Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	136.4	247.0	213.2	234.6	256.8	256.5	264.3
Gravity Recovery and Interior Laboratory (GRAIL)	67.0	122.4	124.1	104.8	41.4	4.7	0.0
Other Missions and Data Analysis	69.3	124.6	89.1	129.9	215.4	251.8	264.3
FY 2009 President's Budget Request	153.0	247.0	258.3	256.0	326.1	140.5	--
Gravity Recovery and Interior Laboratory (GRAIL)	0.0	122.4	122.8	113.1	24.9	5.7	--
Other Missions and Data Analysis	153.0	124.6	135.5	143.0	301.3	134.8	--
Changes from FY 2009 Request	-16.6	0.0	-45.1	-21.4	-69.3	116.0	--

Program Overview

Robotic space exploration holds tremendous opportunity for exploration and discovery. Even with the vast amount of knowledge gained since exploration of the solar system began, there are many unanswered questions about the origin and evolution of our own solar system. NASA's Discovery Program provides the opportunity to utilize innovative missions to uncover the mysteries of the solar system. It provides highly-focused planetary science investigations designed to increase our understanding of the solar system and its evolution. The Discovery Program offers the scientific community the opportunity to assemble and lead cross-functional teams to design and implement exciting science investigations that complement NASA's larger planetary science missions.

All completed Discovery missions (NEAR, Mars Pathfinder, Lunar Prospector, Deep Impact, Stardust, and Genesis) have achieved groundbreaking science, with each taking a unique approach to space exploration. Current Discovery missions include: ASPERA-3, MESSENGER, Dawn, Moon Mineralogy Mapper (M3), EPOXI, StardustNExT, and the Gravity Recovery and Interior Laboratory (GRAIL). Additional details on the GRAIL mission are contained in the GRAIL "Project in Development" pages.

For more information regarding the Discovery Program, see http:/discovery.nasa.gov.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery

Plans For FY 2010

The MESSENGER spacecraft will have completed its third fly-by of Mercury in late FY 2009 (9/2009) and will begin preparations for its Mercury orbit insertion in 2011. The Dawn spacecraft will be cruising from a Mars gravity assist in February 2009 in preparation for its Vesta encounter in 2011. ASPERA-3 will complete collection of data on its extended mission of Mars Express. The Moon Mineralology Mapper (M3) instrument, as a part of the ISRO's Chandrayaan-1 payload, will continue to collect its science measurements and perform data analysis. The EPOXI mission will be approaching and will begin preparation for the encounter of its target, comet Hartley 2, in November 2010. GRAIL will complete its Critical Design Review in the first quarter of FY 2010 and plans to begin Assembly, Test, and Launch Operations (ATLO) by the end of 2010. The next Announcement of Opportunity (AO) for a new Discovery mission will be released in CY 2009 followed by a concept study and selection in 2010.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery

Project Descriptions and Explanation of Changes

GRAIL

GRAIL is in its development phase. GRAIL will perform high-quality gravity field mapping of the Moon to determine its interior structure. GRAIL will provide the most accurate global gravity field to date for any planet, including Earth. GRAIL will enable the public to directly interact with observations through cameras on each satellite dedicated to public outreach and education. GRAIL was selected in December 2007 and given approval to proceed into its Development Phase (Phase C) in January 28, 2009. GRAIL is currently scheduled to launch in September 2011. Additional detail can be found in the GRAIL section of this document.

Other Missions and Data Analysis

The Dawn mission while in its operations phase, has begun a journey to the two largest and most massive asteroids in our solar system, Vesta and Ceres. Vesta's physical characteristics reflect those of the inner planets, whereas Ceres' are more like the icy moons of the outer planets. By studying these contrasts and comparing these two minor planets, scientists will develop an understanding of the transition from the rocky inner regions to the icy outer regions of the Solar System. The Dawn mission marks the first time a spacecraft will orbit a body in the main asteroid belt and the first time a spacecraft will orbit two targets, enabling a detailed and intensive study of both. Dawn launched in September 2007. After a Mars gravity assist in February 2009, the Dawn spacecraft will encounter and orbit Vesta in 2011, then travel an additional three years to reach and orbit Ceres.

MESSENGER, a mission to Mercury, is in its operations phase and launched on August 3, 2004. It has collected the first images toward providing coverage of the entire planet and collected detailed information on the composition and structure of Mercury's crust, its geologic history, the nature of its thin atmosphere and active magnetosphere, and the makeup of its core and polar materials. MESSENGER is the first deep-space mission to use a circularly polarized phased-array antenna - the antenna "points" electronically, which allows MESSENGER to return a large amount of data without using a deployable, gimbaled antenna (such as the one that failed to deploy on the Galileo mission). MESSENGER carries seven scientific instruments and a radio science experiment to accomplish an ambitious objective: return the first data from Mercury orbit. The miniaturized payload ' designed to work in the extreme environment near the Sun ' will image all of Mercury for the first time, as well as gather data on the composition and structure of Mercury's crust, its geologic history, the nature of its active agnetosphere and thin atmosphere, and the makeup of its core and the materials near its poles.

As a result of three 2006 Discovery missions of opportunity being selected on June 19, 2007, Deep Impact and Stardust are both in extended operations phase. The EPOCh mission will use the high-resolution camera on the Deep Impact spacecraft to search for Earth-sized planets around other stars. The DIXI mission will investigate comets using the existing Deep Impact spacecraft for an extended flyby mission to a second comet to take pictures of its nucleus and increase our understanding of the diversity of comets. These two missions were combined into the joint mission EPOXI. The Stardust NExT will use the existing Stardust spacecraft for a flyby of comet Tempel 1. Since the Deep Impact mission visited Tempel 1 in 2005, the comet has made another close approach to the sun, possibly eroding its surface. This flyby is to look for surface changes to Tempel 1 since 2005.

ASPERA-3, a Mission of Opportunity, is in its operational phase. It is one of seven instruments aboard the European Space Agency's Mars Express spacecraft in orbit around Mars, with a goal to study the interaction of the solar wind and Martian atmosphere. The measurements taken by this instrument will help answer the question of how strongly the interplanetary plasma and electromagnetic fields affect the Martian atmosphere.

The M3 instrument, in its operation phase, is part of the scientific payload for ISRO's Chandrayaan-1 mission which launched October 2008 from India. Primary objectives of M3 are to assess the mineral resources of the Moon, and characterize and map the composition of the surface at high spatial resolution. The M3 payload has reached its final polar orbit of the Moon and will operate during the next two years with active data collection concentrated into four 2-month periods. While Global mapping has top priority, additional targeted mapping will occur at M3's highest resolution.

Other Missions & Data Analysis (Continued)

The Discovery Research line provides funding for: Discovery Data Analysis; Sample Return Laboratory Instruments (SRLI) which supports development of new instruments for use in terrestrial laboratories to analyze samples returned from NASA Planetary Science missions; Data Analysis Program (DAP); and participating scientists for the MESSENGER mission. As stated in the ROSES NRA, the DAP is "...to enhance the scientific return of the completed Discovery missions by broadening the science participation in the analysis of data collected and samples returned ...." Specifically, the DAP allows scientists not previously associated with Discovery missions an opportunity to perform data analysis of the data archived in the Planetary Data System or samples (such as those from Stardust) stored at the JSC curation facility, which is also funded by this project. Data access through the Discovery Research project allows a much broader, and perhaps more objective analysis of the data and samples, and also allows research to continue for many years after the mission has been completed. Areas for additional data analyses are proposed by scientists throughout the US planetary community and are competitively selected with major input from science community peer review.

The Discovery Future line provides funds for future Discovery flight missions to be selected via a competitive Announcement of Opportunity (AO) process. Discovery Program Management provides for the management of the Discovery selected flight missions. This line also provides for the development of Announcements of Opportunity (AOs), and supports independent panel reviews and selections process.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Launch an average of one mission per 24 months .	Discovery Program	Same
Complete current prime and funded extended operating missions.	Dawn, MESSENGER, ASPERA-3, EPOXI and StardustNExT	Same
Complete design and begin spacecraft development and assembly	GRAIL	Same

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery

Implementation Schedule

Project	Phase	Beg	End
MESSENGER	Tech		
	Form	Jul-99	Jun-01
	Dev	Jun-01	Aug-04
	Ops	Aug-04	Mar-13
	Res		
ASPERA-3	Tech		
	Form		
	Dev	Sep-00	Jun-03
	Ops	Jun-03	May-11
	Res		
Dawn	Tech		
	Form	Dec-01	
	Dev	Feb-04	Sep-07
	Ops	Sep-07	Nov-15
	Res		
Moon Mineralogy Mapper (M3)	Tech		
	Form	Mar-05	Feb-06
	Dev	Mar-06	Mar-08
	Ops	Mar-08	Jun-12
	Res		
EPOXI	Tech		
	Form		
	Dev		
	Ops	Jun-07	Oct-11
	Res		
Stardust NExT	Tech		
	Form		
	Dev		
	Ops	Jun-07	Feb-11
	Res		
GRAIL	Tech		
	Form	Oct-07	Mar-09
	Dev	Mar-09	Sep-11
	Ops	Oct-11	Jul-12
	Res		
Discovery Management	Tech		
	Form		
	Dev		
	Ops		
	Res	Oct-99	Sep-22

Schedule by Fiscal Year: Prior, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery

Program Management

MSFC is responsible for Discovery program management. Scientific mission priorities and assignment of responsibilities reside with the Science Mission Directorate.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
MESSENGER	MSFC	GSFC, JPL	None
ASPERA-3	MSFC		Sweden; European Space Agency (ESA).
Dawn	MSFC	JPL	German Aerospace Center (DLR); Los Alamos National Labs (LANL); Italian Space Agency; and Max-Planck.
M3	MSFC	JPL	ISRO spacecraft provider. USGS.
EPOXI	MSFC	JPL	Max-Planck-Institute in Garsching, Germany
Stardust-NExT (Stardust-New Exploration of Tempel)	MSFC	JPL	None
GRAIL	MSFC	GSFC, JPL, KSC	None

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery

Acquisition Strategy

With the exception of future NASA Announcements of Opportunity, all major acquisitions are in place.

Southwest Research Institute employs the Principal Investigator and Lead Scientist for ASPERA-3.

The University of California at Los Angeles sponsors the Principal Investigator and Lead Scientist for the Dawn mission.

Brown University sponsors the Principal Investigator and Lead Scientist for M3. SAIC, University of Hawaii, and University of Tennessee are also participants.

The Department of Terrestrial Magnetism at the Carnegie Institution of Washington employs the Principal Investigator and Lead Scientist for MESSENGER.

The University of Maryland employs the Principal Investigator for the EPOXI Mission of Opportunity, the combined EPOCh and DIXI missions.

Cornell University employs the Principal Investigator for the Stardust New Exploration of Tempel 1 (NExT) Mission of Opportunity.

The Massachusetts Institute of Technology (MIT) employs the Principal Investigator and leads the GRAIL mission.

The Discovery Program solicits proposals for full planetary missions and missions of opportunity. The proposals are put together by teams led by a PI which may include firms, small businesses, government and universities. The initial phase of each competitive selection is a concept study, and several missions and missions of opportunity are generally selected for this phase. At the completion of the study phase, one or more concepts may be selected for development, based on their continued scientific merit, technical, management and cost viability, and the availability of funding.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	10/2008	Verified compliance with Agency requirements for program implementation and alignment with Agency strategic goals and objectives. The Discovery Program provides effective technical and schedule analysis support to the projects and continues to actively use risk-based insight as part of its oversight of the projects. The AO process has proven to be a well-defined, disciplined process that is viewed by the science community as fair and effective.	10/2010

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery
Project In Development:	Gravity Recovery and Interior Laboratory

FY 2010 Budget Request

Budget Authority ($ millions)	Prior	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	BTC	LCC TOTAL
FY 2010 President's Budget Request	**1.2**	**67.0**	**122.4**	**124.1**	**104.8**	**41.4**	**4.7**	**0.0**	**0.0**	**465.6**
Formulation	1.2	27.0	22.3	0.0	0.0	0.0	0.0	0.0	0.0	50.5
Development / Implementation	0.0	40.0	100.1	124.1	104.5	27.7	0.0	0.0	0.0	396.4
Operations / Close-out	0.0	0.0	0.0	0.0	0.3	13.7	4.7	0.0	0.0	18.7
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FY 2009 President's Budget Request	**1.2**	**0.0**	**122.4**	**122.8**	**113.1**	**24.9**	**5.7**	**--**	**0.0**	**390.0**
Formulation	1.2	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	1.2
Development / Implementation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	--
Operations / Close-out	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	--
Other	0.0	0.0	122.4	122.8	113.1	24.9	5.7	--	0.0	388.8
Changes from FY 2009 Request	**0.0**	**67.0**	**0.0**	**1.3**	**-8.3**	**16.5**	**-0.9**	**--**	**0.0**	**75.6**
Formulation	0.0	27.0	22.3	0.0	0.0	0.0	0.0	--	0.0	49.3
Development / Implementation	0.0	40.0	100.1	124.1	104.5	27.7	0.0	--	0.0	396.4
Operations / Close-out	0.0	0.0	0.0	0.0	0.3	13.7	4.7	--	0.0	18.7
Other	0.0	0.0	-122.4	-122.8	-113.1	-24.9	-5.6	--	0.0	-388.8

Note: The FY 2010 LCC number in the table above is understated by $30.6M due to the difference in the FY09 enacted bill and the April 2009 initial operating plan. Assuming approval of the initial operating plan, the estimated lifecycle cost will be $496.2M, and the estimated development cost will be $427.0M.

Explanation of Project Changes

GRAIL was confirmed to proceed into implementation phase (KDP-C or Phase C/D) on January 28, 2009. This budget reflects GRAIL approved baseline for schedule, development cost, and life-cycle-cost (LCC) with the 70% cost confidence level.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery
Project In Development:	Gravity Recovery and Interior Laboratory

Project Purpose

GRAIL was selected in December 2007 under the 2006 Discovery Announcement of Opportunity. The overarching scientific goal of the GRAIL mission is to determine the structure of the lunar interior from crust to core. The GRAIL mission will also advance our understanding of the thermal evolution of the Moon and extend our knowledge gained from the Moon to the other terrestrial-type planets.
GRAIL will conduct six lunar science experiments: map the structure of the crust and lithosphere; study the moon's asymmetric thermal evolution; determine the subsurface structure of impact basins and the origin and of masons (i.e., high-gravity areas); study the temporal evolution of crustal brecciation and magmatism; study affect on the structure of the deep lunar interior from lunar tides; and understand the size of the possible lunar inner core.

Project Parameters

GRAIL will achieve its science objectives by placing twin spacecraft in a low altitude (50 km), and nearly circular, polar orbit. The two spacecraft will perform high-precision range-rate measurements between them. Analysis of changes in the spacecraft-to-spacecraft range-rate data caused by gravitational differences will provide direct and high-precision measurements of the lunar gravity. GRAIL will ultimately provide a global, high-accuracy (<10 mGal), high-resolution (30 km) gravity map of the moon. The instrument is based on the successful Earth orbiting Gravity Recovery and Climate Experiment (GRACE) mission.

Project Commitments

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
Flight System	Lockheed Martin	2 spacecraft with s/c separation of 175-225 km, conducting 90-day science phase	Same	Same
Lunar Gravity Ranging System	JPL	Ka-band ranging system determines the precise instantaneous relative range-rate of the two s/c	Same	Same
E/PO MoonKam	Sally Ride Science (SRS)	Take images of the moon, the data will enrich the middle school space science curriculum	Same	Same
Launch Vehicle	ULA	CLIN23 - Delta II Heavy	Same	Same

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery
Project In Development:	Gravity Recovery and Interior Laboratory

Schedule Commitments

Milestone Name	Confirmation Baseline	FY 2009 PB Request	FY 2010 PB Request
Development			
Development (Phase C/D or KDP-C)	January 28, 2009	Same	Same
Critical Design Review (CDR)	November 2009	Same	Same
System Integration Review (formerly ATLO)	July 2010	Same	Same
Launch Readiness Review	September 2011	Same	Same
End of Prime Mission	June 2012	same	same

Development Cost and Schedule Summary

GRAIL was confirmed to proceed into implementation phase (KDP-C or Phase C/D) on January 28, 2009. This budget reflects the approved GRAIL Project baseline for schedule, development cost, and life-cycle-cost (LCC).

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Gravity Recovery and Interior Laboratory	2009	427.0	2009	427.0	0	Launch Readiness	9/8/2011	9/8/2011	0

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**427.0**	**427.0**	**0.0**
Payload	18.1	18.1	0.0
Spacecraft	133.3	133.3	0.0
Ground System	12.3	12.3	0.0
Science	10.8	10.8	0.0
Launch Vehicle	152.8	152.8	0.0
Other	99.7	99.7	0.0

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery
Project In Development:	Gravity Recovery and Interior Laboratory

Project Management

The Gravity Recovery and Interior Laboratory Project is part of the Discovery Program managed by Marshall Space Flight Center. The Principal Investigator from Massachusetts Institute of Technology has delegated day-to-day project management to JPL.

Acquisition Strategy

GRAIL was selected competitively in December 13, 2007 under a Discovery Program Announcement of Opportunity (AO-NNH06ZDA001O).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	10/2008	Assess cost, schedule, and risk status of project. Findings for the review showed that cost and schedule for the 2011 launch are consistent with the project's plans.	10/2010

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Launch Vehicle	One significant risk is the continued availability of Delta II line and launch pad at affordable costs	ULA is committed to ensuring that the Delta II will be ready and continued insight/oversight with KSC.
Spacecraft & Reaction Wheel	Both GRAIL spacecraft are largely single string, and the light weight Reaction Wheel (RW) is a new development.	The single string risks are mitigated by use of proven designs, high reliability parts, and additional testing of critical systems, consistent with the cost and schedule constraints of the project. If the light weight reaction wheel development falls behind schedule, the project will revert back to an existing RW.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	115.1	263.9	264.1	239.9	294.2	239.8	249.6
Juno	95.0	245.0	237.2	174.2	71.4	17.8	18.1
Other Missions and Data Analysis	20.2	19.0	26.9	65.7	222.8	222.0	231.5
FY 2009 President's Budget Request	132.2	263.9	250.3	232.3	227.7	236.9	--
Juno	108.3	245.0	225.2	168.0	14.4	17.8	--
Other Missions and Data Analysis	23.9	19.0	25.1	64.3	213.3	219.1	--
Changes from FY 2009 Request	-17.1	0.0	13.8	7.5	66.5	2.9	--

Program Overview

The New Frontiers Program, comprised of medium-sized to large-sized missions, constitutes a critical element of NASA's solar system exploration capability. Proposed science targets for the New Frontiers Program have included Pluto and the Kuiper Belt, Jupiter, Venus, and sample returns from Earth's Moon and a comet nucleus. The program accomplishes high-quality planetary science investigations using efficient management approaches. The program's prime objectives are to enhance our understanding of the solar system as it is today, and of the solar system's formation and evolution.

New Horizons and Juno are New Frontiers selected flight missions. New Horizons will conduct reconnaissance of Pluto and its moon Charon. Juno's overarching scientific goal is to understand the origin and evolution of Jupiter.

For more information, see http://newfrontiers.msfc.nasa.gov.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers

Plans For FY 2010

The New Frontiers Program is built around a core of high-priority science missions identified by the science community by the National Academy of Sciences. The program allows NASA to solicit competitive innovative proposals from scientists for large new planetary missions that promise the Nation a high return in knowledge gained relative to the cost.

The Juno Mission completed the Preliminary Design Review (PDR)/Non-Advocate Review (NAR) in FY 2008 and NASA confirmed Juno to proceed to Phase C/D at a 70-percent confidence level. The Juno Mission will start Critical Design Review (CDR) by mid- FY 2009. In FY 2010 the Juno mission will enter into ATLO.

By FY 2010, New Horizons will have long passed the orbit of Saturn on its cruise to Pluto. It is on track for a July 2015 arrival. The cruise period will include periodic spacecraft and instrument checkouts and dress rehearsals for the Pluto fly-by.

The third New Frontiers AO will be released in May 2009. Concept studies selection is expected in 2010.

Project Descriptions and Explanation of Changes

Juno

Juno, now in its development phase, is a mission to Jupiter scheduled to launch in August 2011. The Juno science goals are to: determine the oxygen to hydrogen ratio to determine water abundance and estimate core mass in order to decide among alternative theories of planetary origin; understand Jupiter's interior structure and dynamic properties, including internal convection and the size and mass of its core, through mapping of its gravitational and magnetic fields with unprecedented accuracy; map variations in atmospheric composition, temperature, cloud opacity and dynamics to depths greater than 100 bars at all latitudes; and characterize and explore the three-dimensional structure of Jupiter's polar magnetosphere and auroras. Juno uses a simple, spin-stabilized spacecraft in an elliptical polar orbit that minimizes radiation exposure by flying under Jupiter's radiation belts at perijove and outside them at apojove. Juno's baseline orbit remains continuously in sunlight, resulting in benign and stable thermal conditions. Spin stability eliminates complex, power-hungry attitude control components such as reaction wheels. Additional detail can be found in the Juno Project section of this document and at http://newfrontiers.nasa.gov/missions_juno.html.

Other Missions and Data Analysis

The New Frontiers Future Project provides funds for future New Frontiers space missions to be selected via a competitive Announcement of Opportunity process. The Third Announcement of Opportunity (NF-3) draft was released to the community for comments in late 2008. The AO is expected to be released for competition in May 2009. The science targets for this NF-3 AO include: South Pole Aitken Basin Sample Return, Comet Surface sample return, Venus In-Situ Explorer, Network Mars Science, Trojan/Centaur, Asteroid Sample Return, Io Observer, and Ganymede Observer. Mission selection is expected by late CY 2010 or early 2011.

The New Frontiers Research line provides for the Jupiter Data Analysis Project (JDAP), which broadens the science community participation in the analysis of mission data, and allows scientists outside the selected flight team to look at the data from the mission, do research, and publish their findings. Data access through the New Horizons Research project allows a much broader, and perhaps more objective analysis of data and samples. Without JDAP, the findings and publications would not come out until years after the mission, since the New Horizons mission team members are very busy while the spacecraft is flying. Furthermore, the JDAP project facilitates new ideas and approaches, getting young people started in science, and broadening participation to get a critical mass of scientific talent working on mission data at the critical time. In FY 2010 the JDAP program will move to the Outer Planets Research Program.

On January 19, 2006, the New Horizons mission successfully launched on an Atlas V launch vehicle. New Horizons will reach Pluto and its moon, Charon, in July 2015. New Horizons will conduct a reconnaissance of the Pluto-Charon system, mapping their surface composition and surface temperatures, characterizing their geology, characterizing the atmosphere of Pluto, searching for an atmosphere around Charon, and searching for rings and additional satellites around Pluto.

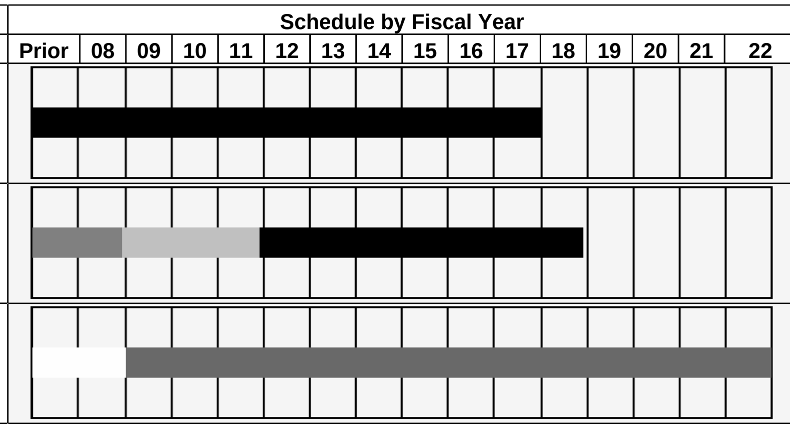
New Frontiers Program Management resides at MSFC and is responsible for selected missions (New Horizons and Juno), and provides for the development of Announcements of Opportunity. The Program Office also supports independent panel review and selection processes.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Launch an average of one mission per 52 months	New Frontiers Program	same

Implementation Schedule



Project	Phase	Beg	End
New Horizons	Tech		
	Form	Nov-01	Mar-03
	Dev	Mar-03	Jan-06
	Ops	Jan-06	Sep-17
	Res		
Juno	Tech		
	Form	Jul-04	Aug-08
	Dev	Aug-08	Aug-11
	Ops	Aug-11	Aug-18
	Res		
New Frontiers Research	Tech		
	Form		
	Dev		
	Ops		
	Res	Oct-08	Sep-22

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

The Science Mission Directorate assigns scientific mission priorities and program responsibilities. MSFC has New Frontiers program management responsibility.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
New Horizons	MSFC	GSFC, JPL	None
Juno	MSFC	JPL, KSC, GSFC	Italian Space Agency (ASI)
New Frontiers Research	HQ	Multi-Center	None

Acquisition Strategy

Future acquisitions of New Frontiers missions occur under open Announcement of Opportunity (AO) competitions. The New Frontiers Program solicits proposals for an entire mission (including instruments), put together by teams led by PIs and comprised of people from industry, small businesses, government, and academia.

Major acquisitions for the New Horizons (APL) and Juno (JPL) projects are in place.

The Principal Investigator for New Horizons is at SouthWest Research Institute, Boulder, CO. Johns Hopkins University/Applied Physics Laboratory has project management responsibility.

The Juno Principal Investigator is from the SouthWest Research Institute, San Antonio. Jet Propulsion Laboratory provides mission project management and Lockheed Martin Space Systems will build the spacecraft. The Italian Space Agency, ASI, is contributing the Ka-band and Infrared Spectrometer instrument.

New Frontiers Research will be funded competitively, selected from the ROSES NRA.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	10/2007	Verified compliance with Agency requirements for program implementation and alignment with Agency strategic goals and objectives. The New Frontiers Program provides effective technical and schedule analysis support to the projects and continues to actively use risk-based insight as part of its oversight of the projects. The AO process has proven to be a well-defined, disciplined process that is viewed by the science community as fair and effective.	12/2009

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers
Project In Development:	Juno

FY 2010 Budget Request

Budget Authority ($ millions)	Prior	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	BTC	LCC TOTAL
FY 2010 President's Budget Request	**130.9**	**95.0**	**245.0**	**237.2**	**174.2**	**71.4**	**17.8**	**18.1**	**102.4**	**1,091.9**
Formulation	130.8	55.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	186.3
Development / Implementation	0.1	39.5	245.0	237.2	158.5	46.9	0.0	0.0	0.0	727.2
Operations / Close-out	0.0	0.0	0.0	0.0	15.7	24.5	17.8	18.1	102.3	178.4
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	--
FY 2009 President's Budget Request	**130.9**	**108.3**	**245.0**	**225.2**	**168.0**	**14.4**	**17.8**	**--**	**0.0**	**909.5**
Formulation	130.9	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	130.9
Development / Implementation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	--
Operations / Close-out	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	--
Other	0.0	108.3	245.0	225.2	168.0	14.4	17.8	--	0.0	778.6
Changes from FY 2009 Request	**0.0**	**-13.3**	**0.0**	**12.0**	**6.2**	**57.0**	**0.0**	**--**	**102.4**	**182.4**
Formulation	-0.1	55.5	0.0	0.0	0.0	0.0	0.0	--	0.0	55.4
Development / Implementation	0.1	39.5	245.0	237.2	158.5	46.9	0.0	--	0.0	727.2
Operations / Close-out	0.0	0.0	0.0	0.0	15.7	24.5	17.8	--	102.3	178.4
Other	0.0	-108.3	-245.0	-225.2	-168.0	-14.4	-17.8	--	0.1	-778.6

Note: The FY 2010 LCC number in the table above is understated by $15.1M due to the difference in the FY09 enacted bill and the April 2009 initial operating plan. Assuming approval of the initial operating plan, the estimated lifecycle cost of Juno will be $1,107.0M, and the estimated development cost will be $742.3M.

Explanation of Project Changes

NASA confirmed Juno to proceed into implementation phase (KDP-C or Phase C/D) on August 05, 2008. The Juno budget is increased to reflect KDP-C decision which established the project's schedule and baseline budget to include a 70% cost confidence level.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers
Project In Development:	Juno

Project Purpose

NASA selected Juno on July 15, 2005, under the New Frontiers Announcement of Opportunity. The overarching scientific goal of the Juno mission is to improve our understanding of the origin and evolution of Jupiter. However, as the archetype of giant planets, Jupiter can also provide knowledge that will improve our understanding of both the origin of our solar system and of planetary systems being discovered around other stars. The investigation focuses on the four science objectives:

Origin: Determine the oxygen-to-hydrogen ratio to determine water abundance and estimate core mass to decide among alternative theories of planetary origin.

Interior: Understand Jupiter's interior structure and dynamic properties through mapping of its gravitational and magnetic fields with unprecedented accuracy, including internal convection and the size and mass of its core.

Atmosphere: Map variations in atmospheric composition, temperature, and cloud opacity and dynamics, to depths greater than 100 bars, at all latitudes.

Magnetosphere: Characterize and explore the three-dimensional structure of Jupiter's polar magnetosphere and auroras.

These objectives have been rated very highly in the National Academy of Sciences' Solar System Exploration Decadal Survey and Sun-Earth Connections Decadal Survey. The Astrophysics Decadal Survey identified the study of star formation, their planetary systems, as well as giant and terrestrial planet birth and evolution as high priority. Juno fulfills key goals outlined in recent NASA and NRC studies and is relevant to NASA's Vision for Space Exploration.

Project Parameters

Juno achieves the science objectives by using a simple spinning, solar-powered spacecraft to make global maps of the gravity, magnetic fields, and atmospheric composition of Jupiter from a unique elliptical polar orbit with a close perijove. The spacecraft carries precise, high-sensitivity radiometers, magnetometers, and gravity science systems. Juno's 32 orbits extensively sample Jupiter's full range of latitudes and longitudes. From its polar perspective Juno combines in-situ and remote sensing observations to explore the polar magnetosphere and determine what drives Jupiter's remarkable auroras.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers
Project In Development:	Juno

Project Commitments

Juno launch date is August 2011, and after a five-year cruise to Jupiter, Jupiter Orbit Insertion (JOI) is scheduled for October 2016. Juno will perform one year of science operations.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
Waves	University of Iowa	Measures radio and plasma emissions; 4 m elec. dipole and search coil	Same	Same
Jupiter Energetic particle Detector Instrument (JEDI)	John Hopkins Applied Physics Lab (APL)	Measures auroral distributions of electrons and ions; TOF vs. energy, ion & electron sensors	Same	Same
Gravity Science	Jet Propulsion Lab (JPL)	Maps Jupiter's gravitational field to determine structure of core; X & Ka-band precision Doppler	Same	Same
Flux-Gate Magnetometer (FGM)	GSFC	Maps Jupiter's Magnetic Field (Vector)	Same	Same
Launch Vehicle	KSC	C3 = 32.0 km2/s2, Capability=3545 kg	Same	Same
UV Spectrometer (UVS)	Southwest Research Institute (SwRI)	FUV spectral imager for auroral emissions	Same	Same
Microwave Radiometer (MWR)	Jet Propulsion Lab (JPL)	6 wavelengths (1.3-50 cm); sounds atmosphere to determine water and ammonia abundances	Same	Same
Spacecraft	Lockheed Martin	Solar-powered, spin-stabilized spacecraft in an elliptical polar orbit that minimizes radiation exposure	Same	Same
Jovian Auroral Distributions Experiment (JADE)	Southwest Research Institute (SwRI)	Ion mass spectrometer & electron analyzers; measures auroral distributions of electrons and ions	Same	Same

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers
Project In Development:	Juno

Schedule Commitments

Formulation started at project selection in July 2005. Juno proceeded into the implementation phase on August 5, 2008.

Milestone Name	Confirmation Baseline	FY 2009 PB Request	FY 2010 PB Request
Formulation			
PDR	5/2008	same	same
ATLO Readiness	3/2010	same	same
Launch	8/2011	same	same
Development			
CDR	3/2009	same	4/2009

Development Cost and Schedule Summary

Juno was confirmed to proceed into implementation phase (KDP-C or Phase C/D) on August 05, 2008. The budget and schedule reflect the approved Juno Project baseline schedule, development cost, and life-cycle-cost (LCC).

Project	Base Year	Base Year Development Cost Estimate ($M)	Current Year	Current Year Development Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Juno	2009	742.3	2009	742.3	0	Launch Readiness	8/7/2011	8/7/2011	0

Development Cost Details

Consistent with 1QTR FY2009 MPAR, below is detailed development estimate supporting August 2011 launch readiness date (LRD).

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**742.3**	**742.3**	**0.0**
Spacecraft	236.5	236.5	0.0
Payloads	63.9	63.9	0.0
Launch Vehicle	190.4	190.4	0.0
Ground Systems	8.8	8.8	0.0
Science/Technology	22.1	22.1	0.0
Other Direct Project Costs	220.6	220.6	0.0

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers
Project In Development:	Juno

Project Management

Juno is part of the New Frontiers Program, with program management at Marshall Space Flight Center. The Principal Investigator, from Southwest Research Institute, has delegated day-to-day Juno project management to the Jet Propulsion Laboratory.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Project Management	Project Management & Oversight	JPL	N/A
Jupiter energetic particle instrument (JEDI)	Jet Propulsion Lab (JPL)	None	None
Plasma Waves Experiment (WAVE)	Jet Propulsion Lab (JPL)	None	None
Management; Microwave radiometer, and Gravity Science Experiment	MSFC/New Frontiers Program Office	Jet Propulsion Lab (JPL)	None
Vector Fluxgate Magnetometer (FGM)	Jet Propulsion Lab (JPL)	Goddard Space Flight Center (GSFC)	None
UVS and JADE instruments	MSFC/New Frontiers Program Office	None	None
Flight System, Integration and Test	Jet Propulsion Lab (JPL)	None	None
Overall responsibility for the development, implementation, operation, and success of the mission	MSFC/New Frontiers Program Office	None	None
JunoCam	Jet Propulsion Lab (JPL)	None	None
KaBand and IR science	Jet Propulsion Lab (JPL)	None	Italian Space Agency (ASI)

Acquisition Strategy

All major acquisitions are in place. Juno was selected competitively in July 15, 2005 under a New Frontiers Program Announcement of Opportunity (AO-03-OSS-03).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO /SRB	05/2008	Assess cost, schedule, and risk status of project/Findings for the review showed that cost and schedule for the 2011 launch are consistent with the project's plans.	04/2009

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers
Project In Development:	Juno

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Solar Array Performance	Highly possible solar array performance could be less than expected in the low-intensity, low-temperature and high-radiation environment of Jupiter.	Performing early radiation tests on solar cells and conservative estimates of performance. Engaging independent team to assess and validate power generation models and assumptions.
Mass Margin	Highly possible erosion of mass margin as subsystems, such as solar arrays, complete CDR updates.	Scrubbing estimates and contingencies for erosion of mass margin.
Juno-MSL Launch conflict	Possible Juno launch conflict with MSL launch slip to 10/2011 resulting from the required 90-day launch separation window.	Working with MSL and the KSC launch service provider to validate the launch separation requirement and ascertain launch options.
Stellar Reference Unit (SRU) performance	Highly unlikely degraded SRU performance on a spinning spacecraft in a high-radiation environment.	Initiated competitive study contracts and radiation testing to select SRU with best performance to meet project needs.

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Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	709.3	381.6	416.1	494.5	405.5	514.3	536.7
2009 Mars Science Lab	545.0	223.3	204.0	194.6	67.3	65.0	30.0
MAVEN	1.0	6.7	53.4	168.7	182.6	138.4	30.6
Other Missions and Data Analysis	163.3	151.6	158.7	131.2	155.7	310.9	476.1
FY 2009 President's Budget Request	553.5	386.5	299.6	344.5	341.1	413.8	--
2009 Mars Science Lab	305.5	223.3	69.0	54.6	37.6	0.0	--
MAVEN	57.7	6.7	68.5	152.5	170.7	121.8	--
Other Missions and Data Analysis	190.3	156.5	162.1	137.4	132.8	292.0	--
Changes from FY 2009 Request	155.8	-4.9	116.5	150.1	64.4	100.5	--

Program Overview

Mars is the most Earth-like planet in our solar system, with land mass approximately equivalent to the Earth's and what appear to be familiar features such as riverbeds, past river deltas, and volcanoes. Mars has the best planetary record of the first billion years of our solar system and holds scientific clues to the development of the solar system, planets, and maybe life itself. The Mars Program has been developed to conduct a rigorous, incremental, discovery-driven exploration of Mars to determine the planet's physical, dynamic, and geological characteristics.

Phoenix arrived safely on the Martian surface and successfully completed its science objectives, producing stunning science data, the first views of the Martian arctic, discovery of perchlorates in the soil, a much more basic soil than hypothesized, and the first chemical of water (ice) on another planet. Spirit and Opportunity are five years into their surface exploration of Mars, and they continue to return a wealth of new results. Opportunity finished its exploration of Victoria Crater and is now moving south to Endurance Crater, twenty times larger than Victoria. Spirit has survived its third winter and conducted further studies in the area of what remains of an ancient hydrothermal system. The Mars Reconnaissance Orbiter (MRO) has completed its first phase of the science mission and has returned fantastic results highlighting the periodicity in the martian climate and delineating a plethora of minerals that have had interaction with water. Mars Odyssey is still going strong, the gamma-ray spectrometer has leant support to the idea of ancient oceans and the Thermal Emission Imaging System has found new evidence of salt deposits. Meanwhile, MSL delays to the 2011 launch opportunity due to technical/schedule problems and launch window constraint, and the Program has engaged ESA in investigating the options for a joint 2016 mission encompassing their ExoMars rover mission.

For more information, see http://mars.jpl.nasa.gov.

Plans For FY 2010

Mars Science Laboratory (MSL) will complete remaining hardware builds, conduct Rover System Environmental Test Program, and be at the launch site by the 3rd quarter of FY 2010.

MAVEN will complete Preliminary Design Review (PDR) by 3rd quarter FY 2010.

ExoMars instruments, including potential US collaborations/contributions, will have an extended Phase B in FY 2010.

Odyssey will be in a new orbit with improved sensitivity to detect minerals on the surface.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration

Project Descriptions and Explanation of Changes

Mars Science Laboratory (MSL)

Currently in its implementation phase, MSL takes a major step forward in Mars exploration, both technically and scientifically, utilizing a new entry, descent, and landing system, a long-duration rover, and ten payload elements for definitive mineralogical and organics measurements. The primary scientific objective is to explore and quantitatively assess a local region on Mars as a potential habitat for past or present life. MSL will lay the ground work for future scientific missions, including Mars Sample Return, and will provide key information for human exploration. Additional detail can be found in the MSL Project section of this document. Due to technical problems and launch window constraints, MSL has been delayed from the 2009 to the 2011 launch opportunity.

Mars Atmosphere and Volatile EvolutioN (MAVEN)

NASA selected the second Mars Scout mission, Mars Atmosphere and Volatile EvolutioN (MAVEN), for formulation phase on September 15, 2008. Currently in it's formulation phase, MAVEN, a robotic orbiter mission, will provide a comprehensive picture of the Mars upper atmosphere, ionosphere, solar energetic drivers, and atmospheric losses. It will deliver key measurements addressing long-standing questions about the climate history and habitability of Mars. NASA's Goddard Space Flight Center in Greenbelt, MD., will manage the project. Lockheed Martin of Littleton, Colo., will build the spacecraft based on designs from NASA's Mars Reconnaissance Orbiter and 2001 Mars Odyssey missions.

Other Missions & Data Analysis

In its third extended mission operation phase, the primary scientific objectives of Odyssey include more sensitive measurement of the mineralogy of the surface, monitoring of inter -annual variations of Mars climate and surface processes, acquiring future mission landing site data, and continuing as a key telecommunications relay at Mars.

Currently in their sixth extended operation phase, both the Spirit and Opportunity rovers continue to explore geological settings on the surface of Mars using a suite of remote sensing and in-situ instruments. Their objective is to expand our understanding of the history and the geological processes that shaped Mars, particularly those involving water.

Currently in its second extended mission operation phase, the objective of Mars Express, a European Space Agency and Italian Space Agency mission, is to search for sub-surface water from orbit. NASA participates in the scientific analysis of mission data, including the recent investigations into the mysterious deposits of the Medusae Fossae Formation.

Currently in its first extended operation phase, MRO science objectives include: 1)provide high-resolution spectral maps and images for interpretation of the geology of the Martian crust; 2)use ground-penetrating radar to map compositional discontinuation and layering under the surface; and 3)create planetary-scale maps of critical atmospheric properties. MRO is also the key telecommunications relay for the first half of the next decade at Mars.

Mars Mission Operations (MMO) provides management and leadership for the development and execution of Mars multi-mission operations. MMO supports and provides operational capabilities at a lower cost and risk to all current Mars projects.

Once missions have concluded their primary mission phase, further funding for extended operations is allocated based on the findings of a senior review board. Their review of each mission enables them to make recommendations for the allocation of the extended operations budget based on scientific merit.

NASA invests in research and analysis of Mars mission data in order to understand how geologic, climatic, and other processes have worked to shape Mars and its environment over time, as well as how they interact today.

NASA selected Urey and MOMA instrument proposals for technology development studies for potential inclusion in the European ExoMars mission. These instruments, currently in Phase B, would help cement future collaboration with ESA. Due to the ESA schedule, the ExoMars launch has been delayed from 2013 to the 2016 launch opportunity.

The Mars Exploration Program plans future missions to Mars that build on scientific discoveries from past missions and incorporate the lessons learned from previous mission successes and failures. Missions in planning include a Mars mission in 2016, 2018, and potentially Mars Sample Return (MSR). Due to cost realism, and to better align with international partners' science, technical and schedule requirements, future Mars missions will likely be built on a joint international program and will use envisioned MSR technology to help retire technical risk of the MSR mission as budgets allow. It should be noted that the MSR current costs estimate is mature, but either additional funds or substantial foreign contributions will be required to implement the project in the 2020/2022 timeframe.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
MEP will provide continual operational presence on Mars	Mars Exploration	Same
At least one Mars mission will be launched at every opportunity (every 26 months)	Mars Exploration	Missed the 2009 launch opportunity due to MSL required launch delay

Implementation Schedule

Schedule by Fiscal Year: Prior, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22

Project	Phase	Beg	End
Mars Odyssey	Tech		
	Form	Apr-97	Apr-99
	Dev	Apr-99	Apr-01
	Ops	Apr-01	Sep-11
	Res		
Mars Exploration Rovers (Spirit & Opportunity)	Tech		
	Form	May-00	Aug-01
	Dev	Aug-01	Jun-03
	Ops	Jun-03	Sep-10
	Res		
Mars Reconnaissance Orbiter (MRO)	Tech		
	Form	Jan-01	Jul-02
	Dev	Jul-02	Aug-05
	Ops	Aug-05	Sep-11
	Res	Oct-11	Sep-17
Mars Scout (Phoenix)	Tech		
	Form	Aug-03	Mar-05
	Dev	Mar-05	Aug-07
	Ops	Aug-07	Aug-08
	Res	Aug-08	Nov-08
Mars Science Laboratory (MSL)	Tech		
	Form	Nov-03	Aug-06
	Dev	Aug-06	Dec-11
	Ops	Dec-11	Oct-13
	Res	Oct-13	Oct-17
Mars Express	Tech		
	Form	Jan-00	Sep-00
	Dev	Sep-00	Jun-03
	Ops	Jun-03	Dec-05
	Res	Dec-05	Sep-11
The Mars Atmosphere and Volatile EvolutioN (MAVEN)	Tech		
	Form	Sep-08	Sep-10
	Dev	Sep-10	Nov-13
	Ops	Nov-13	Dec-14
	Res	Dec-14	Jul-16
Mars R&A	Tech		
	Form		
	Dev		
	Ops		
	Res	Oct-00	Sep-22

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration

Program Management

The Jet Propulsion Laboratory has responsibility for implementation of the Mars Exploration Program.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Mars Exploration Rovers (MER)	JPL	JPL, ARC, GRC, JSC, GSFC	None
Mars Reconnaissance Orbiter (MRO)	JPL	JPL, ARC, GSFC, JSC, MSFC	Agenzia Spaziale Italiana (ASI)
Mars Phoenix	JPL	JPL, ARC, JSC	Canadian Space Agency (CSA)
Mars Science Laboratory (MSL)	JPL	JPL , ARC, GSFC, KSC, GRC, LaRC, JSC	Department of Energy; International partners include Canada, Spain, and Russia.
Mars Atmosphere and Volatile EvolutioN (MAVEN)	JPL	GSFC, KSC, JPL	Centre d'Etude Spatiale des Rayonnements (CESR)
Mars Odyssey	JPL	JPL, MSFC	None
Mars Express (MEX)	JPL	JPL, GSFC	European Space Agency (ESA)
ExoMars	JPL	JPL, ARC, LaRC, GSFC	European Space Agency (ESA)

Acquisition Strategy

The Mars Exploration Program (MEP) has set a goal of open competition for all missions. All major acquisitions for MSL, ExoMars instruments, and MAVEN are in place.

Malin Space Systems, Honeybee Robotics, Lockheed Martin, Aeroflex are providing support and hardware for the MSL mission.

The principal investigator for the MAVEN mission is Dr. Bruce Jakosky of the Laboratory for Atmospheric and Space Physics at the University of Colorado at Boulder. NASA's Goddard Space Flight Center in Greenbelt, Md., will manage the project, and Lockheed Martin of Littleton, Colo., will build the spacecraft.

All research and technology is procured through the ROSES announcement and a competitive, peer-review selection process.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	10/2006	A Program Implementation Review was conducted in October 2006. Review determined the Mars program was functioning well and continuing to make important contributions to science and the Vision, but was short on reserve funding. It also found that MSL is critical for future mission science and technology.	12/2009
All	Senior Review Panel	03/2008	Comparative review of Mars operating missions. Missions are ranked in terms of science, engineering capability, and their programmatic roles as they relate to the Mars Exploration program. The findings lead to mission extension for Odyssey, MER, MEX, and MRO, with orbit time change for the Mars Odyssey mission.	03/2010

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	2009 Mars Science Lab

FY 2010 Budget Request

Budget Authority ($ millions)	Prior	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	BTC	LCC TOTAL
FY 2010 President's Budget Request	**970.1**	**545.0**	**223.3**	**204.0**	**194.6**	**67.3**	**65.0**	**30.0**	**0.0**	**2,299.3**
Formulation	515.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	515.5
Development / Implementation	454.6	545.0	223.3	204.0	194.6	3.5	0.0	0.0	0.0	1,625.0
Operations / Close-out	0.0	0.0	0.0	0.0	0.0	63.8	65.0	30.0	0.0	158.8
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FY 2009 President's Budget Request	**969.8**	**305.5**	**223.3**	**69.0**	**54.6**	**37.6**	**0.0**	**--**	**0.0**	**1,659.8**
Formulation	515.6	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	515.6
Development / Implementation	454.2	305.5	220.0	5.4	0.0	0.0	0.0	--	0.0	985.1
Operations / Close-out	0.0	0.0	3.3	63.6	54.6	37.6	0.0	--	0.0	159.1
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0
Changes from FY 2009 Request	**0.3**	**239.4**	**0.0**	**135.0**	**140.0**	**29.7**	**65.0**	**--**	**0.0**	**639.4**
Formulation	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	-0.1
Development / Implementation	0.4	239.5	3.3	198.6	194.6	3.5	0.0	--	0.0	639.9
Operations / Close-out	0.0	0.0	-3.3	-63.6	-54.6	26.2	65.0	--	0.0	-0.3
Other	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	--	0.0	-0.1

Note: The FY 2010 LCC number in the table above is understated by $6M due to the difference in the FY09 enacted bill and the April 2009 initial operating plan. Assuming approval of the initial operating plan, the estimated lifecycle cost will be $2,305.3M, and the estimated development cost will be $1,631.0M.

Explanation of Project Changes

A launch date of October 2009 no longer is feasible because of testing and hardware challenges that must be addressed to ensure mission success. The window for a 2009 launch ends in late October. The relative positions of Earth and Mars are favorable for flights to Mars only a few weeks every two years. The next launch opportunity after 2009 is in 2011. NASA announced this delay in December 2008, and estimated the lifecycle cost of the mission to be about $2.3 billion; the FY 2010 Budget request reflects that.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	2009 Mars Science Lab

Project Purpose

The Mars Science Laboratory (MSL) mission is the most technologically challenging interplanetary rover ever designed. It will use new technologies to adjust its flight while descending through the Martian atmosphere, and to set the rover on the surface by lowering it on a tether from a hovering descent stage. Advanced research instruments make up a science payload 10 times the mass of instruments on NASA's Spirit and Opportunity Mars rovers. The Mars Science Laboratory is engineered to drive longer distances over rougher terrain than previous rovers. It will employ a new surface propulsion system.

The MSL Project will make detailed measurements of element composition, elemental isotopes and abundance, mineralogy, and organic compounds to determine if Mars has, or ever had, an environment capable of supporting life within the regions it will explore.

MSL has four science objectives: assess the biological potential of at least one selected site on Mars; characterize the geology and geochemistry of the landing region at all appropriate spatial scales; identify planetary processes relevant to past habitability; and characterize the broad spectrum of the Martian surface radiation environment.

For more information, see the MSL homepage at http://marsprogram.jpl.nasa.gov/missions/future/msl.html.

Project Parameters

The MSL is a surface rover which will collect Martian soil and rock samples and analyze them for organic compounds and environmental conditions that could have supported microbial life now or in the past. MSL will be a long-duration (two years) roving science laboratory that will be twice as long and three times as heavy (800-850 kilograms) as the Mars Exploration Rovers, Spirit and Opportunity.

Key technologies developed for MSL include: throttle-controlled, high-thrust engines, required during Martian entry, descent, and landing (EDL); sample acquisition and processing equipment used to acquire and distribute samples to the analytic instrument suite; and long-life, high-reliability, thermal-cycle-resistant electronics for use in the rover.

The EDL system will accommodate a wide range of possible latitude and altitude locations on Mars in order to be discovery-responsive and to have the capability to reach very promising, but difficult-to-reach scientific sites.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	2009 Mars Science Lab

Project Commitments

The Mars Science Laboratory (MSL) will be ready to launch in late CY 2011 and will arrive at Mars after approximately 9 months of flight time. MSL will operate for two Earth years on the surface of Mars and will travel approximately 20 kilometers.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
Rover	JPL	Travel 20 kilometers over the Martian surface.	Same	Same
Stereoscopic and microscopic cameras	Malin Space Systems	Acquire color, stereo images with resolutions up to 0.2 mm/pixel at 2 m range.	Same	Deleted descent imager and camera zoom
Robotic arm tools	Honeybee Robotics	Acquire, process and deliver 75 rock and soil samples to analytic instruments.	Same	Changed the rock grinder to a brush, sample quantity unchanged
Chemistry camera (ChemCam)	Department of Energy/Los Alamos National Laboratory; France	Remotely measure elemental composition of rocks and soil up to 9m from rover.	Same	Same
Alpha Particle X-ray Spectrometer	Canada (CSA)	Measure with high precision the elemental composition of in situ rocks and soil.	Same	Same
Rover Environmental Monitoring System (REMS)	Spain	Monitor key atmospheric measurements including temperature, pressure, wind speed/direction and humidity.	Same	Same
Dynamic Albedo of Neutrons (DAN)	Russia (IKI)	Measure hydrogen content in subsurface deposits.	Same	Same
Cruise stage and entry system	Lockheed Martin	Transport rover to Martian surface and land with impact speed below 1 m/s	Same	Same
Mission operations and data archive	JPL	Conduct one-year cruise and two-year rover primary mission with remotely located science team.	Same	Same
Sample Analysis at Mars (SAM)	NASA/GSFC	Analysis of elemental and isotopic composition of Mars samples	Same	Same
Chemistry & Mineralogy Instrument (CheMin)	NASA/ARC	Analysis of mineral and chemical content of Mars samples	Same	Same
Sample cache	ARC	Hockey puck-sized container will collect sample of Martian soil for possible later collection by a Mars Sample Return mission	New Commitment	Deleted

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	2009 Mars Science Lab

Schedule Commitments

The Mars Science Laboratory Project entered formulation in November 2004, proceeded into the development phase in August 2006, with a launch currently scheduled for late CY 2011.

Milestone Name	Confirmation Baseline	FY 2009 PB Request	FY 2010 PB Request
Development			
Critical Design Review	June 2007	No change	Same
System Integration Review (formerly ATLO)	February 2008	February 2008	Same
Launch Readiness Review	September 2009	September 2009	4QTR CY 2011

Development Cost and Schedule Summary

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
2009 Mars Science Lab	2006	968.6	2009	1,631.0	68	Launch Readiness	9/30/2009	11/7/2011	25

Development Cost Details

Development cost increased due to technical and schedule problems. The current development cost supports the 2011 launch opportunity.

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**968.6**	**1,631.0**	**662.4**
Spacecraft	424.8	943.3	518.5
Payloads	64.9	124.3	59.4
Systems I&T	46.5	92.0	45.5
Launch Vehicle/Services	182.6	215.1	32.5
Ground Systems	45.5	77.7	32.2
Science/Technology	11.4	16.9	5.5
Other direct project cost	192.9	161.7	-31.2

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	2009 Mars Science Lab

Project Management

2009 Mars Science Laboratory is a JPL-managed in-house project. Instrument implementation has been assigned to JPL. The responsible NASA official is the Director for the Planetary Science Division.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Rover	JPL	JPL	None
Stereoscopic and microscopic cameras	JPL	None	None
Robotic arm tools	JPL	JPL	None
Chemistry camera (ChemCam)	JPL	None	Department of Energy and France
Alpha Particle X-ray Spectrometer	JPL	None	Canada
Rover Environmental Monitoring System (REMS)	JPL	None	Spain
Dynamic Albedo of Neutrons (DAN)	JPL	None	Russia
Cruise stage and entry system	JPL	JPL, AMES, LaRC	None
Spacecraft	JPL	JPL	None
Sample Analysis at Mars (SAM)	JPL	GSFC	CNES (France)
Chemistry & Mineralogy Instrument (CheMin)	JPL	ARC	None

Acquisition Strategy

All major acquisitions are in place. All major instruments were competitively selected.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	HQ/SRB	11/2008	Assess maturity of MSL design. Design was deemed adequate to achieve mission science goals, but project needs additional time to work the technical problems and perform adequate testing. The finding led to launch delay, from the 2009 to the 2011 launch window opportunity.	03/2009

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	2009 Mars Science Lab

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Actuators and Avionics	Actuator production and assembly delays can possibly threaten overall schedule. Avionics FPGA designs are maturing later than planned due to design complexity and offset between hardware & software development schedules.	Plans are in place to have Actuator Flight Model deliveries completed by June 09, to complete resolution of Avionics design and test issues by September 2009, and to complete Avionics flight deliveries in early 2010.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Formulation:	Mars Atmosphere & Volatile EvolutioN (MAVEN)

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	1.0	6.7	53.4	168.7	182.6	138.4	30.6
FY 2009 President's Budget Request	57.7	6.7	68.5	152.5	170.7	121.8	--
Total Change from 2009 President's Budget Request	-56.7	0.0	-15.1	16.2	11.8	16.6	--

Project Purpose

MAVEN was selected in September 2008 under the 2006 Mars Scout Announcement of Opportunity. The MAVEN mission will provide a comprehensive picture of the Mars upper atmosphere, ionosphere, solar energetic drivers, and atmospheric losses. MAVEN will deliver comprehensive answers to long-standing questions regarding the loss of Mars' atmosphere, climate history, liquid water, and habitability. MAVEN will provide the first direct measurements ever taken to address key scientific questions about Mars' evolution. Specific MAVEN science objectives consist of:
- Determine structure and composition of the atmosphere and ionosphere;
- Determine the physical and chemical processes that control loss processes;
- Determine escape rates of neutrals;
- Determine escape rates of ions;
- Determine the external inputs that control upper atmosphere and ionosphere structure and that drive escape; and
- Determine the relative escape rates of the stable isotopes and the resulting isotopic fractionation.

Additional information can be found in http://lasp.colorado.edu/maven/

Project Preliminary Parameters

MAVEN will deliver its science using three instrument packages: a stand-alone neutral gas and ion mass spectrometer (NGIMS), capable of measuring thermal neutrals and ions; a stand-alone imaging ultraviolet spectrometer (IUVS); and the Particles and Fields (P&F) package, consisting of six instruments measuring ionospheric properties, energetic ions, solar wind and solar energetic particles, magnetic fields, and solar extreme ultraviolet irradiance.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Formulation:	Mars Atmosphere & Volatile EvolutioN (MAVEN)

Estimated Project Deliverables

The MAVEN measurements will be made from an elliptical orbit with periapsis at 150 km and apoapsis at 6220 km (4.5-hour period). MAVEN will use a sun-pointing, three -axis stabilized spacecraft, with a two-axis gimballed, Mars-pointing platform for the NGIMS, IUVS, and the SupraThermal And Thermal Ion Composition (STATIC) instruments. The spacecraft has a body-mounted high-gain antenna.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
Launch Services	United Launch Alliance (ULA)	Intermediate Class launch service		New
Spacecraft	Lockheed Martin	MRO spacecraft bus and avionic suite, with cross strapping and monopropellant propulsion system		New

Estimated Project Schedule

MAVEN will be launched in November 2013, and will arrive at Mars in September 2014.

Milestone Name	Formulation Agreement Estimate	FY 2009 PB Request	FY 2010 PB Request
Formulation			
PDR	3QTR CY2010		New
CDR	3QTR CY 2011		New
ATLO	3QTR CY 2012		New
Launch	4QTR CY 2013		New
Mars Orbit Insertion	September 2014		New

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Formulation:	Mars Atmosphere & Volatile EvolutioN (MAVEN)

Project Management

The MAVEN is part of the Mars Program managed by the JPL. The PI from the University of Colorado has delegated the day-to-day management to GSFC.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Program Management	JPL	GSFC	
Project management, msn sys engineering, safety and mission assurance, and project scientist	GSFC	GSFC	
Neutral gas and ion mass spectrometer (NGIMS)	GSFC	GSFC	
Navigation, trajectory, and orbit maintenance analysis	GSFC	JPL	
Magnetometer (MAG) - Measures interplanetary, solar wind, and ionospheric magnetic fields	GSFC	GSFC	

Acquisition Strategy

All major acquisitions are in place. MAVEN was selected competitively on September 15, 2008 under the Mars Scout 2006 Announcement of Opportunity (AO- NNH06ZDA002O).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
All	Technical Management Cost	08/2008	Reviewed science, technical approach, cost,and schedule. Finding led to selection of the MAVEN mission.	N/A
Performance	IPAO	N/A	Will assess cost, schedule, and risk status of project.	1QFY11

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
N/A	None identified at this time	

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Outer Planets

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**62.2**	**101.1**	**98.6**	**97.1**	**140.3**	**117.7**	**118.5**
Outer Planets	**62.2**	**101.1**	**98.6**	**97.1**	**140.3**	**117.7**	**118.5**
FY 2009 President's Budget Request	**81.9**	**101.1**	**216.7**	**279.4**	**230.6**	**362.0**	**--**
Outer Planets	**81.9**	**101.1**	**216.7**	**279.4**	**230.6**	**362.0**	**--**
Changes from FY 2009 Request	**-19.8**	**0.0**	**-118.1**	**-182.2**	**-90.3**	**-244.2**	**--**

Program Overview

The Outer Planets Program consists of three strategic elements: the ongoing Cassini mission, a new Outer Planets Flagship mission, and the Flagship Data Analysis project. These elements enable science investigations across a broader array of disciplines and in more depth than competed missions. The science discoveries made by these missions are not expected to be easily displaced with time and are expected to overthrow previous paradigms and create new ones in their place.

Plans For FY 2010

Cassini completed its prime mission in July 2008, and started into an extended mission with a new set of science goals. The primary objective of the Cassini extended mission is to continue mission operations at the prime mission level in order to further investigate the discoveries made of Titan and Enceladus during the prime mission. In FY 2010 Cassini will complete its first extended mission at Saturn. This will include performing nine close flybys of Titan, four with Enceladus, and three with other smaller satellites throughout the year. Scientific studies of Saturn, its rings, and magnetosphere will continue. NASA will evaluate a second mission and science extension in late calendar year 2009.

In February 2009 NASA down-selected the Outer Planets Flagship (OPF) from three science targets to focus on the Europa Jupiter System. In addition to further definition study and technology development efforts for the Europa Jupiter System Mission (EJSM) throughout FY 2010, NASA will also continue to negotiate the details of a potential partnership with the European Space Agency (ESA) and other international partners.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Outer Planets

Project Descriptions and Explanation of Changes

Outer Planets

NASA plans to fund concept studies and technology development for an Outer Planets Flagship mission. In the 2nd quarter of FY 2009, NASA, working jointly with the European Space Agency, selected a mission to Jupiter and its moon Europa for more detailed concept studies.
Projected mission costs and the resource constraints of our potential international partners preclude a new start during FY 2010.

Cassini-Huygens, in its extended operations phase, is an Outer Planets Flagship mission to Saturn that is profoundly altering our understanding of that planet, its famous rings, magnetosphere, icy satellites, and particularly the moons Titan and Enceladus. Cassini-Huygens is an international collaborative effort with a four year orbiter prime mission. Cassini is the first spacecraft to explore the Saturn system in detail, including its rings and moons. A major focus is Saturn's largest moon, Titan, with its dense atmosphere, methane-based meteorology, and geologically active surface. Launched in October 1997, Cassini arrived at Saturn in July 2004, and will continue with its first extension to investigate Saturn and Titan throughout FY 2010.

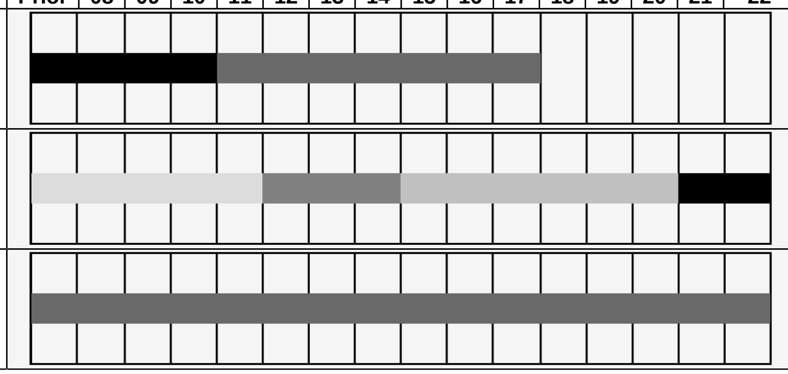
The Cassini Data Analysis Project (CDAP) broadens the science community participation in the analysis of the wealth of new Cassini mission data. The project allows scientists outside the selected flight team to utilize the mission data, conduct research, and publish findings. CDAP dramatically increases the scientific return of the mission and accelerates the rate of that return. Research conducted under CDAP can affect and alter the Cassini imaging targets, such as Titan, and its flybys (e.g., Enceladus plume).

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Deliver science data to Planetary Data Systems (PDS) consistent with science archive plan (in increments within 6 -9 months)	Cassini	Same
Publically release study reports	Outer Planets Flagship	New
Release ROSES and make selections	Research Data Analysis	New

Implementation Schedule

Schedule by Fiscal Year: Prior, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22



Project	Phase	Beg	End
Cassini	Tech		
	Form		Sep-89
	Dev	Oct-89	Oct-97
	Ops	Oct-97	Sep-10
	Res	Oct-97	Sep-17
Outer Planets Flagship	Tech	Jan-07	Sep-11
	Form	Oct-11	Sep-14
	Dev	Oct-14	Sep-20
	Ops	Oct-20	Jul-25
	Res		
Research Data Analysis	Tech		
	Form		
	Dev		
	Ops		
	Res	Oct-97	Sep-22

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

Program management responsibility for the Outer Planets Flagship Program program resides at JPL. Scientific mission priorities for OPF reside with SMD. The responsible official for this program is the Director of Planetary Science.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Cassini	JPL	JPL	The Italian Space Agency provided Cassini's high-gain communication antenna and the Huygens probe was built by the European Space Agency (ESA).
Outer Planets Flagship	JPL	JPL	ESA
Research Data Analysis	HQ	Multi-Center	None

Acquisition Strategy

All major acquisitions contracts for Cassini are in place. The acquisition strategy for the Outer Planets Flagship (OPF) mission is expected to be similar to Cassini. The OPF science payload will be competitively selected.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Senior Review Panel	02/2007	Cassini senior review for an extended mission recommended approval of the extended mission science. Decision on the Cassini second mission extension is expected in CY 2009.	02/2009
Performance	Independent TMC-Science Panels	12/2009	Independent science, technical, management, and cost review of concept studies. Results pending.	11/2010

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Technology

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**65.2**	**64.9**	**89.0**	**98.4**	**102.1**	**93.5**	**91.4**
Technology	**65.2**	**64.9**	**89.0**	**98.4**	**102.1**	**93.5**	**91.4**
FY 2009 President's Budget Request	**84.8**	**64.9**	**69.3**	**69.6**	**71.3**	**73.0**	**--**
Technology	**84.8**	**64.9**	**69.3**	**69.6**	**71.3**	**73.0**	**--**
Changes from FY 2009 Request	**-19.6**	**0.0**	**19.7**	**28.8**	**30.8**	**20.6**	**--**

Program Overview

Planetary Science is a challenging endeavor. Future Planetary Science missions will demand advances in both power and propulsion systems to enable successful trips to harsh environments, far from the Sun, with highly challenging trajectories. To meet these needs, the Planetary Science Technology Program includes the In-Space Propulsion (ISP), Radioisotope Power Systems (RPS), and Advanced Multi-Mission Operations System (AMMOS) Projects.

The ISP Project develops in-space propulsion technologies that can enable or benefit near- and mid¬term NASA missions. These technologies will enhance the performance of planetary science missions by allowing increased science payload mass, minimized launch cost and decreased mission trip times. Furthermore, ISP will enable access to more challenging and interesting science destinations. The ISP Project is completing development of several propulsion technologies in support of future Flagship, Discovery, Mars, and New Frontiers missions. The high-temperature chemical thruster development task, high-priority aerocapture ground activities, electric propulsion development efforts for NASA's Evolutionary Xenon Thruster (NEXT) ion system development, and sample return propulsion technology development are the focus core technologies under study and development.

The Radioisotope Power System (RPS) Project advances the capabilities of spacecraft power systems, thereby making it possible for missions to travel to destinations distant from the sun, or where sunlight is obscured or infrequent. RPS is developing a proto-flight Advanced Stirling Radioisotope Generator (ASRG) by the 2013-2014 time frame and is initiating development of a small RPS system for use in distributed network mission environments. RPS continues low-level investments in advanced thermoelectric conversion and thermal photovoltaic technologies as seeds to meet future needs late in the next decades. Consolidation of multi-mission RPS studies and cross-cutting launch approval activities are now included in the RPS project. Funds will be needed to procure nuclear material to support missions in formulation.

The AMMOS Project provides planetary science missions with a set of navigation and design software tools and services for flight mission training, space communications resources allocation, and improved communication and navigation.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Technology

Plans For FY 2010

The In-Space Propulsion (ISP) Project will:
- Continue electric propulsion life validation testing and analysis of NASA's Evolutionary Xenon Thruster (NEXT);
- Complete high priority technology development activities (large scale aeroshell manufacturing, Guidance Navigation and Control system testing, and space environmental effects testing) for aerocapture; and
- Continue electric propulsion Hall thruster development task towards Technology Readiness Level 6 (TRL6).

Radioisotope Power Systems (RPS) Project will:
- Continue extended performance testing of the Advanced Stirling Radioisotope Generator (ASRG) engineering unit to provide reliability data;
- Begin development of one Advanced Stirling Radioisotope Generator (ASRG) proto-flight unit for delivery by the 2013-2014 time frame;
- Demonstrate 1500-hour lifetime Radioisotope Thermoelectric Generator couples and validate four-couple module power output; and
- Initiate design of a small Radioisotope Power System (deca-watt class).

Advanced Multi-Mission Operations System (AMMOS) will continue to develop multi-mission software tools for spacecraft navigation and mission planning, efficient spacecraft communication, and data handling.

Project Descriptions and Explanation of Changes

Technology

The In-Space Propulsion (ISP) portfolio invests in high-priority technology areas such as Electric Propulsion (Next-Generation Electric Propulsion), Aerocapture Technology, Advanced Chemical propulsion, and sample return propulsion technology development.

Investments in technology planning allow for strategic studies of focused technology areas that are necessary for the achievement of Planetary Science Theme missions.

The Radioisotope Power Systems (RPS) Project develops and matures component technologies and actively manages the integration of component technologies to flight systems that support multi-mission flight applications. The breadth of the previous project has resulted in the initiation of a project structure to manage this integration. The RPS Project manages both the technology investments and the systems developments and transitions acquisition of flight units to a mission-specific user. The project also assumes responsibility for multi-mission RPS studies and cross-cutting launch approval activities. The project integrates DOE and NASA requirements and assesses long-range planning requirements for nuclear material acquisition.

Returning to Planetary Science in FY 2009 from the Heliophysics Deep Space Mission Systems (DSMS) Program, the AMMOS Project provides multi-mission navigation, design, and training tools to flight missions, and undertakes technology investments for improved communications and navigation technologies.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Technology

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
NEXT thruster long duration testing achieves grater than 450 kg of Xenon throughput.	ISP	New
2.65m high temp aeroshell with ablative TPS will be fabricated.	ISP	Same
Advanced Stirling Radioisotope Generator engineering model will demonstrate extended operations (7,000 hours).	RPS	Same
Project formulation for a small RPS development will be completed	RPS	New
Provide standard interfaces in order to enable interoperability among missions.	AMMOS	Same

Program Management

SMD provides overall oversight of the technology program. GRC is responsible for the ISP and RPS projects. JPL is responsible for the AMMOS project.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
ISP	GRC	GRC, MSFC, JPL	None
RPS	GRC	JPL, GRC	Department of Energy
AMMOS	JPL	JPL	None

Acquisition Strategy

Technology activities are solicited using the NASA Research Opportunities in Space and Earth Sciences (ROSES) announcement, and selections are made using a competitive, peer-reviewed process. Lockheed Martin and Sunpower are providing support for the RPS Project.

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Mission Directorate:	Science
Theme:	Astrophysics

Theme Overview

The science goals of NASA's Astrophysics Division are breathtaking: from investigating the very moment of creation of the universe, to learning the full history of the formation of stars and galaxies. NASA is discovering how planetary systems form, how environments hospitable for life develop, and is searching for signatures of life on other worlds may result in the discovery that we are not alone.

The Astrophysics Theme is comprised of the following major science-based programs:

- Physics of the Cosmos Program: Reveal laws and forces of the universe at the most fundamental level in ways that can only be done from space. Missions will probe back to the beginning of time by measuring the cosmic microwave background radiation in novel ways and using gravity waves as an entirely new window on the universe. The nature of dark matter that shepherds the growth of galaxies and large-scale structure will be determined, the mysterious dark energy pervading the universe will be uncovered and the limits of Einstein's theories will be tested.

- Cosmic Origins Program: Discover how the universe developed over cosmic time from the big bang to its modern configuration of galaxies, stars and planets. The focus is to explore how the expanding universe grew into a grand, cosmic web of galaxies; how within the galaxies stars and planets formed; and how stars create the heavy elements such as carbon, oxygen, and iron, that are essential for life.

- Exoplanet Exploration Program: Determine whether we are alone in the universe, by detecting and characterizing planets orbiting other stars in our galaxy. One of the most ambitious but captivating goals of NASA is to identify Earth-like worlds orbiting nearby stars and to search for the signatures of life.

The Astrophysics theme supports a robust research program, 10 operating missions, and 12 flight projects in various stages of planning and execution. As these missions explore the extremes of space, time, matter and energy, new scientific understanding is achieved and new technologies are developed and tested, resulting in great benefit to society and the economic and strategic health of our nation.

For more information, please see http://nasascience.nasa.gov/astrophysics

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**1,395.6**	**1,281.2**	**1,120.9**	**1,074.1**	**1,042.7**	**1,126.3**	**1,139.6**
Astrophysics Research	102.2	135.0	151.9	160.0	165.0	177.2	188.0
Cosmic Origins	870.1	819.2	667.2	598.9	550.3	523.8	452.3
Physics of the Cosmos	148.9	128.3	147.7	188.5	213.9	291.4	330.3
Exoplanet Exploration	156.7	68.1	46.2	57.3	86.9	123.5	167.3
Astrophysics Explorer	117.7	130.7	107.9	69.5	26.6	10.4	1.7
FY 2009 President's Budget Request	**1,337.5**	**1,162.5**	**1,122.4**	**1,057.1**	**1,067.7**	**1,116.0**	**--**
Astrophysics Research	102.2	152.3	170.4	181.0	203.0	198.9	--
Cosmic Origins	807.3	674.4	571.1	515.4	485.6	458.5	--
Physics of the Cosmos	159.0	157.0	219.8	249.0	271.1	326.0	--
Exoplanet Exploration	162.6	48.1	67.7	68.4	96.4	126.2	--
Astrophysics Explorer	106.4	130.6	93.3	43.3	11.7	6.4	--
Total Change from FY 2009 Request	**58.1**	**118.8**	**-1.5**	**17.1**	**-25.0**	**10.3**	**--**

Note: Starting in FY 10, the Astro-H project is in the Astrophysics theme.

Plans for FY 2010

Astrophysics Research

Senior Reviews for operating missions and archives were conducted in the spring of 2008; those results are reflected in the 2010 budget. A comparative evaluation of all Astrophysics operating missions is conducted every two years (next review scheduled for spring of 2010), and of the archives every four years. The science output is evaluated by an independent expert panel, and decisions are made as to which missions will receive funding for extended operation.

In R&A, peer-reviewed investigations are supported in the areas of past missions data analysis, and theoretical studies or modeling of the astrophysical phenomena targeted by past, current, and future missions. Laboratory studies of astrophysical phenomena, limited ground-based observing, and suborbital missions will also continue in FY 2010.

The Balloons Project will continue to work toward advancing the capability of the new super-pressure balloon, which will be used to carry large scientific experiments to the brink of space for 100 days or more.

Cosmic Origins

The James Webb Space Telescope was authorized to proceed into development in July, 2008, and the baseline cost and schedule have been established. The next major milestone is Critical Design Review, which is a review of the complete system design, and is scheduled to take place in March 2010.

Hubble Servicing Mission 4 and Servicing Mission Observatory Verification (SMOV) will be complete by the end of FY 2009 and peer-reviewed science will begin using the new instruments.

The Stratospheric Observatory For Infrared Astronomy (SOFIA) first science flights, which are the first competed science observations, will begin in FY 2010.

Physics of the Cosmos

Herschel and Planck in-orbit check-out will be complete and prime operations will begin. Fermi will remain in its prime operations phase and Chandra will continue on in extended operations.

Exoplanet Exploration

Kepler has launched successfully, in-orbit checkout is underway and science operations will begin in summer 2009.

Astrophysics Explorer

The High-Resolution Soft X-Ray Spectrometer (SXS) instrument was selected in 2008 as a Mission of Opportunity (MoO) and is scheduled to fly on the Japanese Astro-H mission in 2013. This instrument will be in the formulation phase in FY 2010.

The Nuclear Spectroscopic Telescope Array (NuSTAR) mission will hold its confirmation review in preparation to enter development phase in FY 2010.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

NASA enables research to understand the structure, content, and evolution of the universe. This research provides information about humankind's origins and fundamental physics that govern the behavior of matter, energy, space, and time. NASA leads the world in space-based research into the most compelling questions of modern physics, such as the nature of dark matter and dark energy, high-energy cosmic rays, tests of gravity and general relativity, and insight into cosmic inflation during the very early universe. NASA works proactively with the National Science Foundation and Department of Energy in exploring the interfaces between astronomy and physics, and in the search for life in the universe.

NASA-supported researchers look far into the universe, towards the beginning of time, to see the first stars and galaxies forming. They search for Earth-like planets around distant stars, determine if life could exist elsewhere in the galaxy, and investigate the processes that formed our solar system. These efforts are synergistic with Astrobiology, Solar System, Heliophysics and Earth science research supported elsewhere at NASA and in other federal agencies.

Astrophysics funds approximately 2000 research, data analysis and technology grants to research institutions and universities in most states. The proposed Astrophysics portfolio increases supporting research and technology funding in each of the strategic programs. These technology lines will focus on developing new capabilities from the prototype phase through the pre-flight phase, which will feed into flight programs. Astrophysics technology efforts have a long history of contributing to the defense sector (infrared detectors, interferometry, large optics), medical technology and life sciences (X-ray optics and detectors for cancer treatment, large format optical sensors, analysis software), homeland security (high energy detectors of fissile materials), and commercial applications (UV/X-ray photolithography advances in microelectronics, space-based telescopic platforms for Earth imaging).

Relevance to the NASA Mission and Strategic Goals:

Astrophysics supports NASA's achievement of Strategic Plan Sub-Goal 3D: Discover the origin, structure, evolution, and destiny of the universe, and search for Earth-like planets.

This effort is comprised of four focus areas, or Outcomes:
3D.1: Progress in understanding the origin and destiny of the universe, phenomena near black holes, and the nature of gravity.
3D.2: Progress in understanding how the first stars and galaxies formed, and how they changed over time into the objects recognized in the present universe.
3D.3: Progress in understanding how individual stars form and how those processes ultimately affect the formation of planetary systems.
3D.4: Progress in creating a census of extra-solar planets and measuring their properties.

Astrophysics seeks to answer these questions that humankind has been pondering for centuries: How did the universe begin? How will it end? What are the limits of matter and energy, of space and time? How did the universe come to be, and what are the laws of nature that have permitted life to arise in the universe? Throughout history, these questions have served as cornerstones of mythology and philosophy: thought-provoking, but unanswerable. Now, with the aid of cutting-edge science and technology, the answers are within reach.

See FY 2010 Performance Plan, under Management and Performance, for specific annual goals for this Theme.

Relevance to education and public benefits:

Stunning images produced from Astrophysics operating missions continue to inspire the public, revealing the beauty of our universe and the science behind those images. NASA provides the tools to translate the science for the classroom and other learning venues in ways that meet educator needs.

Hubble images are featured on the Space Telescope Science Institute's "Amazing Space" Web site which provides curriculum support tools to classrooms in every state in the union. Spitzer's "Cool Cosmos" Web site offers explorations into the world of the infrared, and Chandra delivers authentic data sets to educators to enhance lessons by allowing students to use the same data that professional researchers use.

A consortium of Astrophysics missions have been featured in a traveling museum exhibit, "Alien Earths", to inform and inspire the public on critical questions related to the search for life elsewhere in our universe. The Astrophysics Exoplanet Exploration Program, in conjunction with the Astronomical Society of the Pacific, has sponsored the creation of "Night Sky Network" amateur astronomy clubs around the nation. NASA also provides toolkits and professional development training to support these groups of space enthusiasts as they help strengthen the public understanding of astronomy and space science.

Mission Directorate:	Science
Theme:	Astrophysics

Performance Achievement Highlights:

For the first time, astronomers using the Chandra Space Telescope have clearly seen the effects of "dark energy" on the most massive collapsed objects in the universe. By tracking how dark energy has stifled the growth of galaxy clusters and combining this with previous studies, scientists have obtained the best clues yet about what dark energy is and what the destiny of the universe could be. These results have consequences for predicting the ultimate fate of the universe. If dark energy is explained by the cosmological constant, the expansion of the universe will continue to accelerate, and the Milky Way and its neighbor galaxy, Andromeda, may never merge with the Virgo cluster. For more information, please see: http://chandra.harvard.edu/index.html

Observations from the Hubble Space Telescope have provided new knowledge on the atmospheres of extrasolar planets. Hubble has made the first detection of an organic molecule in the atmosphere of a Jupiter-sized planet orbiting another star. This breakthrough is an important step in eventually identifying signs of life on a planet outside our solar system. The molecule found by HST is methane, which under the right circumstances can play a key role in prebiotic chemistry, the chemical reactions considered necessary to form life as we know it. This discovery proves that HST and upcoming space missions, such as NASA's James Webb Space Telescope (JWST), can detect organic molecules on planets around other stars by using spectroscopy, which splits light into its components to reveal the "fingerprints" of various chemicals. For more information on Hubble, please go to: http://hubble.nasa.gov/. And for JWST, please see: http://www.jwst.nasa.gov/

Hubble has also taken the first visible-light snapshot of a planet circling another star. Estimated to be no more than three times Jupiter's mass, the planet, called Fomalhaut b, orbits this bright southern star, located 25 light-years away in the constellation Piscis Australis, or the "Southern Fish."

On March 19, 2008, NASA's Swift satellite shattered the record for the most distant object (~7.5 billion light years away) that could be seen with the naked eye. The explosion was a gamma ray burst. Most gamma ray bursts occur when massive stars run out of nuclear fuel. Their cores collapse to form black holes or neutron stars, releasing an intense burst of high-energy gamma rays and ejecting particle jets that rip through space at nearly the speed of light like turbocharged cosmic blowtorches. When the jets plow into surrounding interstellar clouds, they heat the gas, often generating bright afterglows. Gamma ray bursts are the most luminous explosions in the universe since the big bang. For more information, please go to: http://swift.gsfc.nasa.gov/docs/swift/swiftsc.html

In June 2008, NASA launched the Fermi Gamma-Ray Space Telescope (formerly GLAST), which is now in its prime operations stage (http://fermi.gsfc.nasa.gov/). The JWST mission successfully entered the development phase and will launch in June 2014. The Kepler mission, designed to survey our region of the Milky Way Galaxy to detect and characterize hundreds of Earth-size and smaller planets in or nearby the habitable zone, completed all its environmental tests in 2008 and sucessfully launched March 6, 2009. For more information on Kepler, please go to: http://kepler.nasa.gov/

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	Senior Review Panel	04/2008	Comparative review of operating missions. Missions are ranked in terms of science return. In the most recent review, Swift and Chandra missions ranked highest, while RXTE and GP-B ranked lowest. Results and the report can be found at http://nasascience.nasa.gov/about-us/science-strategy/senior-reviews/AstroSR08_Report.pdf	04/2010
Relevance	National Research Council	05/2001	The Decadal Survey process began in 2008 and is underway. The last Decadal, which was published in 2001, prioritized science objectives in Astrophysics.	2010

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Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Research

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	102.2	135.0	151.9	160.0	165.0	177.2	188.0
Astrophysics Research and Analysis	56.9	60.0	61.1	62.5	64.0	66.2	67.8
Balloon Project	24.0	24.6	26.7	28.8	32.4	33.2	35.8
Other Missions and Data Analysis	21.3	50.4	64.1	68.6	68.5	77.9	84.4
FY 2009 President's Budget Request	102.2	152.3	170.4	181.0	203.0	198.9	--
Astrophysics Research and Analysis	50.3	61.4	65.4	69.3	72.6	77.5	--
Balloon Project	22.8	24.6	26.7	28.8	32.4	33.2	--
Other Missions and Data Analysis	29.1	66.3	78.4	82.9	97.9	88.2	--
Changes from FY 2009 Request	0.0	-17.3	-18.5	-21.1	-38.0	-21.6	--

Note: The Astrophysics R&A low-level technology development effort has moved into the program-specific Supporting Research & Technology lines with no impact to R&A.

Program Overview

The Astrophysics Research Program translates missions into science advances by: collecting, processing, and storing mission data; making mission data available to scientists; and funding grants for basic research, and data analysis from past and current missions. All data collected by missions are archived in data centers located at universities and NASA centers throughout the country and are readily available to all researchers and the general public.

Suborbital efforts (balloons and sounding rockets) are significant contributors to meeting the following goals: conducting cutting-edge basic research; developing tools of science; maintaining U.S. leadership in science, engineering, and technology; and training the next generation of scientists and engineers to better compete in the 21st century. For more information, please see: http://nasascience.nasa.gov/researchers/sara/highlights.

For more information on the Astrophysics Data Centers please see: http://nasascience.nasa.gov/astrophysics/astrophysics-data-centers

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Research

Plans For FY 2010

The Astrophysics Research Program will continue to conduct and enable high-quality astrophysical research consistent with NASA's goals and science programs. Peer-reviewed investigations are supported in the areas of analysis of data obtained from past missions, theoretical studies or modeling of the astrophysical phenomena targeted by past, current, and future missions, laboratory studies of astrophysical phenomena, development of new detectors, limited ground-based observing, and suborbital missions.

Among the science areas pursued by the suborbital missions are rocket flights to study x-ray, ultraviolet, and infrared emission from both our galaxy and the early universe, and balloon flights to study cosmic rays from our galaxy, the polarization of the microwave background, and gamma rays from black holes in the nearby universe.

ADCAR covers the activities of the Astrophysics Data Centers and NASA's participation in the Virtual Astronomical Observatory (VAO). The VAO is a collaborative project between NASA and NSF.

The next Astrophysics Senior Review of operating missions is scheduled to be held in spring 2010, and the next archival Senior Review will be in 2012.

The Balloons project has approximately 18 flights planned for FY 2009, and a similar number is expected in FY 2010. Engineering data gathered will enable both the maturing of the science experiment technology for later flights and the development of next-generation super pressure balloons capable of supporting long duration science research (up to 100 days) at any Earth latitude.

In addition to ongoing awards, the Education and Public Outreach Project will competitively select approximately 40 new proposals for small awards averaging $15,000 a year and approximately 15 new proposals for mid-range awards averaging $130,000 a year. New Science Education and Public Outreach Forums will begin operation in FY 2010. In addition to community engagement and communication efforts, an analysis of the existing portfolio of NASA Earth and space science education products will be conducted.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Research

Project Descriptions and Explanation of Changes

Astrophysics Research & Analysis (R&A)

All Research and Analysis grants selected for funding by the Astrophysics Theme are broadly competed through NASA's Research Opportunities in Space and Earth Sciences (ROSES). Grant proposals must relate directly to both Agency and Theme goals and objectives, and all proposals are peer-reviewed by a mix of scientific disciplines and are selected based upon merit. Funded grants include theoretical investigations of phenomena related to missions, analysis of data from past missions, laboratory studies of astrophysical phenomena, development of new detectors and supporting technologies, some ground-based studies, and suborbital missions. The latter include both rocket flights to study x-ray, ultraviolet, and infrared emission from both our galaxy and the early universe, as well as balloon flights to study cosmic rays from our galaxy, the polarization of the microwave background, and gamma rays from black holes in the nearby universe

Balloons

Balloons have been used for decades to conduct scientific studies. While the basics of ballooning have not changed, balloon size and capabilities have increased, and their dependability has improved greatly. The Wallops Flight Facility manages the NASA Balloon Project. The project offers inexpensive, high-altitude flight opportunities for scientists to conduct research and test new technologies prior to spaceflight application. The science experiments being done by balloons cover a wide range of disciplines such as astrophysics, solar and heliospheric physics, as well as Earth upper-atmosphere chemistry.

Other Missions and Data Analysis

Included in this line item are the following projects:

-Astrophysics Data Curation and Archival Research (ADCAR): The Astrophysics Theme has established an archive structure beyond the scope of individual missions, to receive data and make it accessible by creating an ensemble of primarily wavelength-specific astrophysics archives. After the completion of a mission, all archive activities are taken over by the relevant active multi-mission archive. ADCAR covers the activities of the Astrophysics Data Centers and NASA's participation in the Virtual Astronomical Observatory (VAO). ADS maintains bibliographic databases and is one of the data centers supported in the ADCAR activity. For more information see: http://nasascience.nasa.gov/astrophysics/astrophysics-data-centers

-The Astrophysics Senior Review is conducted every two years and is a comparative evaluation of all operating missions in their extended phase. Science output for these missions is evaluated, and a ranking process determines which missions will continue to receive funding for extended operations.

-Keck Single Aperture is a data archive for the High Resolution Echelle Spectrometer (HIRES) instrument. This instrument provides the radial velocity data used to find exoplanets.

-Directorate Support - Space Science: This project funds Agency-wide Fee for Services for the Science Mission Directorate. These fees for services include Defense Contract Audit Service (DCAS) contract administration, Defense Contract Audit Agency (DCAA) audit services and NASA Contract Assurance Services (NCAS) for all of SMD's projects.

-Education and Public Outreach: Education and Public Outreach: This project is a major contributor to the overall NASA education and outreach effort through development and dissemination of new educational and outreach products that utilize SMD science discoveries and by providing opportunities for students and educators, citizen scientists, and the public to engage in authentic experiences working with our data and our research communities. Efforts are carried out through competitively selected awards. There are small awards averaging $15,000 a year and larger award averaging $130,000 per year. The project also supports four Science Education and Public Outreach Forums to foster ongoing engagement of the target audiences through community communication and feedback.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Annual peer-reviewed solicitation for research grant opportunities	Research Program	No change

Program Management

The Science Mission Directorate provides program management, with individual projects managed at Goddard Space Flight Center and the Jet Propulsion Laboratory.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Archival Senior Review Panel	05/2008	Comparative review of archives efficiency and cost effectiveness. The normal review cycle for activities at archive centers is 4 years, for more information on the 2008 Senior Archival review see: http://nasascience.nasa.gov/astrophysics/astrophysics-data-centers/ApArchSR-2008_final.pdf	05/2012
Quality	Balloon working group	06/2008	Review the operations from a scientific standpoint. The outcome of 2008 BWG meeting was that much had been accomplished to increase the reliability of flight and termination systems, Solution to chute shock problem, Rip stitch decelerator, and dragging payloads. The development of the mini-SIP will enable many new small science investigations. There has been a major step forward in solving the deployment problem for the lobed design (super pressure balloon).	06/2009

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Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	870.1	819.2	667.2	598.9	550.3	523.8	452.3
Hubble Space Telescope (HST)	244.9	207.7	112.6	101.6	94.6	91.1	93.2
James Webb Space Telescope (JWST)	510.3	446.9	441.4	385.1	354.6	335.6	259.8
Stratospheric Observatory for Infrared Astronomy (SOFIA)	63.8	72.8	72.8	74.0	75.8	77.6	79.1
Other Missions And Data Analysis	51.2	91.7	40.4	38.3	25.3	19.4	20.2
FY 2009 President's Budget Request	807.3	674.4	571.1	515.4	485.6	458.5	--
Hubble Space Telescope (HST)	228.5	154.9	125.6	114.7	94.8	93.9	--
James Webb Space Telescope (JWST)	448.3	371.9	311.1	265.1	236.1	194.9	--
Stratospheric Observatory for Infrared Astronomy (SOFIA)	62.1	72.8	72.8	57.0	58.8	60.6	--
Other Missions and Data Analysis	68.4	74.7	61.6	78.6	95.9	109.1	--
Changes from FY 2009 Request	62.8	144.8	96.1	83.5	64.7	65.2	--

Note: Includes $75M of Recovery Act funding in FY09. Hubble Fellowship funding, as well as project management funds, have been moved into program-level activities; there is no budgetary impact to Hubble operations.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins

Program Overview

The science goal of Cosmic Origins is to understand the entire sweep of evolution of the universe, from the cosmic big bang to the present. How did the rich structure we observe in the universe today, its planets, stars and galaxies, originate from the tiny fluctuations in the density of matter and energy imprinted by the big bang? What was the nature of the first stars and galaxies, which are so faint and distant that they have never been observed? How did galaxies and the enormous black holes within them form and evolve? How do stars and planets form? What are the conditions needed for life to originate? Are we alone? To address these fundamental questions NASA has developed the world's most sophisticated space observatories and is now building even more advanced facilities.

Cosmic Origins missions explore how the expanding universe grew into a grand, cosmic web of galaxies; how stars and planets formed within the galaxies; how stars create the heavy elements, such as carbon, that are essential for life. Major breakthroughs in our knowledge of the cosmos have already been made with the current suite of missions. But Cosmic Origins science questions will remain vital, even post-JWST. The submillimeter and far-infrared parts of the spectrum are just now being examined by missions like Herschel and SOFIA. In the future, larger telescopes (with mirror diameters of 10 meters or longer) will be required to resolve galaxies and stellar nurseries at these wavelengths and in the ultraviolet. Future collaboration will also be critical for continued progress answering the questions that form the intellectual impetus behind Cosmic Origins.

For more information, please see: http://nasascience.nasa.gov/about-us/smd-programs/cosmic-origins

Plans For FY 2010

Hubble Space Telescope Servicing Mission 4 and the in-orbit checkout of instruments will be complete, and peer-reviewed proposals will begin with the new instruments.

JWST was authorized to proceed into development in July, 2008 and the baseline cost and schedule have been established. The next major milestone, Critical Design Review is scheduled to take place in March 2010, which will result in a review of the complete system design.

SOFIA basic science flights will be the first openly competed science to the general astronomical community; the science will be conducted on two instruments aboard SOFIA: FORCAST (U.S. instrument) and GREAT (German instrument). First science is now scheduled to begin in FY 2010 while the project continues progress toward Limited Operations Capability in 2011.

Spitzer cryogen will run out in spring 2009; the spacecraft will be in its warm operations phase, using remaining imaging capabilities that still exceed what is available from the ground, and will be unmatched until the launch of JWST. Warm Spitzer will be a powerful and unique facility for projects that require precise photometry, and for deep large-scale surveys at near/mid-infrared wavelengths. The spacecraft is funded for two years of warm operations, per results of the 2008 operating missions Senior Review. Spitzer will be reviewed again in the 2010 Senior Review to determine whether to extend warm operations.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins

Project Descriptions and Explanation of Changes

Hubble Space Telescope (HST)

Hubble Space Telescope launched in 1990 and is currently in an extended operations phase. Servicing Mission 4 (SM4), scheduled for May, 2009, will add new batteries, gyros and instruments to extend its life even further into the future. One of NASA's most successful and long-lasting science missions, HST has beamed hundreds of thousands of images back to Earth, shedding light on many of the great mysteries of astronomy. Its gaze has helped determine the age of the universe, the identity of quasars, and the existence of dark energy.

James Webb Space Telescope

JWST is in development phase. The spacecraft will have a large mirror, 21.3 feet in diameter, and a sunshield the size of a tennis court. Neither the mirror nor the sunshield fit into the rocket fully open, so both will fold up and open only after JWST is in space. JWST will reside at the Sun-Earth L2 point, which is about one million miles from the Earth. The telescope and instruments will operate at cryogenic temperature in order to achieve infrared performance. JWST is currently in development phase and launch is scheduled for 2014 on a European Space Agency-supplied Ariane-5 rocket for a five-year science mission (10-year goal) to study the origin and evolution of galaxies, stars, and planetary systems.

Stratospheric Observatory for Infrared Astronomy (SOFIA)

SOFIA is in development phase. Astronomical objects emit many forms of energy, which neither the human eye nor ordinary telescopes can detect. Infrared is one form of this invisible energy. SOFIA is a Boeing 747SP airborne observatory with a 2.5 meter reflecting telescope that will study the universe in the infrared spectrum. Besides this contribution to science progress, SOFIA will be a major factor in the development of new observational techniques, of new instrumentation and in the education of young scientists and teachers in the discipline of infrared astronomy. The project will be at Full Operational Capability (FOC) in 2014.

Other Missions and Data Analysis

Included in this line item are:

-The Spitzer Space Telescope, in extended operations, is an infrared cryogenic telescope equipped with three instruments to study the characteristics of star-forming regions, centers of galaxies, and newly forming planetary systems. Spitzer will complete its cryogenic mission by mid-2009, but funding to operate a warm mission phase was approved as a result of the latest Astrophysics Division operating missions Senior Review. Continued warm operations will be reviewed in the 2010 Senior Review.

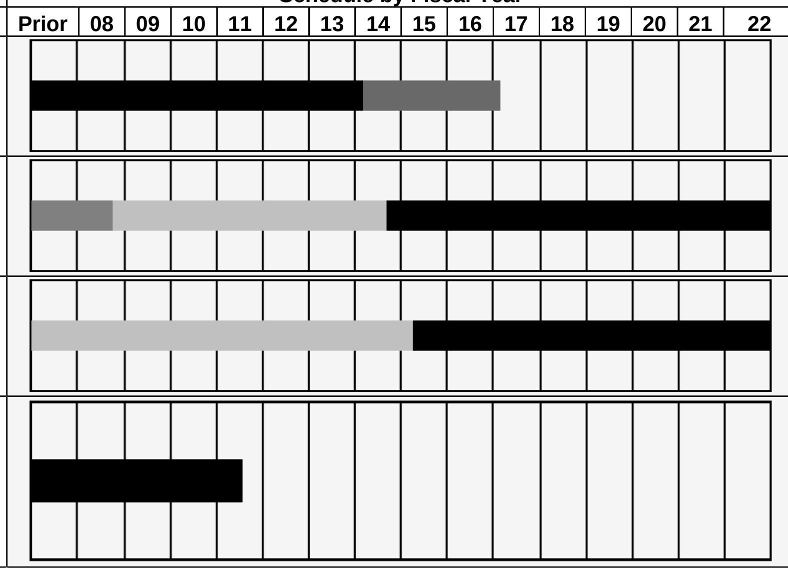
-Cosmic Origins Supporting Research & Technology, which supports Hubble fellowships and program-specific research and early technology development efforts.

-Cosmic Origins Future Missions which supports future mission studies based on the recommendations of the upcoming Astrophysics decadal review.

-Cosmic Origins Program Management which provides programmatic, technical, and business management, as well as program science leadership and coordination for education and public outreach products and services.

Implementation Schedule

Schedule by Fiscal Year



Project	Phase	Beg	End
HST	Tech		
	Form		
	Dev		
	Ops	Apr-90	Dec-13
	Res	Dec-13	Dec-16
JWST	Tech	Apr-96	Apr-99
	Form	Apr-99	Jul-08
	Dev	Jul-08	Jun-14
	Ops	Jun-14	Oct-24
	Res	Oct-24	Oct-25
SOFIA	Tech		
	Form		
	Dev	Dec-96	Dec-14
	Ops	Dec-14	Dec-34
	Res		
Spitzer: Cryogen mission complete in 2009; begin warm operations for two years per Senior Review results.	Tech		
	Form		
	Dev		
	Ops	Aug-03	Apr-11
	Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

Cosmic Origins project management responsibility is as follows:

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
HST	GSFC	GSFC	None
JWST	GSFC	None	European Space Agency (ESA) and Canadian Space Agency (CSA)
SOFIA	DFRC	DFRC & ARC	German Space Agency (DLR)
Spitzer	JPL	JPL	None

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins

Acquisition Strategy

HST: All major acquisitions are in place for operations and servicing. Space Telescope Science Institute, Baltimore, MD and Ball Aerospace and Technologies Corp., Boulder, CO are providing support for SM4. For HST Operations, the Space Telescope Science Institute coordinates with the Hubble European Space Agency Information Center.

JWST: JWST is being built by Northrop Grumman Aerospace Systems (Redondo Beach, CA), teamed with Ball (Boulder, CO), ITT (Rochester, NY) and Alliant Techsystems (Edina, MN). Selections were made via a competitive NASA Request For Proposal.

SOFIA: L3 Communications (Waco,Texas), and MPC Products Corporation (Skokie,IL) are supporting the completion of the development, integration and test of the airborne platform system. L3 modified the SOFIA 747SP aircraft to install the telescope provided by Germany (DLR/DSI). MPC is developing the telescope cavity door drive system. CSC DynCorp (El Segundo, CA) is providing aircraft maintainence support. University Space Research Association (Columbia, MD) will manage the science planning, ground science facilities, science instrument and technology development, and education and public outreach for SOFIA.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Development:	James Webb Space Telescope

FY 2010 Budget Request

Budget Authority ($ millions)	Prior	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	BTC	LCC TOTAL
FY 2010 President's Budget Request	**1,575.0**	**510.3**	**446.9**	**441.4**	**385.1**	**354.6**	**335.6**	**259.8**	**634.9**	**4,943.6**
Formulation	1,575.0	225.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,800.1
Development / Implementation	0.0	285.2	446.9	441.4	385.1	354.6	335.6	259.8	52.5	2,561.1
Operations / Close-out	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	582.4	582.4
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FY 2009 President's Budget Request	**1,575.0**	**448.3**	**371.9**	**311.1**	**265.1**	**236.1**	**194.9**	**--**	**0.0**	**3,402.5**
Formulation	1,575.0	225.1	0.0	0.0	0.0	0.0	0.0	--	0.0	1,800.1
Development / Implementation	0.0	223.2	371.9	311.1	265.1	236.1	194.9	--	0.0	1,602.3
Operations / Close-out	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	--
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.1
Changes from FY 2009 Request	**0.0**	**61.9**	**75.0**	**130.3**	**120.0**	**118.5**	**140.7**	**--**	**634.9**	**1,541.1**
Formulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	--
Development / Implementation	0.0	62.0	75.0	130.3	120.0	118.5	140.7	--	52.5	958.8
Operations / Close-out	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	582.4	582.4
Other	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	--	0.0	-0.1

Note: The FY 2010 LCC number in the table above is understated by $20M due to the difference in the FY 2009 enacted bill and the April 2009 initial operating plan. The FY 2010 JWST baseline LCC is $4,964M, and the Development estimate is $2,581.1M. The FY 2009 Budget Request Prior and BTC figures did not reflect an approved baseline.

Explanation of Project Changes

JWST entered development in late 2008 and the budget and schedule are at a 70% confidence level as a result of the confirmation review process. The newly baselined life-cycle cost is based on a June, 2014 launch readiness date, including costs from formulation through the end of operations. The life-cycle cost incorporates actual costs to date, including long lead items that have already been produced or are currently being manufactured, as well as cost estimates for the remaining work. The cost includes five years of operations (with consumables sufficient for 10 years of operations), data analysis, archiving, and project close-out.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Development:	James Webb Space Telescope

Project Purpose

The James Webb Space Telescope (JWST) was identified by the National Research Council as a top priority new initiative for astronomy and physics for the decade. JWST is a large, deployable, space-based infrared astronomical observatory, scheduled for launch in 2014. The mission is a logical successor to the Hubble Space Telescope (HST), extending beyond Hubble's discoveries by looking into the infrared spectrum, where the highly red-shifted early universe must be observed, where cool objects like protostars and protoplanetary disks emit strongly, and where dust obscures shorter wavelengths.

Hubble has told us much about distant objects, but its infrared coverage is limited. Light from distant galaxies is redshifted, by the expansion of the universe, into the infrared part of the spectrum (from the visible). By examining light redshifted beyond Hubble's sight, JWST will be able to observe things farther away, as their light has taken longer to reach us. Hence it will be looking back further in time.

JWST will explore the mysterious epoch when the first luminous objects in the universe came into being after the big bang. The focus of scientific study will include first light of the universe, assembly of galaxies, origins of stars and planetary systems, and origins of the elements necessary for life.

The telescope is scheduled to launch in 2014 from Kourou, French Guiana, on an ESA-supplied Ariane 5 rocket. Its operational location is the L2 Lagrange point, which is about one million miles from the Earth.

For more information, please see: http://www.jwst.nasa.gov/

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Development:	James Webb Space Telescope

Project Parameters

JWST will be optimized for infrared astronomy, with some capability in the visible range. JWST's instruments are: Near Infrared Camera (NIRCam); Mid Infrared Instrument (MIRI); Near Infrared Spectrograph (NIRSpec); and the Fine Guidance Sensor (FGS).

NIRCam is an imager with a large field of view and high angular resolution. It covers a wavelength range of 0.6 - 5 micrometers and has 10 mercury-cadmium-telluride (HgCdTe) detector arrays. These are analogous to CCDs found in ordinary digital cameras. NIRCam is a science instrument but also a wavefront sensor, which is used to align and focus the optical telescope.

NIRSpec enables scientists to obtain simultaneous spectra of more than 100 objects in a 9-square-arcminute field of view. It provides medium-resolution spectroscopy over a wavelength range from 0.6 - 5 micrometers. NIRSpec employs a micro-electromechanical system "microshutter array" for aperture control, and it has two HgCdTe detector arrays.

MIRI is an imager/spectrograph that covers the wavelength range of 5 - 28 micrometers and it has three Arsenic-doped Silicon detector arrays. The camera module provides wide-field broadband imagery, and the spectrograph module provides medium-resolution spectroscopy over a smaller field of view compared to the imager. The nominal operating temperature for the MIRI is 7 degrees above absolute zero, which is possible through an on-board cooling system.

The FGS is a guider camera that is incorporated into the instrument payload in order to meet the image motion requirements of JWST. This sensor is used for both "guide star" acquisition and fine pointing. The sensor operates over a wavelength range of 1 - 5 micrometers and has two HgCdTe detector arrays. Its field of view provides a 95% probability of acquiring a guide star for any valid pointing direction.

The FGS Tunable Filter Camera is a wide-field, narrow-band camera that provides imagery over a wavelength range of 1.6 - 4.9 micrometers, via tunable Fabry-Perot etalons that are configured to illuminate the detector array with a single order of interference at a user-selected wavelength. The camera has a single HgCdTe detector array.

JWST will continue modifications to the thermal vacuum Chamber A at the Johnson Space Center to achieve the required temperature and contamination control test conditions for hardware prior to flight. The first phase of this project is underway and is funded with a total of $20.4M of FY 2008 and FY 2009 funds. The total cost of the modification remains at $60.6M, $28.0M of which is FY 2010 funding.

The JWST Ground Operations, Science Support Center and archives will be at the Space Telescope Science Institute in Baltimore, MD.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Development:	James Webb Space Telescope

Project Commitments

JWST is scheduled to launch in 2014 and, after six months of on-orbit checkout and commissioning, complete five years of mission operations (with a goal of 10 years of operations.)

The four main science goals are:
- Search for the first galaxies or luminous objects formed after the big bang.
- Determine how galaxies evolved from their formation until now.
- Observe the formation of stars from the first stages to the formation of planetary systems.
- Measure the physical and chemical properties of planetary systems and investigate the potential for life in those systems.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
Observatory	Northrop Grumman Aerospace Systems, Redondo Beach, California	Includes Optical Telescope Element (OTE), Spacecraft, Sunshield, Observatory AI&T and commissioning. The Observatory shall be designed for at least a 5-year lifetime.	N/A	Same
Integrated Science Instrument Module (ISIM)	NASA Goddard Space Flight Center	Contains the Science Instruments (SIs) and Fine Guidance Sensor (FGS). Provides structural, thermal, power, command and data handling resources to the SIs and FGS.	N/A	Same
Near-Infrared Camera (NIRCam) instrument	University of Arizona; Lockheed Martin	Optimized for finding first light sources, and operating over the wavelength range 0.6-5 microns.	N/A	Same
Near-Infrared Spectrometer (NIRSpec)	European Space Agency (ESA)	Operating over the wavelength range 0.6-5 microns with three observing modes.	N/A	Same
Mid-Infrared Instrument (MIRI)	ESA; University of Arizona; Jet Propulsion Laboratory	Operating over the wavelength range 5-27 microns, providing imaging, coronagraphy, and spectroscopy.	N/A	Same
Fine Guidance Sensor	Canadian Space Agency (CSA)	Provides scientific target pointing information to the observatory's attitude control sub-system.	N/A	Same
Launch Vehicle	European Space Agency (ESA)	Ariane V ECA	N/A	Same
Science Operations Center and Mission Operations	Space Telescope Science Institute (STScI)	Mission Operations and Science Operations Center	N/A	Same

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Development:	James Webb Space Telescope

Schedule Commitments

JWST was approved to enter implementation in July, 2008.

Milestone Name	Confirmation Baseline	FY 2009 PB Request	FY 2010 PB Request
Development			
Non-Advocate Review/Preliminary Design Review	March, 2008	N/A	Same
Start phase C/Implementation	July, 2008	N/A	Same
Critical Design Review	March, 2010	N/A	Same
Systems Integration Review (SIR)	May, 2012	N/A	Same
Launch Readiness Date	June, 2014	N/A	Same
Start Phase E	December, 2014	N/A	Same

Development Cost and Schedule Summary

JWST

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
James Webb Space Telescope	2009	2,581.1	2009	2,581.1	0	Launch	6/15/2014	6/15/2014	0

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**2,581.1**	**2,581.1**	**0.0**
Payload	178.4	178.4	0.0
Spacecraft	875.4	875.4	0.0
Systems I&T	67.3	67.3	0.0
Ground Systems	206.8	206.8	0.0
Science/technology	10.5	10.5	0.0
Other (launch services, project management, etc.)	1,242.7	1,242.7	0.0

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Development:	James Webb Space Telescope

Project Management

Goddard Space Flight Center is responsible for James Webb Space Telescope project management.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Observatory	GSFC	GSFC	None
Mission management and System Engineering	GSFC	GSFC	None
Integrated Science Instrument Module (ISIM)	GSFC	GSFC	None
NIRCam	GSFC	GSFC	None
NIRSpec	ESA	None	ESA
MIRI	GSFC	JPL, ARC	ESA
Fine Guidance Sensor - Tunable Filter (FGS-TF)	CSA	None	CSA
Ariane 5 ESA launch vehicle and launch operations	ESA	None	ESA
Ground control systems and science operations and control center	GSFC	None	None

Acquisition Strategy

JWST is being built by Northrop Grumman Aerospace Systems (Redondo Beach, CA), teamed with Ball (Boulder, CO), ITT (Rochester, NY) and Alliant Techsystems (Edina, MN). Selections were made via NASA Request For Proposal.

The Space Telescope Science Institute (STScI), in Baltimore, MD, is developing the Science and Operations Center and associated services.

The Integrated Science Instrument Module (ISIM) is being provided by GSFC.

The University of Arizona, Tucson, is providing the near-infrared science camera (NIRCam), along with Lockheed Martin's Advanced Technology Center in Palo Alto, California. The selection was made via a NASA Announcement of Opportunity.

The European Space Agency is providing the Mid-Infrared Instrument, (MIRI) with management and technical participation by ARC and JPL, which was selected for this role after an internal NASA competition. The Europeans are also providing the Near-Infrared Spectrometer (NIRSpec) and an Ariane 5 launch vehicle.

The Canadian Space Agency is providing the Fine Guidance Sensor.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Development:	James Webb Space Telescope

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	N/A	Critical Design Review	03/2010
Performance	SRB	N/A	Systems Integration Review/Authority to Proceed into Assembly Integration and Testing	05/2012
Performance	SRB	N/A	Test Readiness Review/Authority to Proceed with Environmental Testing	03/2013
Performance	SRB	N/A	Pre-ship Review/Authority to Ship to Launch Site	10/2013
Performance	SRB	N/A	Flight Readiness Review/Authority to Launch	06/2014

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
JWST Manufacturing, I&T	JWST has a long, complicated cryogenic integration and test which has never been performed at this scale.	JWST Standing Review Board regularly reviews the optical telescope element (OTE) testing and observatory-level integration and test planning.
JWST Advanced Technology Development Risk	JWST requires advances in several technologies, which could present cost and schedule problems.	Successful Technology Non-Advocate Review (T-NAR) held in January 2007; risk retired.
JWST Partnership Risk	Because JWST is an international collaboration, NASA may incur schedule and cost impacts caused by challenges in Europe and Canada that are outside of NASA's control. Experience with similar collaborations indicates that this is likely to occur.	NASA has written clearly-defined interfaces and is actively managing and complying with export controls (ITAR).

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Development:	Stratospheric Observatory for Infrared Astronomy (SOFIA)

FY 2010 Budget Request

Budget Authority ($ millions)	Prior	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	BTC	LCC TOTAL
FY 2010 President's Budget Request	**596.2**	**63.8**	**72.8**	**72.8**	**74.0**	**75.8**	**77.6**	**79.1**	**1,843.4**	**2,955.5**
Formulation	35.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.0
Development / Implementation	561.2	63.8	72.8	72.8	74.0	75.8	77.6	79.1	0.0	1,077.1
Operations / Close-out	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,843.4	1,843.4
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FY 2009 President's Budget Request	**595.6**	**62.1**	**72.8**	**72.8**	**57.0**	**58.8**	**60.6**	**--**	**1,599.4**	**2,579.0**
Formulation	35.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	35.0
Development / Implementation	560.6	62.1	72.8	72.8	57.0	58.8	60.6	--	0.0	944.7
Operations / Close-out	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	1,599.4	1,599.4
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	-0.1
Changes from FY 2009 Request	**0.6**	**1.8**	**0.0**	**0.0**	**17.0**	**17.0**	**17.0**	**--**	**244.1**	**376.5**
Formulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	--
Development / Implementation	0.6	1.7	0.0	0.0	17.0	17.0	17.0	--	0.0	132.4
Operations / Close-out	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	244.0	244.0
Other	0.0	0.1	0.0	0.0	0.0	0.0	0.0	--	0.1	0.1

Explanation of Project Changes

The FY09 Budget runout for FY 2011 and beyond assumed that an international partner would be identified to pay some of SOFIA's operational costs. NASA is no longer expecting to rely on an additional partner and has restored funds to SOFIA's operations budget. Also, because attainment of Full Operational Capability is scheduled for December 2014, the Development budget is projected to continue through FY 2014, with Operations starting in FY 2015.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Development:	Stratospheric Observatory for Infrared Astronomy (SOFIA)

Project Purpose

Mission objectives for SOFIA include studying many different kinds of astronomical objects and phenomena, but some of the most significant are: star birth and death; formation of new solar systems; identification of complex molecules in space; planets, comets and asteroids in our solar system; nebulae and dust in galaxies (ecosystems of galaxies); and black holes at the center of galaxies. SOFIA's breadth of coverage serves many scientific quests. It will be NASA's only far-infrared mission when Spitzer runs out of helium, and it is the only mid-infrared mission until JWST. SOFIA's reconfigurability and flexibility ensures cutting edge technology as well as the ability to address new scientific questions. At full operational capability, SOFIA will have eight instruments (6 U.S. instruments; 2 German instruments). The U.S. instruments include: High-speed Imaging Photometer for Occultation (HIPO), First Light Infrared Test Experiment CAMera (FLITECAM), Faint Object InfrRed CAmera for the SOFIA Telescope (FORCAST), CAltech Submillimeter Interstellar Medium Investigations Receiver (CASIMIR), Echelon-Cross -Echelle Spectrograph (EXES), and High-resolution Airborne Wideband Camera (HAWC). The two German instruments are German Receiver for Astronomy at Terahetz Frequencies (GREAT), and Field Imaging Far-Infrared Line Spectrometer (FIFI LS).

For more information, please see: http://www.nasa.gov/mission_pages/SOFIA/index.html

Project Parameters

The Stratospheric Observatory for Infrared Astronomy (SOFIA) was designed as a highly-modified 747SP aircraft with a large open-port cavity aft of the wings, housing a 2.5 meter telescope optimized for infrared/sub-millimeter wavelength astronomy. SOFIA will operate in flight at 41,000 feet using six U.S. instruments and two German instruments. SOFIA will ramp up to 960 science hours per year. Early science instruments will include: High-speed Imaging Photometer for Occultations (HIPO); First Light Infrared Test Experiment Camera (FLITECAM); and German Receiver for Astronomy at Terahertz frequencies (GREAT). These will be followed by six other instruments in the later phases: flights will last six to eight hours on average.

Project Commitments

SOFIA will initiate science observations in 2010, and will begin 20 years at full operational capability as an airborne observatory in 2014.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
Platform	DFRC/L3/MPC/DLR	747SP modified to carry an 18 ton, 2.5 meter telescope	Same	Same
Science Center	ARC/USRA	Science Center will schedule observations, and manage data acquisition and processing	Same	Same
Science Instruments	USRA/Universities	6 U.S. instruments ranging from Infrared to submillimeter	Same	Same
Flight Operations	DFRC/CSC DyneCorp	Flight crew, maintenance, and fuel	Same	Same
High-speed Photometer for Occultations	Lowell Observatory	Simultaneous high-speed time-resolved imaging photometry at two optical wavelengths	Same	Same
First Light Infrared Test Experiment Camera	UCLA	Large field-of-view, narrow- and broad-band photometric imaging and low-resolution spectroscopy from 1 to 5.5 µm	Same	Same
A Wide-field Infrared Camera for SOFIA	Cornell University	Large field-of-view, narrow- and broad-band photometric imaging and moderate-resolution spectroscopy from 4 to 42 µm	Same	Same
Caltech Submillimeter Interstellar Medium Investigations Receiver	Caltech	Modular, dual-channel heterodyne instrument for high-resolution spectroscopy between 150 and 600 µm	Same	Same
High-resolution Airborne Wide-band Camera	University of Chicago Yerkes Observatory	Broad-band, far-infrared camera with four bands between	Same	Same

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Development:	Stratospheric Observatory for Infrared Astronomy (SOFIA)

Schedule Commitments

The development and test plan has been modified to enable earlier science observations by the science community to be concurrent with the late phases of aircraft flight testing. The current plan provides for initial science observations with a subset of science instruments in 2010, followed by completion of the remaining science instruments and refinement of telescope performance, at which point Full Operational Capability (in December 2014) is reached.

Milestone Name	Confirmation Baseline	FY 2009 PB Request	FY 2010 PB Request
Development			
First Flight	2000	2007	2007
First Science (Early Science)	N/A	2009	2010
Full Operational Capability (FOC)	N/A	2014	2014

Development Cost and Schedule Summary

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Stratospheric Observatory for Infrared Astronomy (SOFIA)	2007	919.5	2009	1,077.1	17	FOC	12/30/2013	12/30/2014	12

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**919.5**	**1,077.1**	**157.6**
Aircraft/Spacecraft	657.7	710.2	52.5
Other Costs	62.2	151.5	89.3
Science/Technology	199.6	215.4	15.8

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Development:	Stratospheric Observatory for Infrared Astronomy (SOFIA)

Project Management

The overall Stratospheric Observatory for Infrared Astronomy (SOFIA) project, and the SOFIA airborne system is managed by Dryden Flight Research Center. The SOFIA science is managed by Ames Research Center.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Platform	DFRC	DFRC	Germany - DLR/DSI
Science	ARC	None	Germany - DLR/DSI
Mission Operations and Data Analysis	ARC	None	Germany - DLR/DSI
Instruments (9)	ARC	None	Germany - DLR/DSI

Acquisition Strategy

Dryden Flight Research Center (DFRC) handles the platform project (airframe and telescope). DFRC is working with L-3 Communications (Waco,Texas), and MPC Products Corporation (Skokie,IL) to support the completion of the development, integration and test of the airborne platform system. L-3 modified the SOFIA 747SP aircraft to install the telescope provided by Germany (DLR/DSI). MPC is developing the telescope cavity door drive system. DFRC is also working with CSC DynCorp (El Segundo, CA) which is providing aircraft maintainence support.

Ames Research Center (ARC) handles the science management. ARC is working with University Space Research Association (Columbia, MD) to manage the science planning, ground science facilities, science instrument and technology development, and education and public outreach for SOFIA.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SMOR - Independent Team	7/2008	Assess the science operations. Main finding was to make SOFIA science data available to general community	N/A
Performance	Standing Review Board	N/A	Early science project review	12/2009

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Late delivery of Cavity Door Drive System	Late delivery of software that operates the telescope observation doors on the aircraft will impact the schedule to initiate open door flight testing and science observations.	NASA has stationed a NASA representative at the vendor's facility to support and oversee the vendor until delivery of the software. NASA has reviewed and revised the schedule for testing of the software for schedule efficiency.

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Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	148.9	128.3	147.7	188.5	213.9	291.4	330.3
Other Missions and Data Analysis	148.9	128.3	147.7	188.5	213.9	291.4	330.3
FY 2009 President's Budget Request	159.0	157.0	219.8	249.0	271.1	326.0	--
Other Missions and Data Analysis	159.0	157.0	219.8	249.0	271.1	326.0	--
Changes from FY 2009 Request	-10.1	-28.8	-72.1	-60.5	-57.1	-34.6	--

Program Overview

The Physics of the Cosmos (PCOS) Program focuses on some of the most profound questions in contemporary science: How did the universe begin? What is the universe composed of, and what is its ultimate fate? What are the fundamental laws that govern the workings of space, time, matter and energy?

These fundamental questions can be approached by asking more specific questions: What happens to matter, energy, and time at the edge of a black hole, where Einstein's theory of gravity is put to its harshest test? What is the nature of dark matter and dark energy which pervade the universe?

It is possible that the answers to these questions will usher in a revolutionary new paradigm of physics. It is the goal of the PCOS Program to observe and study those phenomena in the cosmos, from observing the most energetic regions in the universe, those near the surfaces of super massive black holes, to peering back to the very beginning of time using the completely unexplored spectrum of gravitational radiation. The Fermi mission, for example, will search for signs of new laws of physics and what composes the mysterious dark matter. It will attempt to explain how black holes accelerate immense jets of material to nearly light speed. The XMM-Newton mission has helped scientists solve a number of cosmic mysteries, ranging from enigmatic black holes to the origins of the universe itself. Chandra will reveal new details about phenomena in our universe as scientists can now see rings and jets in the regions around a pulsar, like the one in the Crab Nebula supernova remnant.

For more information see:
http://nasascience.nasa.gov/about-us/smd-programs/physics-of-the-cosmos

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos

Plans For FY 2010

Herschel and Planck are scheduled to launch in May 2009 and will be in full science operations by FY 2010.

The Fermi Gamma Ray Space Telescope will continue in its prime operations phase. LISA, IXO and JDEM will continue low level technology development while awaiting final results of the Astrophysics decadal survey.

Project Descriptions and Explanation of Changes

Other Missions and Data Analysis

-The Herschel Space Observatory is a collaborative mission with the European Space Agency and is scheduled for a May 2009 launch. It has the largest single mirror ever built for a space telescope and it will collect long-wavelength radiation from some of the coldest and most distant objects in the universe. NASA has contributed to instruments onboard Herschel and will also host U.S. astronomer access to data through the NASA Herschel Science Center.

-Planck is also an ESA-led mission, with substantial NASA contributions, scheduled for launch in May, 2009. It will reveal the geometry and contents of the universe, how the universe grew immediately after its birth, and how the stage was set for the universe to evolve into structures that are seen today, such as galaxies. It will provide an order of magnitude increased precision in its measurement of the Cosmic Microwave Background (CMB).

-Fermi Gamma-ray Space Telescope is a joint NASA/DOE mission formerly called GLAST. Fermi launched June, 2008 and is currently in operational phase. It is designed to detect the highest energy gamma-rays ever measured in a space-based mission and will provide a full-sky map filled with thousands of gamma-ray sources, increasing the current tally by orders of magnitude.

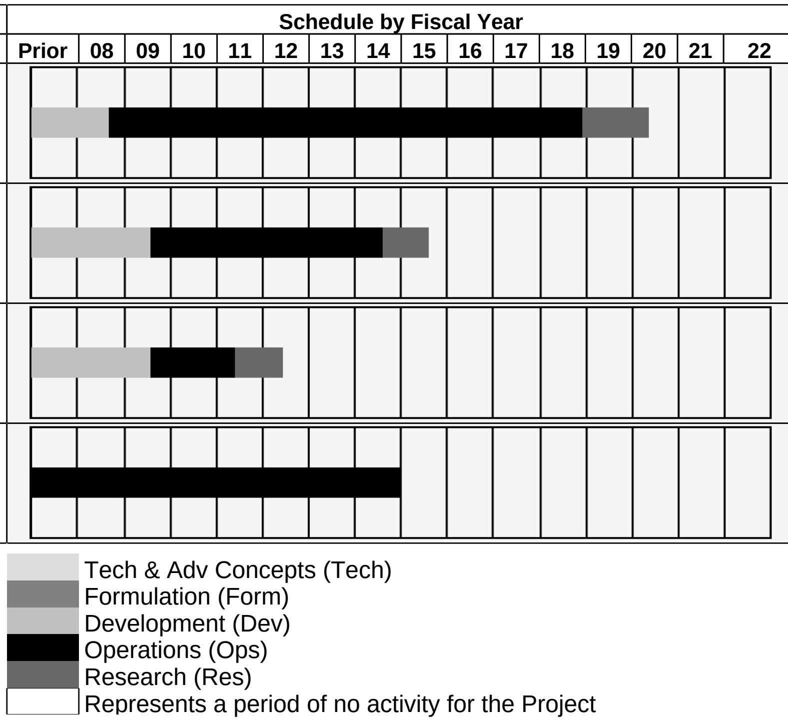
-Chandra, a flagship X-ray observatory currently in extended operations, has allowed scientists to image complex systems in exquisite detail, and to determine the positions of thousands of distant X-ray sources. Chandra has also provided unique information on diverse subjects ranging from the presence and amount of dark matter in the universe to phenomena occurring near the horizons of black holes. Chandra ranked second in the FY 2008 Astrophysics Senior Review.

-The Laser Interferometer Space Antenna (LISA) is currently doing low level technology development through 2010 when the results of the Astrophysics decadal survey will be known. LISA, a joint mission with the European Space Agency, will provide a first view of the gravitational radiation spectrum from space, enabling scientists to "see" in new ways how the universe evolved, and allowing powerful new tests of fundamental laws.

-The International X-ray Observatory (IXO), formerly Constellation-X, is currently in pre-formulation doing low level technology development through 2010 when the results of the Astrophysics decadal survey will be known. It is a joint X-ray observatory with participation from NASA, the European Space Agency (ESA) and the Japanese Aerospace Exploration Agency (JAXA). Science objectives are the study of black holes and matter under extreme conditions, and the life cycles of matter and energy in the universe.

-The Joint Dark Energy Mission (JDEM), currently in pre-Phase A, is a space-based observatory that will make precision cosmological observations to measure the effects of dark energy on the recent expansion history of the universe and on the growth of structure in the universe.

Implementation Schedule



Project	Phase	Beg	End
Fermi	Tech	Jun-98	Dec-99
	Form	Dec-99	Dec-03
	Dev	Dec-03	Jun-08
	Ops	Jun-08	Aug-18
	Res	Sep-18	Feb-20
Herschel	Tech		
	Form	Sep-97	Sep-01
	Dev	Oct-01	May-09
	Ops	May-09	May-14
	Res	May-14	May-15
Planck	Tech		
	Form	Sep-97	Sep-01
	Dev	Oct-01	May-09
	Ops	May-09	Mar-11
	Res	Mar-11	Mar-12
Chandra	Tech		
	Form		
	Dev		
	Ops	Jun-99	Sep-14
	Res		

Program Management

Goddard Space Flight Center has Program management responsibility. Project management is as follows:

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Fermi	GSFC	GSFC	Japan, Italy, France, Sweden, and Germany
Herschel (Instrumentation)	JPL	JPL	ESA
Planck (Instrumentation)	JPL	JPL	ESA
JDEM	GSFC	TBD	TBD
LISA	GSFC	GSFC/JPL	ESA
IXO	GSFC	GSFC	JAXA and ESA
Chandra	MSFC	None	None

Acquisition Strategy

The acquisition strategies for JDEM, IXO, and LISA are under development. NASA will seek to maximize the amount of competition to ensure that the best concepts and science are supported.

U.S. elements for the Herschel and Planck missions have been delivered to ESA.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Exoplanet Exploration

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**156.7**	**68.1**	**46.2**	**57.3**	**86.9**	**123.5**	**167.3**
Other Missions and Data Analysis	156.7	68.1	46.2	57.3	86.9	123.5	167.3
FY 2009 President's Budget Request	**162.6**	**48.1**	**67.7**	**68.4**	**96.4**	**126.2**	**--**
Other Missions and Data Analysis	162.6	48.1	67.7	68.4	96.4	126.2	--
Changes from FY 2009 Request	**-5.9**	**20.0**	**-21.5**	**-11.1**	**-9.5**	**-2.7**	**--**

Program Overview

Today we stand on the threshold of a voyage of unprecedented scope and ambition, promising insight into one of humankind's most timeless questions: Are we alone? One of the most exciting new fields of research within the NASA Astrophysics portfolio is the search for planets, particularly Earth-like planets, around other stars. During the last 15 years, astronomers have discovered over 300 planets orbiting nearby stars. Most of these planets were found using ground-based telescopes, and most of them are gas or ice giants, similar to the four outer planets in our own Solar System. The majority of these planets orbit much closer to their parent stars than do the giant planets in our system, some as close as 0.04 AU (1 AU = 1 astronomical unit = mean Earth-Sun distance, 93 million miles). Mercury, by comparison, orbits the Sun at a distance of about 0.4 AU (about 37 million miles).

Most of the known extrasolar planets have been discovered by the radial velocity, or the Doppler method, in which one measures the tiny back-and-forth motion of a star as a planet orbits around it. The Doppler method tends to favor the detection of massive planets since the greater the mass of the planet, the greater the "wobble" it induces in the parent star. Approximately thirty planets have been found using a second technique, the transit method, in which one measures the slight dimming of a star's light that occurs as a planet passes in front of it. The transit method only works on systems in which the planet's orbital plane is nearly parallel to one's line of sight. The Kepler mission is specifically designed to survey our region of the Milky Way galaxy to discover hundreds of Earth-size and smaller planets using the transit method to determine how many of the billions of stars in our galaxy have such planets.

In the future, through the use of astrometry, precision interferometry and eventually direct detection, NASA plans to embark on a series of missions designed to detect and characterize Earth-sized planets that are orbiting in the "habitable zone" of nearby stars (the range of distances at which liquid water could be stable at the planet's surface). The Agency's long-term vision for exoplanet exploration includes missions optimized not only to detect extrasolar planets, but also to measure their characteristics.

For more information, please see: http://exep.jpl.nasa.gov/

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Exoplanet Exploration

Plans For FY 2010

The Exoplanet Exploration Program (EXEP) will assess different techniques and mission concepts for detecting and characterizing extrasolar planets, including space-based astrometric, coronagraphic, and statistical concepts.

The Space Interferometry Mission (SIM) continues technology development pending results of the 2010 decadal survey.

Keck Interferometer development is complete and the interferometer is operational. Operations have been turned over to the California Association for Research in Astronomy (CARA). By early FY 2010, the interferometer Key Science program characterization of dust levels around nearby sun-like stars will be completed, helping to assess the level of impact on future exoplanet characterization missions.

Kepler launched on March 6, 2009, and by 2010 the mission will be in full operations phase.

Project Descriptions and Explanation of Changes

Other Missions and Data Analysis

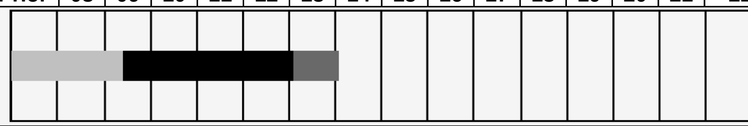
This line item contains the following projects:

-Kepler launched in March 2009 and is finishing in-orbit checkout; the operations phase will begin in summer 2009. It is specifically designed to survey the distant stars in our region of the Milky Way galaxy to detect and characterize hundreds of Earth-size and smaller planets in or near the "habitable zone." The habitable zone encompasses the distances from a star where liquid water can exist on a planet's surface.

-Keck Operations is the NASA portion of the Keck Observatory partnership. NASA uses its share of observing time for support of Exoplanet and other astrophysics related science. Observation time is competed time, organized through the Exoplanet Exploration SR&T project.

-SIM is a mission under study in support of NASA's goal of searching for habitable planets. The project is currently doing risk reduction engineering, and is studying alternate designs over a range of cost and performance levels in support of the next Astrophysics decadal survey.

Implementation Schedule

Project	Schedule by Fiscal Year	Phase Dates		
	Prior 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22		Beg	End
Kepler		Tech		
		Form	Dec-01	May-05
		Dev	May-05	Mar-09
		Ops	Mar-09	Nov-12
		Res	Nov-12	Nov-13

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

The Jet Propulsion Laboratory is resposible for program management.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Kepler	JPL (Development) & ARC (MO&DA)	JPL (Development) & ARC (MO&DA)	None
SIM	JPL	JPL	None

Acquisition Strategy

All major acquisitions for Kepler are in place. Ames Research Center and Ball Aerospace & Technologies (Boulder, CO) were selected as the Kepler development and operations team via a competative NASA Discovery Program Announcement of Opportunity. The Laboratory for Atmospheric and Space Physics (Boulder, CO) was chosen as a subcontractor for mission operations.

The acquisition strategy for the next Exoplanet mission is not yet determined. NASA will seek to use merit-based review as the basis for determining mission content to ensure that the best science and implementation strategy are supported.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Exoplanet Task Force	01/2008	Determine planet-finding research and technology approach & prioritization leading up to the next decadal survey. Report and recommended strategy published and sent to respective agencies. For more information, please see: http://nasascience.nasa.gov/about-us/NAC-subcommittees/nac-documents/2008-01_APS_ExoPTF.pdf	N/A
Performance	SRB	New	Program Assessment	2010

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Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**117.7**	**130.7**	**107.9**	**69.5**	**26.6**	**10.4**	**1.7**
Wide - Field Infrared Survey Explorer (WISE)	**72.7**	**65.2**	**13.0**	**5.2**	**1.6**	**0.2**	**0.0**
Nuclear Spectroscopic Telescope Array (NuStar)	**16.7**	**38.7**	**59.9**	**33.7**	**6.8**	**6.4**	**0.0**
Other Missions and Data Analysis	**28.3**	**26.8**	**35.0**	**30.6**	**18.2**	**3.8**	**1.7**
FY 2009 President's Budget Request	**106.4**	**130.6**	**93.3**	**43.3**	**11.7**	**6.4**	**--**
Wide - Field Infrared Survey Explorer (WISE)	**71.8**	**65.2**	**13.0**	**5.2**	**1.6**	**0.0**	**--**
Nuclear Spectroscopic Telescope Array (NuStar)	**0.0**	**41.5**	**57.8**	**31.0**	**6.8**	**6.4**	**--**
Other Missions and Data Analysis	**34.6**	**23.9**	**22.5**	**7.1**	**3.2**	**0.0**	**--**
Changes from FY 2009 Request	**11.3**	**0.1**	**14.5**	**26.2**	**15.0**	**4.0**	**--**

Note: Astrophysics Explorer budget has increased due to the addition of the recently selected Astro-H/SXS Mission of Opportunity. FY 2010 President's Budget Request is understated by $9.9M due to the transfer of Astro-H from Heliophysics Explorer to Astrophysics Explorer Program in FY2010.

Program Overview

The Explorer Program provides frequent flight opportunities for world-class astrophysics and space physics investigations, using an innovative and efficient approach to spacecraft development and operations. The program is composed of a series of independent space science missions that share a common funding and management structure. The program emphasizes missions that can be accomplished under the control of the scientific research community within specified life cycle cost requirements. The program provides access to space and launch vehicle funding. These funds are part of the total cost cap for each mission.

The Wide-field Infrared Survey Explorer (WISE) is the only Astrophysics Explorer mission currently in development. The Nuclear Spectroscopic Telescope Array (NuSTAR) and Astro-H missions are in formulation. Astro-H is a Mission of Opportunity selected in 2008; the mission will be led by Japan, with NASA's contribution being a Soft X-ray Spectrometer (SXS). Please refer to the Heliophysics Theme for information on additional Explorer projects. For more information, visit: http://explorers.gsfc.nasa.gov.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer

Plans For FY 2010

The WISE launch, and the start of prime operations are scheduled for FY 2010. Dependent upon cryogen life, the mission may be extended beyond its seven month baseline.

The Nuclear Spectroscopic Telescope Array (NuSTAR) mission will hold its confirmation review in August 2009 in preparation to enter the development phase in FY 2010.

The SXS instrument for Astro-H is scheduled to be in the development phase by FY 2010, as the mission is scheduled to have a preliminary design review and a critical design review in FY 2010.

Suzaku will enter its fifth year of operations and its second year of key project observations. Key projects are defined as comprehensive observing programs sampling a number of objects of a particular class, or surveying a large region of the sky, in order to take maximal advantage of the unique attributes of Suzaku to address important astrophysical problems.

Swift will continue to in its extended operations phase, per results of the most recent Senior Review.

Project Descriptions and Explanation of Changes

Wide-field Infrared Survey Explorer (WISE)

Currently in development and planned for launch in 2009, the Wide-field Infrared Survey Explorer (WISE) will provide an all-sky survey of galaxies in the infrared. During its six-month mission, WISE will map the sky in infrared light, searching for the nearest and coolest stars, the origins of stellar and planetary systems, and the most luminous galaxies in the universe. WISE's infrared survey will provide an essential catalog for the James Webb Space Telescope. As the telescope orbits from the North Pole to the South Pole and then back up to the North Pole, it will sweep out a circle in the sky. As Earth moves around the Sun, this circle will shift, until WISE has observed the entire sky.

Nuclear Spectroscopic Telescope Array (NuSTAR)

The Nuclear Spectroscopic Telescope Array (NuSTAR), currently in formulation, is planned for launch in August 2011. NuSTAR will provide a greater capability for using high-energy X-rays to detect black holes than any currently existing instrument. NuSTAR has been designed to answer fundamental questions about the universe, such as: How are black holes distributed through the cosmos? How were the elements of the universe created? What powers the most extreme active galaxies? This mission will expand the ability to understand the origin of cosmic rays and help predict the destinies of stars and galaxies.

Other Missions and Data Analysis

Included in this line item are five operating spacecraft in their extended operations phase:

-Suzaku is Japan's fifth X-ray astronomy mission, on which NASA provided the five X-ray mirrors, as well as one instrument: the micro-calorimeter spectrometer. Suzaku studies black holes, neutron stars, and quasars, to unravel the physics of high-energy processes and the behavior of matter under extreme conditions.

-Swift studies the position, brightness, and physical properties of gamma-ray bursts. Within seconds of detecting a burst, Swift relays a burst's location to ground stations, allowing both groundbased and space-based telescopes around the world the opportunity to observe the burst's afterglow.

-The Galaxy Evolution Explorer (GALEX) is exploring the origin and evolution of galaxies, the origins of stars and heavy elements, and is conducting an all-sky ultraviolet survey.

-The Wilkinson Microwave Anisotropy Probe (WMAP), studies the early universe by measuring the cosmic microwave background radiation over the full sky. WMAP produced the earliest "baby picture" of the universe, showing temperature variation of microwave light 379,000 years after the big bang, over 13 billion years ago.

-Rossi X-Ray Timing Explorer (RXTE) observes the high-energy worlds of black holes, neutron stars, and X-ray pulsars, gathering important information about processes and structures in white-dwarf stars, X-ray binaries, neutron stars, pulsars, and black holes.

Also included in this line item is the new Mission of Opportunity, Astro-H, which is an X-ray observation satellite under development by JAXA. With a 2013 launch, the mission objectives are to: trace the growth history of the largest structures in the universe, provide insights into the behavior of material in extreme gravitational fields, determine the spin of black holes and the equation of state of neutron stars, trace shock acceleration structures in clusters of galaxies, and investigate the detailed physics of jets. NASA is participating in this mission by providing the High-Resolution Soft X-Ray Spectrometer (SXS) instrument.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer

Implementation Schedule

Project	Schedule by Fiscal Year: Prior, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22	Phase Dates	Beg	End
WISE		Tech		
		Form	Apr-02	Oct-06
		Dev	Oct-06	Nov-09
		Ops	Nov-09	May-10
		Res	May-10	May-13
Swift		Tech		
		Form		
		Dev		
		Ops	Apr-04	Sep-12
		Res		
Suzaku		Tech		
		Form		
		Dev		
		Ops	May-05	Sep-11
		Res		
WMAP		Tech		
		Form		
		Dev		
		Ops	Jun-01	Sep-11
		Res		
GALEX		Tech		
		Form		
		Dev		
		Ops	Apr-03	Sep-12
		Res		
RXTE		Tech		
		Form		
		Dev		
		Ops	Dec-95	Sep-10
		Res		
NuSTAR		Tech		
		Form	Feb-08	Nov-09
		Dev	Nov-09	Aug-11
		Ops	Aug-11	Sep-13
		Res		
Astro-H		Tech		
		Form	Jun-08	Aug-09
		Dev	Aug-09	Aug-13
		Ops	Aug-13	Aug-15
		Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer

Program Management

The Astrophysics Explorer Program is a multiple-project program with program responsibility assigned to Goddard Space Flight Center (GSFC).

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
WISE	GSFC	JPL	None.
GALEX	GSFC	N/A	None.
NuSTAR	GSFC	JPL	None.
Astro-H	GSFC	N/A	None.
Swift	GSFC	N/A	None.
Suzaku	GSFC	N/A	None.
WMAP	GSFC	N/A	None.
RXTE	GSFC	N/A	None.

Acquisition Strategy

Explorer projects are selected through competitive Announcements of Opportunity, from which multiple investigations are selected for initial concept studies, followed by a competitive down-select to proceed to the next stage of formulation. Investigations are selected to proceed from one phase to the next through execution of contract options, based on successful technical, cost, and schedule performance in the previous phases.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer
Project In Development:	Wide-Field Infrared Survey Explorer

FY 2010 Budget Request

Budget Authority ($ millions)	Prior	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	BTC	LCC TOTAL
FY 2010 President's Budget Request	**152.5**	**72.7**	**65.2**	**13.0**	**5.2**	**1.6**	**0.2**	**0.0**	**0.0**	**310.5**
Formulation	96.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	96.6
Development / Implementation	55.9	72.7	65.2	0.0	0.0	0.0	0.0	0.0	0.0	193.8
Operations / Close-out	0.0	0.0	0.0	13.0	5.2	1.6	0.2	0.0	0.0	20.0
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
FY 2009 President's Budget Request	**153.7**	**71.8**	**65.2**	**13.0**	**5.2**	**1.6**	**0.0**	**--**	**0.0**	**310.5**
Formulation	96.6	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	96.6
Development / Implementation	57.1	71.8	65.2	0.0	0.0	0.0	0.0	--	0.0	194.1
Operations / Close-out	0.0	0.0	0.0	13.0	5.2	1.6	0.0	--	0.0	19.8
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0
Changes from FY 2009 Request	**-1.2**	**0.9**	**0.0**	**0.0**	**0.0**	**0.0**	**0.2**	**--**	**0.0**	**0.0**
Formulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	--
Development / Implementation	-1.2	0.9	0.0	0.0	0.0	0.0	0.0	--	0.0	-0.3
Operations / Close-out	0.0	0.0	0.0	0.0	0.0	0.0	0.2	--	0.0	0.2
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.1

Note: The FY 2010 LCC number in the table above is understated by $4M due to the difference in the FY09 enacted bill and the April 2009 initial operating plan. Assuming approval of NASA's Initial Operating Plan for FY 2009, the estimated lifecycle cost of WISE will be $314.5M, and the estimated Development cost will be $197.8M.

Explanation of Project Changes

Although only minor changes are seen in the table above, NASA's Initial Operating Plan for FY 2009 requests an increase of $4.0M for additional testing of the spacecraft, reducing risk for the November 2009 launch.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer
Project In Development:	Wide-Field Infrared Survey Explorer

Project Purpose

The Wide-Field Infrared Survey Explorer (WISE) mission has six objectives: finding the most luminous galaxies in the universe; finding the closest stars to the Sun; detecting most main-belt asteroids larger than three kilometers; extending the 2MASS Project survey into the thermal infrared; enabling a wide variety of studies ranging from the evolution of protoplanetary debris disks to the history of star formation in normal galaxies; and providing a catalog for the James Webb Space Telescope.

For more information see: http://wise.ssl.berkeley.edu/

Project Parameters

The single WISE instrument is a four-channel imager that will take overlapping snapshots of the sky. WISE includes: a two-stage, solid-hydrogen cryostat to cool detectors and optics; a 40-centimeter telescope and reimaging optics; and a scan mirror to stabilize the line-of-sight while the spacecraft scans the sky.

Project Commitments

WISE will launch in November 2009 on a six-month mission (with a one-month checkout) to provide an all-sky survey in the wavelengths from 3.5 to 23 microns--up to 1000 times more sensitive than the Infrared Astronomical Satellite (IRAS) survey.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
Spacecraft	Ball Aerospace & Technologies Corporation (BATC)	40-centimeter telescope	Same	Same
Launch Vehicle	United Launch Alliance (ULA)	Delta 2	Same	Same
Science Payload	Space Dynamics Laboratory (SDL)	Instrument integration and launch support	Same	Same
Mission Operations and Data Management	UCLA	Management of the data and mission operations	Same	Same

Schedule Commitments

WISE entered development in October 2006 after an extended formulation phase. WISE is scheduled to launch in November 2009.

Milestone Name	Confirmation Baseline	FY 2009 PB Request	FY 2010 PB Request
Development			
Begin Development	October 2006	October 2006	Same
Assembly, Test & Launch Operations	April 2009	April 2009	Same
Launch Readiness	November 2009	November 2009	Same

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer
Project In Development:	Wide-Field Infrared Survey Explorer

Development Cost and Schedule Summary

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Wide-Field Infrared Survey Explorer	2007	192.1	2009	197.8	3	Launch Readiness	11/30/2009	11/30/2009	0

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**192.1**	**197.8**	**5.7**
I & T Systems	5.3	4.7	-0.6
Technology Development	3.4	3.0	-0.4
Aircraft/Spacecraft	37.8	37.4	-0.4
Ground Systems	13.6	11.9	-1.7
Launch Vehicle	87.5	76.9	-10.6
Other	16.5	36.1	19.6
Payload	23.0	23.4	0.4
Science/Technology	5.0	4.4	-0.6

Project Management

The Jet Propulsion Laboratory is responsible for project management.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Spacecraft	JPL	None	None
Mission operations and data analysis	JPL	JPL	None
Payload	JPL	None	None

Acquisition Strategy

The Wide-field Infrared Survey Explorer was selected competitively as part of the Explorer Announcement of Opportunity in 2002. All elements of the project were included in the competitive proposal. The cryogenic instrument is being built by Space Dynamics Laboratory (Logan, UT); Ball Aerospace and Technologies Corporation (Boulder, CO) is building the spacecraft; University of California, Los Angeles (Los Angeles, CA) is managing the mission operations and data center; and United Launch Alliance (Denver, CO) is providing the launch vehicle.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer
Project In Development:	Wide-Field Infrared Survey Explorer

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Standing Review Board (SRB)	11/2008	The System Integration Review (SIR) evaluated the readiness of the project to start flight system assembly, test, and launch operations. The WISE project passed the SIR.	N/A
Quality	Standing Review Board (SRB)	N/A	The Operations Readiness Review examines the actual system characteristics and the procedures used in the system's operation and ensure that all system and support (flight or ground) hardware, software, personnel, and procedures are ready for operations and that user documentation accurately reflects the deployed state of the system.	9/2009
Quality	Standing Review Board (SRB)	N/A	The Flight Readiness Review examines tests, demonstrations, analyses, and audits that determine the system's readiness for a safe and successful flight/launch and the subsequent flight operations.	10/2009

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Cover deployment reliability	Premature deployment of the WISE cover could result in venting of the cryogen and loss of the mission. Failure to deploy would block light from entering the telescope and would also result in loss of the mission.	Cover deployment actuation circuitry has been reviewed with great care and includes components with extensive flight heritage. End-to-end testing and monitoring will be conducted during spacecraft level ground testing.
Hydrogen cryostat safety	The cryogen for the WISE cryostat is solid hydrogen. Operational errors could result in an explosion.	The WISE hardware and work procedures are designed with safety foremost in mind. Risk has been mitigated through careful design, review, training, and practice.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer
Project In Formulation:	Nuclear Spectroscopic Telescope Array

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	16.7	38.7	59.9	33.7	6.8	6.4	0.0
FY 2009 President's Budget Request	0.0	41.5	57.8	31.0	6.8	6.4	--
Total Change from 2009 President's Budget Request	16.7	-2.8	2.1	2.7	0.0	0.0	--

Project Purpose

The Nuclear Spectroscopic Telescope Array (NuSTAR) is an Explorer mission currently planned for an August 2011 launch. NuSTAR, unlike Chandra and XMM-Newton, will observe the universe at high X-ray energy levels. By focusing higher energy X-rays, NuSTAR will start to answer several fundamental questions about the universe including: How are black holes distributed through the cosmos? How were heavy elements forged in the explosions of massive stars? What powers the most extreme active galaxies?

NuSTAR's primary science goal is to make the first deep observations of regions of the sky in the high energy X-ray band (6-79 keV) in order to locate massive black holes in other galaxies, locate and examine the remnants of collapsed stars in our galaxy, observe selected very high energy gamma-ray sources, and observe any supernovae of opportunity in the local group of galaxies. NuSTAR's key science products will be sensitive high-energy X-ray survey maps of the celestial sky that will guide the X-ray astronomy community research for several years to come.

For more information see: http://www.nustar.caltech.edu/

Project Preliminary Parameters

NuSTAR will image the sky in the high energy X-ray band (6-79 KeV) and the spacecraft will be 3-axis stabilized. The primary science instruments will be two identical focusing X-ray telescopes which utilize an extendable 10-meter mast. The launch vehicle will be a Pegasus XL.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer
Project In Formulation:	Nuclear Spectroscopic Telescope Array

Estimated Project Deliverables

NuSTAR will be launched in August 2011 into a 550km circular orbit around the Earth, with an orbital inclination currently planned in the 5-27 degree range. Prime operations phase is two years. No extended mission is currently budgeted.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
Spacecraft	Orbital Sciences Corporation	Spacecraft design, fabrication and testing.		Same
Mission operations ,focal plane assembly and instrument electronics	University of California, Berkeley	Aperture stop, active shield module and mechanical enclosures		Same
X-ray optics development	Columbia University, GSFC and the Danish Technical University	Overall optics assembly management and manufacturing		Same
Mast, canister and instrument structure	ATK	Delivery of mast, canister and instrument structure for the spacecraft		Same

Estimated Project Schedule

NuSTAR was authorized for mission re-start in September 2007 and was authorized to proceed into Phase B in January 2008. Confirmation to proceed into Phase C (implementation) is planned for August 2009.

Milestone Name	Formulation Agreement Estimate	FY 2009 PB Request	FY 2010 PB Request
Formulation			
Preliminary Design Review			January 2008
Confirmation Review			August 2009
Launch			August 2011

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer
Project In Formulation:	Nuclear Spectroscopic Telescope Array

Project Management

The Jet Propulsion Laboratory is responsible for NuSTAR Project Management.

The Principal Investigator at the California Institute of Technology is responsible for mission science.

Acquisition Strategy

NuSTAR was selected via a NASA Explorers Announcement of Opportunity.

The spacecraft is being developed by Orbital Sciences Corporation (OSC) in Dulles, Virginia.

X-ray optics are being developed by Columbia University (NY), GSFC (MD), and the Danish Technical University.

Alliant Techsystems (ATK, Goleta, CA) is responsible for mission mast and structure. The California Institute of Technology and UC Berkeley are completing the focal plane assembly and electronics.

JPL is responsible for overall instrument integration, and OSC is completing overall observatory integration. Caltech is responsible for science and UC Berkeley is responsible for mission operations.

Launch vehicle acquisition is through KSC.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	07/2008	SRR Authority to enter Phase B	N/A
Performance	SRB	N/A	Preliminary Design Review (PDR); authority to enter Phase C	06/2009

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Mission Directorate:	Science
Theme:	Heliophysics

Theme Overview

The Earth resides in the extended atmosphere of an active star. While sunlight enables and sustains life, the Sun's variability produces streams of high energy particles and radiation that can harm life and important technology (such as satellites and power grids). Under the protective shield of its magnetic field and atmosphere, Earth is an island in the universe where life has developed and flourished.

The goal of the Heliophysics Division is to understand the Sun, heliosphere, and planetary environments as a single connected system. In addition to solar processes, this domain of study includes the interaction of solar plasma and radiation with Earth, other planets, and our galaxy. By analyzing the connections between the Sun, solar wind, the planetary space environments, and the galaxy, scientists are uncovering fundamental physical processes that occur throughout the universe. Understanding these processes will allow scientists to predict the impacts of solar variability on humans, technological systems, and even the presence of life itself.

Scientists have already discovered ways to peer into the internal workings of the Sun and understand how Earth's magnetosphere responds to solar activity. The challenge now is to explore the full system of complex interactions that characterize the relationship of the Sun with the solar system.

NASA's Heliophysics Division strives to answer the following big questions:

- How does solar variability affect human society, technological systems and the habitability of planets?
- What are the hazards and resources in the solar system environment that will affect the extension of human presence in space?
- How and why does the Sun vary and what are the consequences?
- What are the fundamental physical processes of the space environment?

A combination of interrelated elements is necessary to make progress in answering these questions. They include a complement of missions of varying sizes to collect new science data, timely development of technologies that enable new science, and acquisition of knowledge through research, analysis, theory, and modeling.

Mission Directorate:	Science
Theme:	Heliophysics

FY 2010 Budget Request

Budget Authority ($ millions)	**FY 2008 Actual**	**FY 2009 Enacted**	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
FY 2010 President's Budget Request	**787.6**	**591.6**	**605.0**	**672.6**	**720.5**	**742.7**	**762.6**
Heliophysics Research	183.3	195.9	178.6	178.1	183.1	190.6	194.3
Living with a Star	218.1	238.6	212.2	204.6	208.7	230.0	236.6
Solar Terrestrial Probes	71.9	123.1	143.0	169.1	170.6	160.8	164.3
Heliophysics Explorer Program	48.1	31.4	69.4	119.7	158.1	161.3	167.4
New Millennium	15.0	2.7	1.8	1.1	0.0	0.0	0.0
Near Earth Networks	40.9	0.0	0.0	0.0	0.0	0.0	0.0
Deep Space Mission Systems (DSMS)	210.3	0.0	0.0	0.0	0.0	0.0	0.0
FY 2009 President's Budget Request	**840.9**	**577.3**	**598.9**	**689.4**	**741.2**	**746.6**	**--**
Heliophysics Research	181.2	184.8	180.3	175.3	179.8	187.5	--
Living with a Star	217.1	223.8	212.0	216.6	232.8	237.5	--
Solar Terrestrial Probes	105.9	123.1	137.5	171.4	172.6	161.5	--
Heliophysics Explorer Program	61.0	41.3	66.8	125.1	156.0	160.1	--
New Millennium	25.8	4.3	2.2	1.1	0.0	0.0	--
Near Earth Networks	39.5	0.0	0.0	0.0	0.0	0.0	--
Deep Space Mission Systems (DSMS)	210.5	0.0	0.0	0.0	0.0	0.0	--
Total Change from FY 2009 Request	**-53.3**	**14.3**	**6.2**	**-16.8**	**-20.7**	**-3.9**	**--**

Note: Starting in FY 10, the Astro-H project is in the Astrophysics theme.

Plans for FY 2010

Heliophysics Research

The Research program will continue to operate 16 missions and 27 spacecraft and conduct another senior review of these missions. Heliophysics data centers will continue to archive and distribute collected science data.

Living with a Star

The Solar Dynamics Observatory will launch in early FY10. NASA will award instrument contracts for the Solar Probe mission. The Radiation Belt Storm Probes (RBSP) mission will complete mission Critical Design Review.

Solar Terrestrial Probes

The Magnetospheric Multiscale Mission(MMS) will continue development work, progressing towards mission Critical Design Review. STEREO and Hinode will continue mission operations.

Heliophysics Explorer Program

Small Explorers (SMEX) selections (to be selected in 2009) will begin their formulation activities. The IBEX, CINDI, TWINS, AIM, and THEMIS missions will continue mission operations.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

The Heliophysics Program is guided by U.S. National Space Policy and follows NASA's tradition of establishing its priorities through consultation with world-class experts. Heliophysics relies on two advisory bodies for scientific assessments and decadal surveys: the National Research Council's Space Studies Board and the NASA Advisory Council.

Heliophysics missions such as the Advanced Composition Explorer provide critical data to the Department of Defense, the Federal Aviation Administration, and the National Oceanographic and Atmospheric Administration to guard against space weather impacts. The Living With a Star (LWS) program targets research and technologies that are relevant to the operational needs of these agencies. The nation's safety, security, and economy have become increasingly dependent on technologies that are susceptible to the extremes of space weather -- severe disturbances of the upper atmosphere and of the near-Earth space environment that are driven by the magnetic activity of the Sun. Space weather events can damage satellites and power grids, and disrupt air traffic communications. Inter-agency activities are coordinated through the National Space Weather Program Council (NSWPC) within the Office of the Federal Coordinator for Meteorology. Organizations around the world also access Heliophysics data via the International Space Environment Service.

Heliophysics is also working to improve our understanding of magnetic reconnection, a process that occurs throughout the universe when stressed magnetic field lines suddenly transition to a new shape. This understanding is expected to greatly benefit the Department of Energy's efforts in the area of fusion energy, as magnetic reconnection phenomena play a critical role in virtually every configuration that is being explored to confine high-temperature plasmas.

Internationally, NASA's Heliophysics Program plays a leadership role with both the International Heliophysical Year and International Living With a Star activities, leveraging space assets and resources to achieve greater scientific advancement now and in the future.

Relevance to the NASA Mission and Strategic Goals:

Heliophysics supports NASA's Strategic Plan Sub-Goal 3B: Understand the Sun and its effect on Earth and the solar system. This effort is comprised of three focus areas, or Outcomes:
3B.1: Progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium.
3B.2: Progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability and planetary magnetic fields.
3B.3: Progress in developing the capability to predict the extreme and dynamic conditions in space in order to maximize the safety and productivity of human and robotic explorers.

Heliophysics researchers study the Sun and its influence on the solar system. Using data from a group of spacecraft that form an extended network of sensors, NASA seeks to understand the fundamental physics behind Sun-planet interactions and study space environmental hazards. Improved understanding and observations of solar events and the interaction between Earth and the Sun will provide the information needed to develop early warning systems and technologies to protect astronauts, spacecraft, and the systems that support them from hazardous space radiation. This progress strengthens our nation's space leadership and creates a robust science and technology base supporting all of NASA's space activities.

See FY 2010 Performance Plan for specific annual goals.

Relevance to education and public benefits:

Society is increasingly dependent on modern technology, including power grids, global positioning, weather forecasting and satellite communications. The valuable assets that support these technologies are vulnerable to solar activity and space weather events, so the need to predict solar events and mitigate their effect is critical to the public's safety, security, and the Nation's economy. A newly released report by the National Academy of Sciences titled "Severe Space Weather Events -- Understanding Societal and Economic Impacts" for the first time attempts to quantify the effects of extreme space weather on the nation (www.nap.edu/catalog/12507.html). The report concludes that improving forecasting capabilities and raising public awareness are instrumental in mitigating severe consequences. The Heliophysics Program supports the rapid transition of research results, models and data into operational products that benefit the public and other segments of the United States Government.

Heliophysics education programs include the award-winning Family Science Night, which introduces local communities to a wide range of Heliophysics-related topics. The Program partners with Astrophysics and Earth Science for a multi-disciplinary approach to such topics as light and spectrum, the seasons, and solar power. The IBEX mission has partnered with Adler Planetarium in Chicago to develop a planetarium show that communicates the scientific goals and results of the IBEX mission. The STEREO mission regularly provides selected images and movies to over 250 science centers through the ViewSpace outreach program and the Astronomical Bulletins of the American Museum of National History in New York.

Mission Directorate:	Science
Theme:	Heliophysics

Performance Achievement Highlights:

The Explorer program achieved three successful launches in 2008. The Two Wide-angle Imaging Neutral-atom Spectrometers (TWINS-B) mission was launched and is now providing (along with TWINS-A) the first ever 3-D images of the magnetosphere. The Coupled Ion-Neutral Dynamics Investigation (CINDI) instrument on the Communication/Navigation Outage Forecast System (C/NOFS) Air Force spacecraft is observing the ionosphere at the lowest recorded solar minimum. Interstellar Boundary Explorer (IBEX) was successfully launched in October 2008 to provide the first ever images of the heliosphere (a bubble in space produced by the solar wind). In addition, six Small Explorers (SMEX) proposals and the GOLD Mission of Opportunity were selected to complete concept study reports.

Time History of Events and Macroscale Interactions during Substorms (THEMIS) successfully completed the first tail season of its observing plan with five operational spacecraft resulting in significant progress in understanding how Earth's magnetic field stores energy from the solar wind until it is released, producing substorms.

After 18 years of operations, ULYSSES was decommissioned. In its final year, it detected the lowest solar wind velocities and densities (40% lower than during any solar cycle) ever recorded during solar minimum. At the same time Solar and Heliospheric Observatory (SOHO) measurements indicate that the Sun's polar fields are smaller by a factor of two. The change in strength suggests that the upcoming solar cycle may be significantly different than previous well-observed cycles.

The twin Solar Terrestrial Relations Observatory (STEREO) imagers have exceeded expectations with their ability to image the slow solar wind, co-rotating interaction regions, and coronal mass ejections. During 2007, STEREO observed a series of solar wind wave fronts sweeping past Earth.

SDO completed observatory-level testing and check-out and is ready for launch when an Atlas launch vehicle slot opens. MMS was approved to proceed into Phase B. Radiation Belt Storm Probes (RBSP) was recently confirmed to begin implementation and has started Phase C. The Balloon Array for Radiation-belt Relativistic Electron Losses (BARREL) mission started Phase B and completed System Requirements Review. Space Environment Testbeds (SET) was successfully completed and shipped to the US Air Force for integration & testing on the Deployable Structures Experiment (DSX) spacecraft. Solar Probe Plus, a mission to study the origins of hazardous solar storms, started Pre-Phase A studies. NASA approved Solar Orbiter to enter Phase A and is developing a collaborative agreement for a joint mission with the European Space Agency (ESA).

In the New Millenium Program (NMP), the Space Technology 7 project completed development and a successful pre-ship Review. Sounding Rockets completed 12 suborbital launches, supporting seven science investigations, two technology demonstrations and one educational project.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	National Research Council	12/2003	The Decadal Research Strategy assessed the current status and future directions of NASA's programs in solar and space physics research. The report identifies broad scientific challenges that define the focus and thrust of solar and space physics research for the decade 2003 through 2013 and presents a prioritized set of missions, facilities, and programs designed to address those challenges.	12/2012
Relevance	NAC/Helio-physics Subcommittee	09/2006	Review of Heliophysics Strategic Plan including science and program implementation strategies and relevance to the NASA Strategies and goals. Review concluded that the Heliophysics program as defined in the recent roadmap can be carried out with the current funding profile. However, concerns exist with regard to R&A and Explorer program funding.	09/2009
Quality	Senior Review Panel	04/2008	All Heliophysics Operating Missions were reviewed for their continued relevance to the strategic goals of the Heliophysics division. All missions except FAST received satisfactory or excellent ratings.	04/2010
Performance	NAC/Helio-physics Subcommittee	07/2008	Reviews of selected annual performance goals as documented in Performance and Accountability Report (PAR). Review found that Heliophysics has achieved its annual goals, and made significant progress toward understanding our local space environment and the fundamental science that is beginning to enable a reliable space weather predictive capability.	07/2009

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Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Research

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**183.3**	**195.9**	**178.6**	**178.1**	**183.1**	**190.6**	**194.3**
Heliophysics Research and Analysis	33.0	31.0	35.4	38.4	39.1	40.1	41.1
Sounding Rocket Operations	51.0	77.4	66.5	67.5	68.9	71.4	73.1
Other Missions and Data Analysis	99.4	87.5	76.7	72.3	75.1	79.1	80.1
FY 2009 President's Budget Request	**181.2**	**184.8**	**180.3**	**175.3**	**179.8**	**187.5**	**--**
Heliophysics Research and Analysis	30.9	33.9	35.9	38.9	39.6	40.5	--
Sounding Rockets Operations	42.9	63.4	66.5	67.5	68.9	71.4	--
Other Missions and Data Analysis	107.3	87.5	77.9	69.0	71.4	75.5	--
Changes from FY 2009 Request	**2.1**	**11.1**	**-1.7**	**2.8**	**3.3**	**3.1**	**--**

Note: Reallocation of extended mission budget to other programs for extended mission operations.

Program Overview

The science of Heliophysics is a unique blend of Astrophysics and Meteorology, involving the study of the interactions between gravitational and magnetic forces. The Heliophysics Research Program supports investigations of the Sun and planetary space environments by operating 16 missions (involving 27 spacecraft) and processing, archiving and distributing the data they collect. This fleet of spacecraft undertaking Heliophysics investigations, spanning all the space above the Earth's lower atmosphere, and from the core of the Sun to the outermost reaches of the solar wind, is informally termed the "Heliophysics Great Observatory" since the aggregation of data from all the spacecraft results in research synergies that would not be possible otherwise.

Heliophysics Research & Analysis routinely solicits proposals in several broad areas in order to advance our knowledge in support of NASA strategic goals. In addition, NASA occassionally offers special solicitations to take advantage of research opportunities that arise from the current solar environment. The Research Program also funds scientific investigations based on suborbital platforms, such as balloons or sounding rockets, and maintains some of the vital communications infrastructure to do so at Wallops Flight Facility. The Research and Analysis and Guest Investigator Projects fund more in-depth scientific investigations using all of this collected data via a competitive process that is held each year.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Research

Plans For FY 2010

The Research and Analysis Program will hold its annual competition for new research awards; approximately $15 million will be available for the competition resulting in approximately 90 new awards. Guest Investigator Program will also hold its annual competition for new awards with approximately $13 million available for new awards.

All missions operating beyond their prime phase will be evaluated by a NASA-sponsored Senior Review in April 2010 to determine their status and optimize the allocation of funding for FY 2011 and beyond in order to achieve NASA's strategic science goals. The Sounding Rockets Program will launch approximately 22 missions, from domestic and international locations. The Research Range will provide launch instrumentation for NASA suborbital programs and projects at both local and remote locations. Science Data and Computing Technology will continue to sustain the National Space Science Data Center and hold its annual competition for the Applied Information Systems Research where approximately $2 million will be available for new research awards.

Project Descriptions and Explanation of Changes

Heliophysics Research and Analysis

Research and Analysis comprises an ever-evolving suite of individual Principal Investigator-proposed investigations that cover the complete range of science disciplines and techniques essential to achieve the Heliophysics Theme objectives and to take full advantage of the scientific data collected by NASA missions. Research and Analysis covers four elements: Geospace Science, Low-Cost Access to Space, Solar and Heliospheric Physics, and Heliophysics Theory.

Geospace Science studies the physics of magnetospheres, including their formation and fundamental interactions with plasmas, fields, and particles (Earth's magnetosphere is emphasized, but studies of the magnetospheres of planets, comets, and other primordial bodies are also supported). Geospace Science deals with the physics of the mesosphere, thermosphere, ionosphere, and aurorae of Earth, including the coupling of these phenomena to the lower atmosphere and magnetosphere.

Low-Cost Access to Space funds science investigations that may be completed through suborbital rocket or balloon flight of experimental instrumentation, as well as proof-tests of new concepts in experimental techniques that may ultimately find application in free-flying Heliophysics space missions.

Solar and Heliospheric Physics treats the Sun as a typical star, as the dominant, time-varying source of energy, plasma, and energetic particles in the solar system (especially concerning its influence on Earth). This project investigates the origin and propagation of the solar wind and magnetic field from the Sun to the Heliopause (the boundary between the solar wind and the interstellar medium), the acceleration and transport of energetic particles in the heliosphere and the interface of solar influence with the interstellar medium.

The Heliophysics Theory Program supports efforts to attack problems using relatively large "critical mass" groups of investigators that are beyond the scope of smaller research and technology efforts.

Sounding Rocket Operations

Sounding Rockets: This project funds all suborbital mission activities (payload integration, launch, and mission operation) that support science investigations funded in other parts of the research program. (Including Heliophysics and Astrophysics Research and Analysis programs and even exploration technology test and demonstration programs.)   Sounding Rockets present unique low-cost platforms that provide direct access to Earth's mesosphere (50-90 kilometers), lower thermosphere (90-120 kilometers), and the Earth's magnetosphere (up to 1,500 kilometers). Because of their short duration and access to Earth's upper atmosphere and the space environment, sounding rocket suborbital missions also enable calibration under-flights of orbital missions, repeated proof-of-concept technology demonstration missions, and valuable end-to-end space mission experience for scientists and engineers learning to develop and execute discovery-oriented orbital missions.

Research Range: The Research Range effort funds NASA's only test range, located at Wallops Flight Facility, for launch of suborbital and orbital vehicles, supporting launch operations, tracking, telemetry and command (TT&C) capabilities. The Wallops Research Range also supports a mobile TT&C capability to support launches safely from a number of launch sites worldwide, many of which have limited capabilities of their own. The NASA Research Range is one of the few ranges in the Nation to offer a mobile capability. The Range maintains it own airspace and supports a wide variety of small launch vehicles, suborbital missions, and airborne missions utilizing non-FAA-certified vehicles such as unmanned aircraft systems.

Other Missions and Data Analysis

Following the commissioning and checkout phase of any spacecraft, Headquarters management responsibility for operations and data analysis transitions to the Heliophysics Research Program. (However, a number of operating spacecraft still receive funding from their respective development programs.) The Research Program is responsible for collecting, archiving, and distributing the data collected by all operating spacecraft. Current operating spacecraft include: Cluster II, AIM, ACE, THEMIS, Voyager, Wind, Geotail, TWINS, RHESSI, CINDI, STEREO, SOHO, TIMED, Hinode, and SDO (to launch in 2009). It is this collective asset that provides the data, expertise, and research results that contribute directly to the national goal of real-time space weather prediction and to fundamental research on solar and space plasma physics. In 2008, these missions underwent their biannual Senior Review from which new budgets have been recommended, consistent with their evolving scientific goals. Major decisions based on the Senior Review findings included the termination of the FAST mission, approval to proceed with the Artemis mission (a splitting of two of the high-orbit satellites in the THEMIS constellation to lunar orbits), as well as continuing with the THEMIS-Low mission.

The Space Physics Data Facility (SPDF) leads in the design and implementation of unique multi-mission and multi-disciplinary data services, innovative ground data system concepts, educational programs, and cross-cutting data, modeling and visualization research. NASA's Solar Data Analysis Center provides a variety of routes to current and past solar images and digital data. Links on the home page (http://umbra.nascom.nasa.gov) will bring you up-to-date on the current state of the Sun and its surrounding atmosphere.

The Heliophysics Guest Investigator Program (GIP) is a critical component of the Heliophysics Operating Missions. The GIP program selects the best ideas from a broad community of researchers in universities and institutions across the country, enabling optimum science return through utilization of data from the operating missions. This year all Heliophysics Education efforts will be consolidated under this project and competed via the Research Opportunities in Space and Earth Science (ROSES) announcement in order to better coordinate program and mission activities. NASA will select education and outreach proposals that best explain and inspire students and the public on the science of Heliophysics and the societal impacts of space weather.

Science Data and Computing: Science Data and Computing includes two elements, the National Space Science Data Center (NSSDC) and administration of the Applied Information Systems Research (AISR) investigations selected under the ROSES NASA Research Announcements (NRA). Both are SMD-wide support activities. The NSSDC is responsible for assuring the permanent archiving and preservation of space science data from past missions. The AISR Program exploits advances in information science and technology to enhance the science productivity from SMD-sponsored missions.

Science Planning & Research Support: This project funds scientists to be on peer review panels and other community science support efforts (e.g., strategic road mapping, support to NRC boards, interagency working groups, SMD advisory groups and other reviews as requested by SMD).

GSFC Building Support: The Exploration Sciences building, currently under construction at the Goddard Space Flight Center, is a 262,500 square-foot laboratory and office building. The facility will provide state-of-the-art laboratory, support, and office space for 750 scientists. By consolidating science work groups, it is expected to increase work efficiency and scientific collaboration. The new facility will replace the 44-year old Research Projects Laboratory building and the 37-year old Space Science Data Center building.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Annual peer-reviewed research solicitation for grant opportunities	Research & Analysis	None

Implementation Schedule

Schedule by Fiscal Year: Prior, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22

Project	Phase	Beg	End
Voyager	Tech		
	Form		
	Dev		
	Ops	Aug-77	Aug-13
	Res		Aug-14
Geotail	Tech		
	Form		
	Dev		
	Ops	Jul-92	Jul-08
	Res		Jul-10
Wind	Tech		
	Form		
	Dev		
	Ops	Nov-94	Nov-13
	Res		Nov-14
Solar and Heliospheric Observatory (SOHO)	Tech		
	Form		
	Dev		
	Ops	Dec-95	Dec-13
	Res		Dec-14
Advanced Composition Explorer (ACE)	Tech		
	Form		
	Dev		
	Ops	Aug-97	Aug-13
	Res		Aug-14
Cluster-II	Tech		
	Form		
	Dev		
	Ops	Jul-00	Jul-10
	Res		Jul-11
Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics (TIMED)	Tech		
	Form		
	Dev		
	Ops	Dec-01	Dec-13
	Res		Dec-14
RHESSI	Tech		
	Form		
	Dev		
	Ops	Feb-02	Feb-13
	Res		Feb-14

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Research

Program Management

NASA Headquarters has program management resonsiblity for the Heliophysics Research Program.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Research and Analysis	SMD	All NASA Centers	None
Heliophysics Operating Missions	SMD	GSFC and JPL	ESA and JAXA
Sounding Rockets and Research Range	SMD	GSFC	None
Science Data and Computing	SMD	GSFC and other NASA Centers	None

Acquisition Strategy

All acquisitions in the Heliophysics Research and Analysis (R&A) component are based on full and open competition. Proposals are peer reviewed and selected based on the NASA research announcement, Research Opportunities in Space and Earth Sciences (ROSES). Universities, government research labs, and industry throughout the U.S. participate in R&A research projects. The Heliophysics Operating Missions and instrument teams were previously selected from NASA Announcements of Opportunity. NASA evaluates the allocation of funding among the operating missions bi-annually through the Heliophysics Senior Review.

Both the prime contracts for the Sounding Rocket Operations and for Research Range Operations are currently being re-competed. The new contracts are expected to be in place by late 2009.

The Science Data and Computing component holds a competition where proposals are peer reviewed and selected based on ROSES research announcement. Universities, government research labs, and industry throughout the United States participate in Science Data and Computing Technology research projects.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Senior Review Panel	N/A	The Heliophysics data centers along with the NSSDC will undergo a Senior Review panel in July 2009 to assess their operational effectiveness.	07/2009

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Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	218.1	238.6	212.2	204.6	208.7	230.0	236.6
Solar Dynamics Observatory (SDO)	108.1	20.8	34.1	20.2	18.6	16.3	15.6
Radiation Belt Storm Probes (RBSP)	67.8	154.4	137.1	127.9	105.1	22.0	17.3
Solar Probe Plus	13.9	18.0	4.0	16.6	36.7	57.8	81.3
Other Missions and Data Analysis	28.4	45.3	37.0	39.8	48.3	134.0	122.4
FY 2009 President's Budget Request	217.1	223.8	212.0	216.6	232.8	237.5	--
Solar Dynamics Observatory (SDO)	90.0	24.1	14.2	14.0	14.9	14.1	--
Radiation Belt Storm Probes (RBSP)	77.7	154.4	154.7	113.4	57.9	15.8	--
Solar Probe Plus	13.9	0.0	3.4	40.1	74.2	106.3	--
Other Missions and Data Analysis	35.5	45.3	39.7	49.2	85.8	101.3	--
Changes from FY 2009 Request	1.0	14.7	0.2	-11.9	-24.1	-7.5	--

Note: SDO budget increased to accommodate launch delay. RBSP budget rephased consistent with budget approved at Confirmation Review. Solar Probe Plus budget is consistent with a 2018 launch date.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star

Program Overview

The Living with a Star (LWS) Program seeks to improve our understanding of how and why the Sun varies, how the Earth and solar system respond, and most importantly, how this variability and response affect life on Earth. This improved understanding of solar variability (i.e., space weather) and its effects will lead to a reliable predictive capability for space weather. This capability is essential to safe and successful future space exploration and increased use of complex technological systems to improve the safety and quality of life on the ground. LWS accomplishes its goals with a combination of new science missions and yearly science research grant opportunities. Its first mission, the Solar Dynamics Observatory (SDO), will complement and improve upon major capabilities of the Solar and Helispheric Observatory (SOHO), launched in 1995.

Prof. James van Allen made the first major discovery of the space age with Explorer 1 in 1958: the existence of Earth's two radiation belts, which are now named after him. The second LWS mission, the Radiation Belt Storm Probes (RBSP), will analyze these phenomena in unprecedented detail. Two identical spacecraft in elliptical orbits will make simultaneous measurements of processes that accelerate and transport radiation particles as they transit through Earth's radiation belts. The RBSP results will enable the development of models for Earth's radiation belts and for other related but under-sampled planetary environments, such as Mars. Spacecraft and aeronautics engineers will apply the models to improve spacecraft design and to alert operators or pilots of predicted storms and ionizing radiation that could impact crew health or vehicle operations.

Two additional missions are currently developing mission concepts: the Solar Probe Plus (SPP) mission and Solar Orbiter Collaboration (SOC) with the European Space Agency. Solar Probe Plus will explore the Sun from very close range (inside 10 solar radii) to improve our understanding of the generation and flow of the solar wind that links the Sun to the Earth and the solar system. The SOC will investigate the links between the solar surface, corona, and inner heliosphere from as close as 45 solar radii and image the side of the Sun not visible from Earth.

For more information, please see http://lws.gsfc.nasa.gov/.

Plans For FY 2010

The Solar Dynamics Observatory will launch in November 2009. NASA plans to award instrument contracts for the Solar Probe Plus mission. Detailed design activities for the Solar Orbiter Collaboration with the European Space Agency will begin following the selection of the science instruments. The RBSP mission will continue fabrication and test activities and conduct the System Integration Review. The Space Environment Testbeds and BARREL projects will continue testing for their upcoming launches in 2013 and 2012 respectively.

Project Descriptions and Explanation of Changes

Solar Dynamics Observatory (SDO)

The Solar Dynamics Observatory (SDO) is currently in development. It will investigate how the Sun's magnetic field is structured, as well as how its energy is converted and released into the heliosphere in the forms of solar wind, energetic particles, and variations in solar irradiance. The SDO mission will launch in October or November of 2009, a delay of 10 months from the previously planned launch date, due to problems securing a spot on the Atlas V launch vehicle manifest. Additional detail can be found in the SDO section of this document.

Radiation Belt Storm Probes (RBSP)

The RBSP mission will improve the understanding of how solar storms interact with and change particles, fields, and radiation in Earth's Van Allen radiation belts and atmosphere. This knowledge could be applied to any planet in our solar system that has a magnetic core. This mission was recently confirmed to proceed into the development phase and is scheduled to launch in May 2012. Additional detail can be found in the RBSP section of this document.

Solar Probe Plus

The Solar Probe Plus mission is currently in formulation. It will perform the first in-situ measurements very close to the Sun (as close as 10 solar radii) to improve our understanding of the generation and flow of the solar wind that links the Sun to the Earth and the solar system. NASA is examining several Solar Probe Plus mission architectures and technologies for the mission. Instruments will be selected in 2010 in support of a 2018 launch. Additional detail can be found in the Solar Probe Plus section of this document.

Other Missions and Data Analysis

Space Environment Testbeds (SET): The Space Environment Testbeds (SET) will improve the engineering approach to accommodate and/or mitigate the effects of solar variability on spacecraft design and operations. It has two components: a data mining element that has been completed and a space flight mission. The flight mission is a testbed that has been delivered to the U.S. Air Force for integration onto its Demonstration and Science Experiments (DSX) payload. The DSX launch is scheduled for 2013.

Balloon Array for Radiation-belt Relativistic Electron Losses (BARREL): BARREL is a balloon-based mission that will launch a series of science instruments to complement the measurements made on the Radiation Belt Storm Probes (RBSP) mission. BARREL will measure the precipitation of relativistic electrons from the radiation belts. Implementation responsibility has been assigned to the Wallops Balloon Program Office.

Solar Orbiter Collaboration (SOC): The Solar Orbiter Collaboration (SOC) is a cost sharing mission with the European Space Agency (ESA) wherein ESA provides the spacecraft, the ESA member states provide most instrument/science investigations, and the LWS Program provides the launch vehicle and three instrument/science investigations. These instruments were selected in March 2009 and will continue formulation work in 2010. The SOC will provide close-up views of the Sun's polar regions and its back-side and will tune its orbit to the direction of the Sun's rotation. This will permit the spacecraft's instruments to observe emissions and solar wind from one specific area for much longer than currently possible and will provide more insight into the evolution of sunspots, active regions, coronal holes and other solar features and phenomenona than past missions.

Living with a Star Science: LWS science funds competitively-selected proposals that improve the understanding of the physics of the integrated system that links the Sun to the heliosphere and planetary atmospheres. This improved understanding will be achieved through data analysis to support the development of new or revised theories and models and is the precursor to a predictive space weather capability.

Implementation Schedule

Schedule by Fiscal Year: Prior, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22

Project	Phase	Beg	End
SDO	Tech		
	Form	Aug-02	Jul-04
	Dev	Jul-04	Oct-09
	Ops	Oct-09	Oct-14
	Res	Oct-14	Oct-15
RBSP	Tech		
	Form	Sep-06	Dec-08
	Dev	Dec-08	May-12
	Ops	May-12	May-14
	Res	May-14	May-15
BARREL	Tech		
	Form	Sep-06	Apr-10
	Dev	Apr-10	Dec-12
	Ops	Dec-12	Dec-13
	Res	Dec-13	Mar-15
SET	Tech		
	Form	Jan-04	Jan-06
	Dev	Jan-06	Apr-12
	Ops	Apr-12	Apr-13
	Res	Apr-13	Oct-13

- Tech & Adv Concepts (Tech)
- Formulation (Form)
- Development (Dev)
- Operations (Ops)
- Research (Res)
- Represents a period of no activity for the Project

Program Management

Goddard Space Flight Center (GSFC) is the managing center for the program. Missions are implemented by GSFC or Johns Hopkins University-Applied Physics Laboratory (JHU-APL).

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
SDO	GSFC	GSFC	None
RBSP	JHU/APL	None	National Reconnaissance Office (NRO)
BARREL	GSFC	GSFC	None
Solar Probe Plus	JHU/APL	TBD	TBD
SOC	GSFC	TBD	TBD
SET	GSFC	GSFC	CNES (French Space Agency, Centre National d'Etudes Spatiales), DERA (Defence Evaluation and Research Agency)

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star

Acquisition Strategy

LWS missions will be managed either by Goddard Space Flight Center (GSFC) or by Johns Hopkins University - Applied Physics Laboratory (JHU-APL). All missions will report to GSFC as the managing center for the program. The Science Mission Directorate Associate Administrator will determine which organization will manage each mission, and whether the spacecraft will be procured or built in-house at the managing organization for the mission.

The SDO launch vehicle and two instruments were selected through full and open competition, and one instrument is being provided sole-source from the Lockheed Martin Corporation. The spacecraft is an in-house build at GSFC.

Four instrument suites for the Radiation Belt Storm Probes (RBSP) were selected through full and open competition, and one instrument was manifested at the request of the National Reconnaissance Office. The launch vehicle will be selected through full and open competition, and the spacecraft is an in-house build at JHU/APL.

BARREL was selected through full and open competition through the same solicitation as the RBSP instruments. Two SET experiments were selected through full and open competition, and two were contributed by CNES and DERA.

Solar Probe Plus will continue being studied in preparation for the selection of science investigations. NASA-led Solar Orbiter Collaboration (SOC) instruments are to be selected using full and open competition as will the Solar Probe Plus and SOC launch vehicles. No decision has been made regarding the acquisition of the Solar Probe spacecraft.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	02/2009	Overall assessment of life cycle cost, schedule and deliverables of the LWS Program. Review board concluded that these programs have met their success criteria and should continue in accordance with their existing plans.	02/2011

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Solar Dynamics Observatory (SDO)

FY 2010 Budget Request

Budget Authority ($ millions)	Prior	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	BTC	LCC TOTAL
FY 2010 President's Budget Request	**619.1**	**108.1**	**20.8**	**34.1**	**20.2**	**18.6**	**16.3**	**15.6**	**17.2**	**870.0**
Formulation	84.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	84.9
Development / Implementation	534.2	108.1	20.8	21.9	0.0	0.0	0.0	0.0	0.0	685.0
Operations / Close-out	0.0	0.0	0.0	12.2	20.2	18.6	16.3	15.6	17.2	100.1
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FY 2009 President's Budget Request	**618.7**	**90.0**	**24.1**	**14.2**	**14.0**	**14.9**	**14.1**	**--**	**8.6**	**798.5**
Formulation	84.9	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	84.9
Development / Implementation	522.1	90.0	3.2	0.0	0.0	0.0	0.0	--	0.0	615.3
Operations / Close-out	0.0	0.0	20.9	14.2	14.0	14.9	14.1	--	8.6	86.7
Other	11.7	0.0	0.0	0.0	0.0	0.0	0.0	--	-0.1	11.6
Changes from FY 2009 Request	**0.4**	**18.1**	**-3.3**	**19.9**	**6.3**	**3.6**	**2.2**	**--**	**8.7**	**71.4**
Formulation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	--
Development / Implementation	12.1	18.1	17.6	21.9	0.0	0.0	0.0	--	0.0	69.7
Operations / Close-out	0.0	0.0	-20.9	-2.0	6.2	3.7	2.2	--	8.6	13.4
Other	-11.7	0.0	0.0	0.0	0.1	-0.1	0.0	--	0.1	-11.7

Note: The FY 2010 LCC number in the table above is overstated by $2.4M due to the difference in the FY09 enacted bill and the April 2009 initial operating plan. Assuming approval of the FY 2009 Inital Operating Plan, the estimated SDO lifecycle cost will be $867.6M, and the estimated Development costs will be $682.6M.

Explanation of Project Changes

The SDO mission will launch in November of 2009, a delay of 11 months from the previously planned launch date, due to problems securing a spot on the Atlas V launch vehicle manifest. The delay resulted in a significant increase in Development costs. The operations budget has also been increased to reduce risk.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Solar Dynamics Observatory (SDO)

Project Purpose

The Solar Dynamics Observatory (SDO) is the first mission for the Living With a Star (LWS) Program. It will investigate how the Sun's magnetic field is structured and how its energy is converted and released into the heliosphere in the forms of solar wind, energetic particles, and variations in solar irradiance. Scientists will analyze SDO data to improve the science needed for space weather predictions. The five-year prime life is designed to provide measurements over a substantial portion of the solar cycle.

SDO measures subsurface flows, photopheric magnetic fields, high-temperature solar atmospheric structures, and the extreme ultraviolet spectral irradiance that affects Earth's atmosphere. SDO plans to provide crucial understanding of solar activity, the solar cycle, and the inputs to geospace. Predictive modeling cannot improve without the improved data SDO will provide. SDO is an essential replacement for the aging SOHO spacecraft.

For more information please go to the website for SDO: http://nasascience.nasa.gov/missions/sdo.

Project Parameters

The SDO satellite will be placed into an inclined geosynchronous orbit to allow for a nearly-continuous observation of the Sun, a high-science data downlink rate, and contact with a single, dedicated, ground station. The combined data from the satellite and the three science instruments--the Helioseismic and Magnetic Imager (HMI), the Extreme Ultraviolet Variability Experiment (EVE), and the Atmospheric Imaging Assembly (AIA)--will require a downlink rate of 1.4 terrabytes per day.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Solar Dynamics Observatory (SDO)

Project Commitments

SDO will launch in November 2009 to begin a five-year prime mission in geosynchronous Earth orbit.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
Helioseismic and Magnetic Imager (HMI)	Stanford University	Resolution of 1 arc-second, with noise level <= 40 meters per second and 25 Gauss respectively: obtain full-disk photospheric velocity and longitudinal magnetic field measurements every 60 seconds.	Same	Same
Atlas V Evolved Expendable Launch Vehicle (EELV)Vehicle	KSC and Lockheed Martin	Deliver a 3,200 kg spacecraft to geosynchronous transfer orbit at about 2,500 km altitude.	Same	Same
Spacecraft	GSFC	Deliver high-rate data from instrument to ground station with a high accuracy for 5 years.	Same	Same
Atmospheric Imaging Assembly (AIA)	Lockheed Martin Solar Astrophysics Laboratory	Field-of-view of 40 arc-minutes in 1 chromospheric, 3 coronal wavelength bands with 1.2 arc-second resolution, and a cadence of 4 images every 10s: obtain full-disk images of the solar atmosphere.	Same	Same
Extreme Ultraviolet Variability Experiment (EVE)	University of Colorado	Make hourly solar spectral irradiance measurements in 6 emission lines at resolution of 0.2 nanometers, and measure Helium II emission line with resolution of 5 nanometers.	Same	Same
Ground System	GSFC	Transmit 1.3 MB/sec of Ka-band science data to the scientists and have 30-day backup ground storage.	Same	Same

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Solar Dynamics Observatory (SDO)

Schedule Commitments

NASA authorized the Solar Dynamics Observatory (SDO) project to begin formulation in August 2002 and to enter phase B in October 2003. After an independent review coincident with the project's Preliminary Design Review, the NASA Program Management Council confirmed the SDO Project to begin development in July 2004.

Milestone Name	Confirmation Baseline	FY 2009 PB Request	FY 2010 PB Request
Development			
Begin Implementation	July 2004	Same	Same
Critical Design Review	February 2005	April 2005	Same
Complete Spacecraft Structure	January 2006	March 2006	Same
Deliver Science Instruments to Spacecraft	February 2007	November 2007	Same
Launch Readiness	August 2008	December 2008	November 2009

Development Cost and Schedule Summary

Development costs have increased to accommodate the launch delay from December 2008 to November 2009.

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Solar Dynamics Observatory (SDO)	2006	623.7	2009	682.6	9	Launch Readiness	8/30/2008	11/1/2009	14

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**623.7**	**682.6**	**58.9**
Spacecraft	234.1	147.8	-86.3
Payload	181.8	152.4	-29.4
I & T	0.0	5.4	5.4
Launch Vehicle	120.6	108.3	-12.3
Ground System	69.7	44.7	-25.0
Science / Technology	0.0	0.0	0.0
Other	17.5	210.9	193.4
Reserve	0.0	13.1	13.1

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Solar Dynamics Observatory (SDO)

Project Management

The spacecraft has been built in-house at Goddard Space Flight Center (GSFC). GSFC is also responsible for management, design, integration, test, and operations. The Heliophysics Division Director is the responsible official for this project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Helioseimic and Magnetic Imager (HMI)	GSFC	None	None
EELV	KSC	KSC	None
Spacecraft design, integration, and test	GSFC	GSFC	None
Atmospheric Imaging Assembly (AIA)	GSFC	None	None
Extreme Ultraviolet Variability Experiment (EVE)	GSFC	None	None
Mission Operations	GSFC	GSFC	None

Acquisition Strategy

All major acquisitions are currently in place. The SDO spacecraft and ground system have been designed, developed, and tested in-house at GSFC using a combination of GSFC civil servants and local task contractors. The SDO project procurement office sub-contracted for spacecraft sub-assemblies, components and parts. The ground system components include a dedicated ground station antenna/facility and science data distribution system at White Sands, New Mexico, and a mission operations center at GSFC. The EVE and HMI science investigations were procured through the Announcement of Opportunity (AO) process. NASA acquired the AIA instrument through a sole-source contract on an emergency basis after the original provider was unable to demonstrate readiness to enter Phase B.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	09/2008	Assess project status on cost and schedule. Project was approved to proceed with rebaselining to new launch date of November 2009 with associated cost increase.	09/2009

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Solar Dynamics Observatory (SDO)

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Operations in Radiation Environment	Mission lifetime and reliability may be limited due to the severe ionizing radiation environment in geosynchronous Earth orbit (GEO).	Develop and verify requirements for operation that begin at the materials and component levels and continue through the level of the entire observatory. Liklihood of risk: possible, but not likely.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Radiation Belt Storm Probes (RBSP)

FY 2010 Budget Request

Budget Authority ($ millions)	Prior	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	BTC	LCC TOTAL
FY 2010 President's Budget Request	**49.0**	**67.8**	**154.4**	**137.1**	**127.9**	**105.1**	**22.0**	**17.3**	**5.2**	**685.8**
Formulation	49.0	39.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	88.2
Development / Implementation	0.0	28.8	154.2	137.1	127.9	85.9	0.0	0.0	0.0	533.9
Operations / Close-out	0.0	0.0	0.0	0.0	0.0	19.2	22.0	17.3	5.2	63.7
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FY 2009 President's Budget Request	**49.0**	**77.7**	**154.4**	**154.7**	**113.4**	**57.9**	**15.8**	**--**	**0.0**	**622.9**
Formulation	49.0	77.1	20.3	0.0	0.0	0.0	0.0	--	0.0	146.4
Development / Implementation	0.0	0.6	134.1	154.7	113.4	20.9	0.0	--	0.0	423.7
Operations / Close-out	0.0	0.0	0.0	0.0	0.0	37.0	15.8	--	0.0	52.8
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0
Changes from FY 2009 Request	**0.0**	**-9.9**	**0.0**	**-17.6**	**14.5**	**47.2**	**6.2**	**--**	**5.2**	**63.0**
Formulation	0.0	-38.1	-20.1	0.0	0.0	0.0	0.0	--	0.0	-58.2
Development / Implementation	0.0	28.2	20.1	-17.6	14.5	65.0	0.0	--	0.0	110.2
Operations / Close-out	0.0	0.0	0.0	0.0	0.0	-17.8	6.2	--	5.2	10.9
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.1

Explanation of Project Changes

RBSP was recently confirmed to proceed into the development phase, and will now launch in May 2012. In confirming the project, NASA added 7 months and $52M to the project's schedule and cost to ensure the project entered development at a 70% cost and schedule confidence level.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Radiation Belt Storm Probes (RBSP)

Project Purpose

The Radiation Belt Storm Probes (RBSP) mission will observe the fundamental processes that energize and transport radiation particles in Earth's inner magnetosphere (the area in and around the Earth's radiation belts). These dynamic processes operate throughout the universe at other planets and stars, and they continuously operate within Earth's immediate space environment.

The primary science objective of the RBSP mission is to provide understanding, ideally to the point of predictability, of how populations of relativistic electrons and penetrating ions in space form or change in response to variable inputs of energy from the Sun. The RBSP mission lifetime will provide sufficient local time, altitude, and event coverage to improve our understanding, and determine the relative significance of the various mechanisms that operate within the radiation belts.

RBSP observations will provide new knowledge on the dynamics and extremes of the radiation belts that are important to all technological systems that fly in and through geospace. It is also very important that we understand the space weather in geospace as we resume human exploration because it can impact the many US space assets that play a role in our national security and support human exploration.

Project Parameters

The RBSP mission is comprised of two identical spacecraft in elliptical, low-inclination orbits that travel independently through Earth's radiation belts to distinguish time and space variations in the measured ions, electrons, and fields.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Radiation Belt Storm Probes (RBSP)

Project Commitments

The Radiation Belt Storm Probes (RBSP) project will launch two identical spacecraft in 2012 to begin a two-year prime mission.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
EELV	KSC	Deliver a spacecraft to operational orbit	Same	Same
Energetic Particle, Composition and Thermal Plasma Suite (ECT)	Boston University	Measure the electron & ion spectra & composition to understand the electron & ion changes	Same	Same
Radiation Belt Storm Probes Ion Composition Experiment (RBSPICE)	New Jersey Institute of Technology	Measure the ring current in the magnetosphere during geomagnetic storms	Same	Same
Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS)	University of Iowa	Measure the magnetic fields & plasma waves	Same	Same
Electric Field and Waves Instrument for the NASA RBSP Mission (EFW)	University of Minnesota	Measure the electric fields in the radiation belts	Same	Same
Proton Spectrometer Belt Research (PSBR)	National Reconnaissance Office	Measure the inner Van Allen belt protons	Same	Same
Spacecraft	JHU-APL	Operate science instruments in high radiation; transmit science data to ground	Same	Same
Ground System	Primary ground station at JHU/APL; instrument operation is distributed among investigators	Receive science data from two spacecraft; distribute to archive	Same	Same

Schedule Commitments

The RBSP project was authorized to begin formulation in September 2006 when the selections for science investigations were announced. It was confirmed to proceed into development on December 19, 2008. Schedule details are still under development and are subject to change.

Milestone Name	Confirmation Baseline	FY 2009 PB Request	FY 2010 PB Request
Development			
Begin Implementation	January 2009	N/A	January 2009
Critical Design Review	December 2009	N/A	December 2009
System Integration Review	November 2010	N/A	November 2010
Launch Readiness Review	May 2012	N/A	May 2012

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Radiation Belt Storm Probes (RBSP)

Development Cost and Schedule Summary

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Radiation Belt Storm Probes (RBSP)	2009	533.9	2009	533.9	0	Launch Readiness	5/31/2012	5/31/2012	0

Development Cost Details

Development cost details are still under work by the project and are subject to change.

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**533.9**	**533.9**	**0.0**
Spacecraft	85.6	85.6	0.0
Payload	95.4	95.4	0.0
System I&T	36.9	36.9	0.0
Launch Vehicle	133.6	133.6	0.0
Ground System	16.3	16.3	0.0
Science/Technology	3.1	3.1	0.0
Other	163.0	163.0	0.0

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Radiation Belt Storm Probes (RBSP)

Project Management

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Ground Systems	APL	None	None
Data Analysis	APL	None	National Reconnaissance Office
Instrument Development	APL	None	National Reconnaissance Office
Spacecraft design, integration with instrument, and test	APL	None	None
Mission Operations	APL	None	None
Expendable Launch Vehicle	KSC	TBD	None

Acquisition Strategy

The RBSP spacecraft and ground system are being designed, developed, and tested at the JHU-APL. The acquisition of sub-contracted spacecraft sub-assemblies, components, and parts is through procurement contracts issued by the JHU-APL Procurement Office. Instrument development participants include the University of Iowa, University of Minnesota, New Jersey Institute of Technology, and Boston University, as well as contributions from the National Reconnaissance Office and the Czech Republic.

The ground system components were defined during the formulation phases (Phases A and B) and include a mission operations center at the JHU-APL.

The Energetic Particle, Composition and Thermal Plasma Suite (ECT), Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS), Electric Field and Waves Instrument for the NASA RBSP Mission (EFW), and Radiation Belt Storm ProbesIons Composition Experiment (RBSPICE) science investigations were procured through the Announcement of Opportunity process. The Proton Spectrometer Belt Research (PSBR) instrument is being contributed through an agreement with the National Reconnaissance Office.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Senior Review Board	10/2008	Preliminary Design Review. Review concluded that the RBSP design was sufficiently mature to proceed to KDP-C.	12/2009

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Formulation:	Solar Probe Plus

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	13.9	18.0	4.0	16.6	36.7	57.8	81.3
FY 2009 President's Budget Request	13.9	0.0	3.4	40.1	74.2	106.3	--
Total Change from 2009 President's Budget Request	0.0	18.0	0.7	-23.4	-37.6	-48.6	--

Project Purpose

Solar Probe Plus will be an extraordinary and historic mission, exploring the Sun's outer atmosphere, or corona, as it extends out into space. Approaching as close as 9.5 solar radii, Solar Probe Plus will repeatedly sample the near-Sun environment, revolutionizing our knowledge and understanding of coronal heating and of the origin and evolution of the solar wind, answering critical questions in heliophysics that have been ranked as top priorities for decades. Moreover, by making direct, in-situ measurements of the region where some of the most hazardous solar energetic particles are energized, Solar Probe Plus will make a fundamental contribution to our ability to characterize and forecast the radiation environment in which future space explorers will work and live.

For more information please see Solar Probe project at: http://nasascience.nasa.gov/missions/solar_probe.

Project Preliminary Parameters

The first near-Sun pass occurs three months after launch, at a heliocentric distance of 35 RS (Solar Radius). Over the next several years successive Venus gravity assist maneuvers gradually lower the spacecraft's near-Sun pass to approximately 9.5 RS, by far the closest any spacecraft has ever come to the Sun. With an August 2018 launch, Solar Probe Plus will spend, during its seven year mission, a total of 30 hours inside 10 RS, 961 hours inside 20 RS, and 2149 hours inside 30 RS, sampling the solar wind as it evolves with rising solar activity toward an increasingly complex structure.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Formulation:	Solar Probe Plus

Estimated Project Deliverables

Solar Probe will launch from KSC on an EELV in 2018, with an expected mission duration of 7 years.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
EELV	KSC	Deliver the spacecraft to operational orbit	N/A	Same
Ground Systems	TBD	Receive science data and telemetry from spacecraft, command spacecraft, distribute science data to investigator teams	N/A	Same
Spacecraft	TBD	Transport instruments to science destination, operate instruments, modify orbit including several Venus gravity	N/A	Same
Instruments	NASA-funded investigators	Perform in situ measurements and remote observations of the Sun	N/A	Same

Estimated Project Schedule

The release of Solar Probe Announcement of Opportunity to solicit science investigations occurs in April/May 2009. NASA anticipates announcing selections in the Fall of 2009 and beginning formulation then. Phase B will begin in December 2012 following a successful preliminary Non-Advocate Review (PNAR).

Milestone Name	Formulation Agreement Estimate	FY 2009 PB Request	FY 2010 PB Request
Formulation			
Mission Definition Review	04/2012	N/A	04/2012
Initial Confirmation Review	09/2012	N/A	09/2012
Confirmation Review	03/2014	N/A	03/2014
Launch	08/2018	N/A	08/2018

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Formulation:	Solar Probe Plus

Project Management

Johns Hopkins University/Applied Physics Laboratory (JHU/APL) will lead the implementation of the project. GSFC is responsible for oversight and science management including data analysis during opeations.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Instrument	GSFC	TBD	None
EELV	GSFC	KSC	None
Spacecraft	TBD	TBD	None
Mission Operations	GSFC	GSFC	None

Acquisition Strategy

A Solar Probe Announcement of Opportunity will be used to acquire the science investigations. The acquisition strategy for the spacecraft itself will be determined later in 2009. The spacecraft sub-assemblies, components, and parts will be procured by JHU-APL. The ground system components will be defined during formulation and will be determined by the implementing organization for the project. The Phase E contracts will be managed by GSFC.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	N/A	Assess project readiness to proceed to Phase B.	07/2012

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	71.9	123.1	143.0	169.1	170.6	160.8	164.3
Magnetospheric Multiscale (MMS)	43.1	94.6	118.6	149.3	148.8	137.5	143.8
Other Missions and Data Analysis	28.8	28.5	24.4	19.8	21.8	23.3	20.5
FY 2009 President's Budget Request	105.9	123.1	137.5	171.4	172.6	161.5	--
Magnetospheric Multiscale (MMS)	73.2	94.6	116.0	149.3	148.8	137.5	--
Other Missions and Data Analysis	32.7	28.5	21.5	22.0	23.9	24.1	--
Changes from FY 2009 Request	-34.0	0.0	5.5	-2.2	-2.0	-0.7	--

Note: Extended operations budgets increased for STEREO and Hinode missions. MMS budget increased to accommodate higher than expected launch vehicle costs.

Program Overview

The primary goal of the Solar Terrestrial Probes (STP) Program is to explore the connection between the Sun and the solar system. To accomplish this goal, STP investigations focus on specific scientific areas that will help us understand how plasma behaves in the space between the Sun and Earth. STP missions address processes such as the variability of the Sun, the responses of the planets to these variations, and the interaction of the Sun and solar system. STP missions are strategically defined and investigations are competitively selected. Strategic mission lines afford the space physics community the opportunity to plan specific missions to address important research focus areas and thus make significant progress in elucidating the fundamental processes of Heliophysics.

For more information please see Solar Terrestrial Probes Program at: http://stp.gsfc.nasa.gov/.

Plans For FY 2010

The Magnetospheric Multiscale Mission will complete its mission Critical Design Review (CDR). The Hinode Mission will complete its mission success criteria. The STEREO mission will commence joint observations with SDO.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes

Project Descriptions and Explanation of Changes

Magnetospheric Multiscale (MMS)

MMS is a four-spacecraft mission planned for launch no earlier than 2014 with a two-year mission life. MMS is designed to study magnetic reconnection in key boundary regions of the Earth's magnetosphere. Reconnection is a fundamental process that occurs throughout the universe, by which magnetic energy is converted into heat, radiation, and particle acceleration. The best laboratory for understanding this process is the Earth's magnetosphere, where reconnection between the Earth's and Sun's magnetic fields powers magnetic storms and substorms on our planet, otherwise known as "space weather." The spacecraft will probe the regions of geospace most critical to measuring reconnection. Additional detail can be found in the Magnetospheric Multiscale Project section of this document.

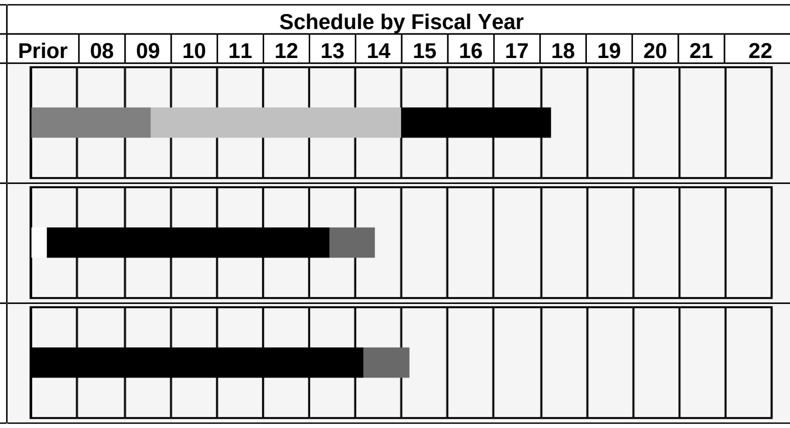
Other Missions and Data Analysis

Solar TErrestrial RElations Observatory (STEREO): Launched on October 25, 2006, STEREO is now an operating mission employing two nearly identical observatories to provide three-dimensional measurements of the Sun to study the nature of coronal mass ejections. These powerful eruptions are a major source of the magnetic disruptions on Earth and a key component of space weather, which can greatly affect satellite operations, communications, power systems, the lives of humans in space, and global climate.

Solar B (Hinode): Hinode launched on September 22, 2006, from Japan's Uchinoura Space Center to begin its three-year mission to explore the magnetic fields of the Sun. NASA developed three science instrument components: the Focal Plane Package (FPP), the X-Ray Telescope (XRT), and the Extreme Ultraviolet Imaging Spectrometer (EIS) and provides operations support for science planning and instrument command generation activities. A follow-on to the highly successful Japan/US/UK Yohkoh (Solar-A) satellite that operated between 1991 and 2001, Hinode consists of a coordinated set of optical, Extreme-Ultraviolet (EUV), and X-ray instruments that will investigate the interaction between the Sun's magnetic field and its corona. The result will be an improved understanding of the mechanisms that power the solar atmosphere and drive solar eruptions.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes

Implementation Schedule



Project	Phase	Beg	End
Magnetospheric Multiscale (MMS)	Tech		
	Form	May-02	Apr-09
	Dev	Apr-09	Oct-14
	Ops	Oct-14	Dec-17
	Res		
STEREO	Tech		
	Form	May-01	Mar-02
	Dev	Mar-02	Jan-07
	Ops	Jan-07	Feb-13
	Res		Feb-14
Solar-B (Hinode)	Tech		
	Form	Dec-98	Nov-00
	Dev	Nov-00	Nov-06
	Ops	Nov-06	Nov-13
	Res		Nov-14

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

Program management responsibility for the STP Program is assigned to the Goddard Space Flight Center (GSFC).

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
MMS	GSFC	GSFC	Austria, Sweden, France
Solar B (Hinode)	MSFC	MSFC	JAXA
STEREO	GSFC	None	United Kingdom

Acquisition Strategy

STP missions are strategically defined and investigations are competitively selected. The STP uses full and open competitions to the greatest extent possible for the acquisition of scientific instruments, spacecraft, and science investigations, including research and analysis.
The MMS spacecraft and Mission Operations Center will be in-house builds at GSFC. The Southwest Research Institute (SwRI) is the single MMS instrument suite contractor, selected through a full and open competition. All instruments are developed by the SwRI team which includes SwRI, their subcontractors, their international partners, and the GSFC Fast Plasma Instrument.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	02/2009	Overall assessment of life cycle cost, schedule and deliverables of the STP Program. Review board concluded that these programs have met their success criteria and should continue in accordance with their existing plans.	02/2011

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes
Project In Formulation:	Magnetospheric Multiscale (MMS)

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	43.1	94.6	118.6	149.3	148.8	137.5	143.8
FY 2009 President's Budget Request	73.2	94.6	116.0	149.3	148.8	137.5	--
Total Change from 2009 President's Budget Request	-30.1	0.0	2.6	0.0	0.0	0.0	--

Project Purpose

The Magnetospheric Multiscale (MMS) Project will use four identically instrumented spacecraft to perform the first definitive study of magnetic reconnection in space. Reconnection occurs in all astrophysical plasma systems but can be studied efficiently only in the Earth's magnetosphere. It is thought to be of great importance for energy transfer throughout the universe and is an efficient and fast acceleration mechanism. Reconnection is the primary process by which energy is transferred from the solar wind to Earth's magnetosphere and is the critical physical process determining the size of a space weather geomagnetic storm. MMS will determine why magnetic reconnection occurs, where it occurs, how it varies, how magnetic energy is coupled into heat and particle kinetic energy, and how this energy is coupled into the surrounding plasma.

MMS results will be needed as soon as possible as a basis for the predictive models of space weather needed to undertake heliospheric weather prediction in support of Exploration. Magnetic reconnection is a primary source of energy release and particle acceleration in plasmas. No mission has ever been properly instrumented and configured to measure the small-scale features of reconnection in space. For more information see: http://stp.gsfc.nasa.gov/missions/mms/mms.htm.

Project Preliminary Parameters

The MMS instrument payload will measure electric and magnetic fields and plasmas within the small-scale diffusion regions where magnetic reconnection occurs. High temporal and spatial resolution measurements will permit direct observation of the microphysical processes that allow it to proceed. The four spacecraft and instrument suites have identical design requirements. A two-phase, low-inclination orbit will probe both the dayside magnetopause and the nightside magnetotail neutral sheet where reconnection is known to frequently occur. The primary target of Phase 1 is the dayside magnetopause reconnection region. Phase 2 will focus on the near-Earth neutral line in the magnetotail. The four spacecraft will fly in a tetrahedron formation and the separation between the observatories will be adjustable over a range of 10 to 400 kilometers during science operations and within the area of interest. The mission design life is two years after spacecraft checkout and full commissioning of the instruments.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes
Project In Formulation:	Magnetospheric Multiscale (MMS)

Estimated Project Deliverables

NASA plans to launch four identically-instrumented spacecraft on an Evolved Expendable Launch Vehicle (EELV) into a highly elliptical Earth orbit in October 2014 and begin two years of scientific measurements that will enable an understanding of fundamental plasma physics processes associated with magnetic reconnection.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
Launch Vehicle	KSC	Deliver ~4,000-kg payload consisting of 4 observatories to a highly elliptical Earth orbit	Same	Same
Ground Systems	GSFC	Provide during operations minimum science data payback of ~4 Gbits of data per observatory each day.	Same	Same
Spacecraft	GSFC	Deliver high-rate data from instruments to ground station with a high accuracy for 2 years	Same	Same
Electric Field Instruments	Southwest Research Institute	Provide measurements of electric fields (time resolution 1 ms) and magnetic fields (time resolution 10 ms)	Same	Same
Fast Plasma Investigation	GSFC	Provide plasma wave measurements (electric vector to 100 KHz).	Same	Same
Energetic Particle Detectors	JHU/APL	Provide high-resolution measurement of energetic particles	Same	Same
Hot Plasma Composition Analyzers	Southwest Research Institute	Three-dimensional measurements of hot plasma composition (time resolution 10s).	Same	Same
Science Operations Center	LASP	Science data to the community and archive	Same	Same

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes
Project In Formulation:	Magnetospheric Multiscale (MMS)

Estimated Project Schedule

Magnetospheric Multiscale (MMS) began formulation in 2002 and the project's Initial Confirmation Review was held in November 2007 and approved. The Non-Advocate and Confirmation Reviews are planned for 2009.

Milestone Name	Formulation Agreement Estimate	FY 2009 PB Request	FY 2010 PB Request
Formulation			
Mission Definition Review	September 2007	Same	Same
Initial Confirmation Review	November 2007	Same	Same
Confirmation Review	April 2009	April 2009	June 2009
Launch	October 2014	Same	Same

Project Management

The Goddard Space Flight Center (GSFC) has program management responsibility for the Solar Terrestrial Probes Program and Project Management responsibility for the MMS project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Four Instrument Suites	GSFC, Southwest Research Institute	GSFC	Austrian Space Agency, Sweden (SNSB), France (CNES), and Japan (JAXA)
Launch Vehicle	KSC	KSC	None
Four Spacecraft	GSFC	GSFC	None
Mission Operations	GSFC	GSFC	None
Science Operations	GSFC, LASP	None	None

Acquisition Strategy

The MMS spacecraft is being designed, developed, and tested in-house at GSFC using a combination of GSFC civil servants and local support service contractors. The acquisition of subcontracted spacecraft sub-assemblies, components, and parts is through procurement contracts issued by the MMS Procurement office. Instrument development activities are under contract with the Southwest Research Institute (SwRI). Instrument development subcontracts include Lockheed Martin, JAXA/MEISEI, University of New Hampshire, Johns Hopkins University/Applied Physics Laboratory, Aerospace Corporation, and a team at GSFC. The Mission Operations Center and the Flight Dynamics Operations Area will be developed and operated at GSFC using a combination of GSFC civil servants and local support service contractors. The Science Operations Center for the Instruments will be developed and operated at the Laboratory for Atmospheric and Space Physics at the University of Colorado and is under contract to SwRI.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes
Project In Formulation:	Magnetospheric Multiscale (MMS)

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	09/2007	To assess MMS readiness to proceed into Phase B. MMS was approved to enter Phase B.	05/2009

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Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	48.1	31.4	69.4	119.7	158.1	161.3	167.4
GOLD	0.3	0.5	0.5	10.6	10.9	6.7	0.9
Other Missions and Data Analysis	47.9	30.9	68.9	109.1	147.2	154.6	166.5
FY 2009 President's Budget Request	61.0	41.3	66.8	125.1	156.0	160.1	--
Other Missions and Data Analysis	61.0	41.3	66.8	125.1	156.0	160.1	--
Changes from FY 2009 Request	-12.9	-9.9	2.6	-5.4	2.1	1.2	--

Note: FY 2010 President's Budget Request is overstated by $9.9M due to the transfer of Astro-H from Heliophysics Explorer to Astrophysics Explorer Program in FY 2010.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

Program Overview

The Heliophysics Explorer Program provides frequent flight opportunities for world-class astrophysics and space physics investigations using innovative and streamlined management approaches for spacecraft development and operations.

Explorer missions are highly responsive to new knowledge, new technology, and updated scientific priorities by launching smaller missions that can be conceived and executed in a relatively short development cycle. Priorities are based on an open competition of concepts solicited from the scientific community. The program also enables participation in missions of opportunity provided by other U.S. or international agencies. The program emphasizes missions that can be accomplished under the control of the scientific research community within constrained mission life-cycle costs. The program also seeks to enhance public awareness of space science by incorporating educational and public outreach activities into each mission.

All investigations are competitively selected. Full missions can either be Medium-Class Explorers (MIDEX) or Small Explorers (SMEX). Mission of Opportunity (MO) space science investigations are typically instruments flown as part of a non-NASA space mission. MOs are conducted on a no-exchange-of-funds basis with the organization sponsoring the mission.

Following the commissioning and checkout phase of the spacecraft, HQ management responsibility for the operational phase transitions to the Heliophysics Research Program. While the Research Program assumes management responsibilities, funds for operating missions is provided by the Explorer Program.

The Heliophysics Explorer Program is currently conducting a SMEX Announcement of Opportunity (AO) selection competition and expects to select 2 missions to proceed into full development during 2009. The Explorer Program is also considering selecting a second MO during 2009. One MO was previously selected under the same SMEX AO competition: the High-Resolution Soft X-Ray Spectrometer (SXS). SXS is an instrument that will fly on board the ASTRO-H X-ray observation satellite under development by the Japan Aerospace Exploration Agency (JAXA). The SXS investigation is an Astrophysics mission and its budget and management responsibility have been transferred to the Astrophysics Division.

The Interstellar Boundary Explorer (IBEX) launched in October 2008 is now operating. The Coupled Ion Neutral Dynamics Investigation (CINDI), and Two Wide-angle Imaging Neutral-atom Spectrometers B (TWINS-B) instruments also launched in 2008 and are conducting prime science operations. Two Explorer missions are currently in development in the Astrophysics Division: the Widefield Infrared Survey Explorer (WISE) and the Nuclear Spectroscopic Telescope Array (NuSTAR). Details and the associated budget can be found in the Astrophysics section of this document.

For more information, please see Explorer Program at http://explorers.gsfc.nasa.gov/missions.html

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

Plans For FY 2010

The newly selected SMEX missions will progress towards their development phase. The THEMIS and IBEX missions will complete their mission success criteria. THEMIS will continue to provide scientists with important details on how the planet's magnetosphere works and the important Sun-Earth connection. IBEX will continue its primary science mission of mapping the heliosphere and uncovering the global interaction between the solar wind and the interstellar medium, producing its first all-sky map in 2010. TWINS-B and CINDI will both enter their second year on orbit. AIM will complete its primary mission to study Polar Mesospheric Clouds.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

Project Descriptions and Explanation of Changes

Global-scale Observations of the Limb and Disk (GOLD)

GOLD is a recently selected mission of opportunity, implemented by Principal Investigator at the University of Central Florida, Orlando, Fla. GOLD will increase our understanding of the temperature and composition in the ionosphere, and provide understanding of the global scale response of the Earth's thermosphere and ionosphere. GOLD was conditionally selected under the most recent Explorer AO, and will be reviewed in 2009 to determine if it will continue into development.

GOLD will advance the general current scientific understanding of Thermosphere-Ionosphere forcing by providing neutral densities and temperatures in the thermosphere as well as densities in the nighttime ionosphere. GOLD will provide the first large-scale "snapshot" of temperature that can be compared with a simultaneous "snapshot" of composition changes to understand how these two major parameters simultaneously react to this these various forcing mechanisms. The relationship between universal time, local time and longitudinal changes in these key parameters can be unambiguously separated by the GOLD observations to enable us to address these interactions.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

Other Missions and Data Analysis

Aeronomy of Ice in Mesophere (AIM): The primary objective of the AIM mission is to understand why polar mesospheric clouds (PMCs) form and why they vary. AIM will also determine the causes of Earth's highest-altitude clouds, which form in the coldest part of the atmosphere about 50 miles above the polar regions every summer. AIM launched on April 25, 2007, on board a Pegasus XL from Vanderberg Air Force Base. Hampton University will maintain operations for two years. This mission is supplying spectacular data which is leading to new science discoveries.

Coupled Ion-Neutral Dynamics Investigation (CINDI): CINDI is a NASA-sponsored Mission of Opportunity (MO) conducted by the University of Texas at Dallas (UTD). CINDI will discover the role of ion-neutral interactions in the generation of small- and large-scale electric fields in Earth's upper atmosphere. In addition, the CINDI instruments will provide measurements of the three-dimensional neutral winds and ion drifts. CINDI will operate for at least two years. This mission launched April 16, 2008, aboard the Air Force Research Laboratory's Communication/Navigation Outage Forecast System (C/NOFS) spacecraft. Early discoveries have been reported at the American Geophysical Union 2008 Fall Meeting.

Interstellar Boundary Explorer (IBEX): IBEX will allow the first glimpse into the edge of the solar system, where the solar wind interacts with winds from other stars. This region is a breeding ground for anomalous cosmic rays that form a component of energetic particles from beyond the solar system that pose health and safety hazards for humans exploring beyond Earth's orbit. As the solar wind from the Sun flows out beyond Pluto, it collides with the material between the stars, forming a shock front. IBEX contains two neutral atom imagers that are designed to detect particles from the so -called termination shock at the boundary between the solar system and interstellar space. IBEX will make these observations from an elliptical Earth orbit that takes it beyond the interference of Earth's magnetosphere. IBEX launched on October 5, 2008, on a Pegasus XL from Kwajalein. Southwest Research Institute will maintain operations for two years.

Time History of Events and Macroscale Interactions during Substorms (THEMIS): THEMIS has provided breakthroughs in our understanding of the onset and evolution of magnetospheric substorms. NASA's THEMIS mission uses five identical micro-spacecraft (probes) to answer the fundamental questions regarding magnetospheric substorm instability, a dominant mechanism of transport and explosive release of solar wind energy within geospace. In addition to addressing its primary objective, THEMIS answers critical questions in radiation belt physics and solar wind-magnetosphere energy coupling. THEMIS is a Medium-Class Explorers (MIDEX) mission that launched on February 17, 2007, from Cape Canaveral, Florida, on board a Delta II rocket. The University of California, Berkeley maintains operations of the five satellites.

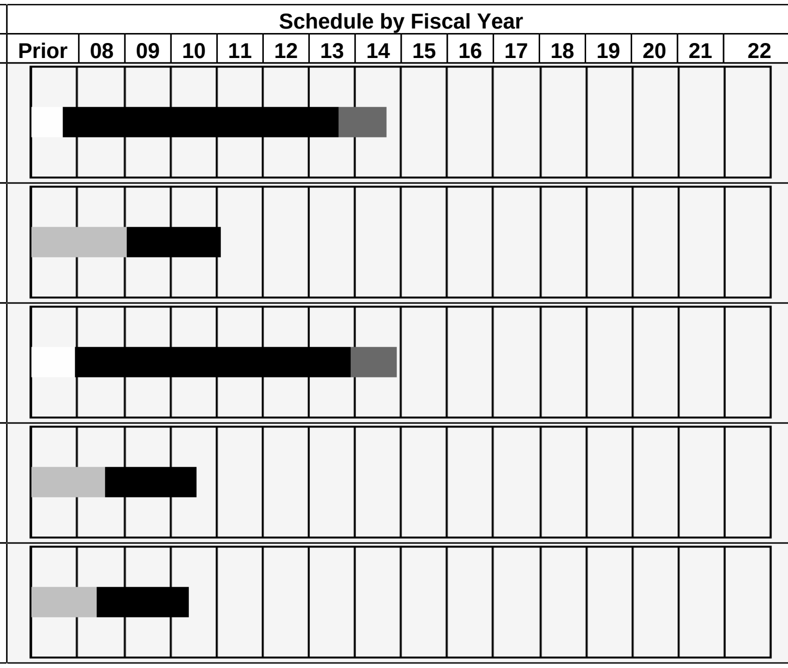
Two Wide-angle Imaging Neutral-atom Spectrometers (TWINS-B): TWINS-B will provide the second half of the stereo imaging capability of Earth's magnetosphere in conjunction with the TWINS-A mission. The region surrounding the planet is controlled by its magnetic field and contains the Van Allen radiation belts and other energetic charged particles. TWINS-B will enable three-dimensional global visualization of this region, which will lead to a greatly enhanced understanding of the connections between different regions of the magnetosphere and their relation to the solar wind. TWINS-B was launched as a NASA-sponsored Mission of Opportunity in February 2008.

Explorer Future Missions: This project holds funding to be used for all future Explorer mission selections. Once a mission is selected, funding is moved into a new project.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Select up to two new SMEX missions (SMEX-12 and -13) from the most recent Announcement of Opportunity	Explorer Future Mission	None

Implementation Schedule



Project	Phase	Beg	End
AIM	Tech		
	Form	Jul-02	Apr-04
	Dev	Apr-04	May-07
	Ops	May-07	May-13
	Res		May-14
IBEX	Tech		
	Form	Jan-05	Mar-06
	Dev	Mar-06	Oct-08
	Ops	Oct-08	Oct-10
	Res		
THEMIS	Tech		
	Form	Oct-02	Apr-04
	Dev	Apr-04	Aug-07
	Ops	Aug-07	Aug-13
	Res		Aug-14
CINDI	Tech		
	Form	Sep-00	Nov-01
	Dev	Nov-01	Apr-08
	Ops	Apr-08	Apr-10
	Res		
TWINS-B	Tech		
	Form		
	Dev	Apr-99	Feb-08
	Ops	Feb-08	Feb-10
	Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

Goddard Space Flight Center (GSFC) has Program Management responsibility for all Heliophysics Explorer Programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
AIM	GSFC	None	N/A
IBEX	GSFC	GSFC	N/A
THEMIS	GSFC	None	N/A
CINDI	GSFC	None	DoD
TWINS-B	GSFC	None	DoD
GOLD	GSFC	None	N/A

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

Acquisition Strategy

The Heliophysics Explorer Program has established an acquisition strategy that contracts for the whole mission (concept through delivery of science data and analysis), with emphasis on performance incentives and a cost cap for each mission.

Investigations are selected through the Announcement of Opportunity (AO) process, where multiple investigations are selected competitively for initial concept studies with a competitive down-select to proceed to the next stage of formulation. The investigations are selected to proceed from one phase to the next through execution of contract options, based on successful technical, cost, and schedule performance in the previous phases.

The following awards have been made for development and mission operations:

IBEX: Orbital Science Corporation, Los Alamos National Laboratory, Lockheed Martin Advance Technology Center, Southwest Research Institute (mission operations).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Space Science Support Office	03/2008	Review and evaluate Small Explorers (SMEX) Announcements of Opportunity proposals for selection. Review will provide written evaluation for selection of two full SMEX missions and has already supported the selection of a Mission of Opportunity, the High-Resolution Soft X-Ray Spectrometer (SXS).	04/2009
Performance	IPAO	02/2009	Overall assessment of life cycle cost, schedule and deliverables of the Explorer Program. Review board concluded that these programs have met their success criteria and should continue in accordance with their existing plans.	02/2011

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Mission Directorate:	Science
Theme:	Heliophysics
Program:	New Millennium

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**15.0**	**2.7**	**1.8**	**1.1**	**0.0**	**0.0**	**0.0**
New Millennium	**15.0**	**2.7**	**1.8**	**1.1**	**0.0**	**0.0**	**0.0**
FY 2009 President's Budget Request	**25.8**	**4.3**	**2.2**	**1.1**	**0.0**	**0.0**	**--**
New Millennium	**25.8**	**4.3**	**2.2**	**1.1**	**0.0**	**0.0**	**--**
Changes from FY 2009 Request	**-10.8**	**-1.6**	**-0.4**	**0.0**	**0.0**	**0.0**	**--**

Program Overview

The New Millennium Program (NMP) is a technology flight validation program designed to mature key emerging and breakthrough technologies that will enable future NASA science missions. The objective of the program is to accelerate the incorporation of new technologies into future NASA science missions by conducting in-space validation and testing. The NMP allows NASA to conduct technology maturation and validation activities in low cost projects, rather than during science mission development of larger, more expensive missions.

The NMP is being phased out and all current activities will be finished by FY 2012. A small amount of funding remains to cover closeout costs.

For more information, please see: http://nmp.jpl.nasa.gov.

Plans For FY 2010

Space Technology 7 micro-valve assembly will be launched on an European Space Agency (ESA) spacecraft. Program closeout activities will continue.

Project Descriptions and Explanation of Changes

New Millennium

Space Technology 7's Disturbance Reduction System (DRS) incorporates enhanced micro-Newton thruster technology, which works with enhanced sensor technology provided by the European Space Agency. Together, these technologies will demonstrate precision spacecraft control, validating position-measurement of objects in weightlessness with 100-times greater accuracy than ever before.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	New Millennium

Implementation Schedule

Project	Schedule by Fiscal Year															Phase Dates		
	Prior	08	09	10	11	12	13	14	15	16	17	18	19	20	22		Beg	End
Space Technology 7																Tech	Apr-01	Apr-03
																Form	Apr-03	Jul-03
																Dev	Jul-03	Jan-10
																Ops	Jan-10	Jan-11
																Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

The New Millennium Program is managed by Jet Propulsion Laboratory.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Space Technology 7	JPL	JPL	European Space Agency and Busek Corporation

Acquisition Strategy

No further acquisitions are planned.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	01/2007	Program Implementation Review. Results were reported to the Agency PMC on 9/12/2007. Review concluded that there should be more emphasis on technology infusion.	N/A

Overview

NASA research continues to contribute directly to aeronautics breakthroughs. As the Agency's lead organization for aeronautics research, NASA's Aeronautics Research Mission Directorate (ARMD) oversees cutting-edge research whose goal is to generate the innovative concepts, tools and technologies that will enable revolutionary advances in future aircraft, as well as to the airspace in which they will fly. NASA has put together a robust research portfolio that addresses these advances and the challenges facing our Nation as it transforms its air transportation system to meet growing capacity needs. In addition, the portfolio ensures aeronautics research and critical core competencies will continue to play a vital role in supporting NASA's human and robotic space exploration activities.

Growth in the air transportation system is vital to the well being of our Nation. In the United States, 151 domestic airlines fly 8,100 aircraft; annual operating revenue for commercial flight stands at $164 billion. Twenty-five percent of U.S.-based company sales depend on air transportation, while the aviation industry directly or indirectly accounts for 634,500 American jobs.

Nevertheless, current needs exceed the limited solutions that aviation currently offers, requiring dramatic improvements in safety, capacity, environmental compatibility, robustness and freedom of mobility throughout the global airspace. In the next two decades, we must develop advances that improve aircraft and system efficiency, reduce aviation's impact on the environment and allow more people to utilize air travel in ways that are more significant than all the gains realized over the last three decades.

Each of NASA's five programs, Aviation Safety, Airspace Systems, Fundamental Aeronautics, Aeronautics Test, and Integrated Systems Research uniquely address specific aeronautical-research needs while taking an integrated approach in addressing critical long term challenges. By continuing to expand the boundaries of aeronautical knowledge for the benefit of the Nation as well as NASA's partners in academia, industry and other government agencies, NASA's programs are also helping to foster a collaborative research environment in which ideas and knowledge are exchanged across all communities.

NASA Aeronautics is now in full execution of a robust fundamental research program that is well aligned with the principles, goals and objectives of the National Aeronautics Research and Development (R&D) Policy and directly supports the development of the Next Generation Air Transportation System (NextGen). NASA's commitment to technical excellence and strong partnerships will ensure our continued focus on those challenges needed to support the needs of the Nation's air transportation system and the Agency's space exploration mission.

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**511.4**	**650.0**	**507.0**	**514.0**	**521.0**	**529.0**	**536.0**
Aeronautics	511.4	650.0	507.0	514.0	521.0	529.0	536.0
FY 2009 President's Budget Request	**511.7**	**446.5**	**447.5**	**452.4**	**456.7**	**467.7**	**--**
Aeronautics	511.7	446.5	447.5	452.4	456.7	467.7	--
Total Change from FY 2009 President's Budget Request	**-0.3**	**203.5**	**59.5**	**61.6**	**64.3**	**61.3**	**--**

Note: In all budget tables, the FY 2010 President's Budget Request depicts the September 2008 Operating Plan for the 2008 Actuals and the 2009 Omnibus Appropriations Act (P.L. 111-8) and the American Recovery and Reinvestment Act (P.L. 111-5) for the 2009 enacted.

Plans for FY 2010

Aeronautics Research

Aeronautics

New Initiatives:

In response to several external mandates and recommendations and based on NASA's own assessment, NASA is initiating a program of integrated, system-level focused activities. The intent of this program is to accelerate the transition of key Next Generation Air Transportation System (NextGen) research and development (R&D) results to industry and government, and to expand development of key testbeds to enable testing of integrated, system-level capabilities. In addition, these activities will inform future foundational research by exposing key technology challenges. The focus of the Integrated Systems Research Program will initially be the development of new vehicle concepts and enabling technologies that will simultaneously reduce fuel burn, noise and emissions. As future opportunities for systems-level research arise, new systems-level research projects will be added to the Integrated Systems Research Program. The Integrated Systems Research Program will begin in FY 2010 at a funding level of $62.4 million.

Major Changes:

Aeronautics research into planetary entry, descent and landing (EDL) has been conducted within the Supersonics and Hypersonics projects of the Fundamental Aeronautics Program. In practice, EDL is an integral part of any space mission and is not divided into distinct hypersonics and supersonics phases. All EDL technology research and development is now combined in the Hypersonics project. This change will provide more focus to technical developments and will also yield technical management efficiencies.

Some of the technologies to be matured within the ISRP project will be drawn from the fundamental technologies within the Subsonic Fixed Wing (SFW) project of the Fundamental Aeronautics Program. With this work transfer the SFW project is streamlining its research content, and this is enabling new efficiencies across the foundational disciplines remaining in the project. Therefore we are transferring funds from SFW to the Airspace Systems Program in order to accelerate the development of new airspace management concepts. Details of these new activities are included in the Airspace Systems Program section.

The Airspace Systems Program has been reorganized from the NextGen Airspace and NextGen Airportal projects into the NextGen Concepts and Technology Development project and the NextGen Systems Analysis, Integration and Evaluation project. The previously planned work on airspace concepts, technologies and systems will continue, but the project structure is now better aligned to the nature of the work being performed.

To enable more efficient tracking and management of the headquarters operations, ARMD is consolidating headquarter's activities currently in the Airspace Systems Program, the Aeronautics Test Program and the Aviation Safety Program into the Fundamental Aeronautics Program. There is no programmatic budget impact to the programs. This results in an increase in the Fundamental Aeronautics Program budget and a corresponding decrease in the other three programs.

Major Highlights for FY 2010

In FY2010, the Aeronautics Research Mission Directorate will continue its commitment to conducting long-term cutting edge research for the benefit of the broad aeronautics community. Each of the five programs within ARMD will play a significant role in FY2010 in addressing the challenge of meeting the growing capacity needs of the Next Generation Air Transportation System (NextGen) as well as contributing to the R&D challenges in aviation safety, promising new flight regimes, and aviation environmental impacts. Specifically,

- The Aviation Safety Program will take a proactive approach to safety challenges with new and current vehicles and with operations in the Nation's current and future air transportation system. In addition, the Program is initiating an effort to examine key challenges in verifying and validating flight critical software systems.

- The Airspace Systems Program will develop and enable future concepts, capabilities, and technologies that will enable major increases in air traffic management effectiveness, flexibility, and efficiency, while maintaining safety, to meet capacity and mobility requirements of the NextGen.

- The Fundamental Aeronautics Program will continue to develop prediction and analysis tools for reduced uncertainty in design process and advanced multidisciplinary design and analysis capability to guide our research and technology investments and realize integrated technology advances in future aircraft.

- The Aeronautics Test Program will ensure the strategic availability, accessibility, and capability of a critical suite of aeronautics ground test facilities and flight operations assets necessary to meet Agency and National aeronautics needs.

- The Integrated Systems Research Program's initial effort will take an integrated system-level approach to reduce the environmental impact of aviation (in terms of noise, local and global emissions, and local air quality) in the area of air vehicle technologies.

Theme Overview

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**511.4**	**650.0**	**507.0**	**514.0**	**521.0**	**529.0**	**536.0**
Aviation Safety	66.5	89.3	60.1	59.6	59.2	61.7	62.5
Airspace Systems	100.1	121.5	81.4	82.9	83.9	87.2	88.3
Fundamental Aeronautics	269.6	307.6	228.4	230.0	233.6	239.0	245.9
Aeronautics Test Program	75.1	131.6	74.7	77.1	77.2	76.6	78.7
Integrated Systems Research	0.0	0.0	62.4	64.4	67.1	64.4	60.5
FY 2009 President's Budget Request	**511.7**	**446.5**	**447.5**	**452.4**	**456.7**	**467.7**	**--**
Aviation Safety	66.5	62.6	65.9	65.0	64.5	66.5	--
Airspace Systems	100.1	74.6	72.7	74.2	75.4	78.4	--
Fundamental Aeronautics	269.9	235.4	233.2	235.2	238.6	244.6	--
Aeronautics Test Program	75.1	73.9	75.8	78.0	78.2	78.2	--
Total Change from FY 2009 Request	**-0.3**	**203.5**	**59.5**	**61.6**	**64.3**	**61.3**	**--**

Relevance

Relevance to national priorities, relevant fields, and customer needs:

The Office of Science and Technology Policy (OSTP) National Science and Technology Council (NSTC) Committee on Technology chartered an Aeronautics Science and Technology (AS&T) Subcommittee in September 2005. NASA's Associate Administrator for ARMD is a co-chair of the Subcommittee, which drafted the Nation's first Aeronautics Research and Development Policy, released by the White House in December 2006. The policy establishes a set of U.S. aeronautics research objectives, defines the appropriate role of the federal government in aeronautics research and development (R&D), defines the roles and responsibilities of the various departments and agencies in aeronautics R&D, addresses R&D test and evaluation infrastructure, and addresses the coordination of aeronautics research across the federal government. NASA's ARMD efforts are aligned with this policy.

ARMD's research portfolio also aligns very well with the recommendations of the 2006 National Research Council (NRC) Decadal Survey. All five of the Common Themes identified in the Decadal Survey are present across ARMD's research programs, and 47 of the 51 Technical Challenges are also well represented in the portfolio. A detailed response to the survey was documented in a Report to Congress submitted in August 2007.

Finally, in December 2007, the President approved the first National Aeronautics R&D Plan. ARMD's research portfolio is closely aligned with this plan.

Relevance to the NASA Mission and Strategic Goals:

ARMD's focus on long-term, cutting-edge research that expands the boundaries of aeronautical knowledge for the benefit of the broad aeronautics community directly supports NASA's mission to pioneer the future in space exploration, scientific discovery, and aeronautics research. NASA's fundamental aeronautics research will have far-reaching effects on both civilian aviation and space exploration. ARMD's work supports Sub-goal 3E, "Advance knowledge in the fundamental disciplines of aeronautics, and develop technologies for safer aircraft and higher capacity airspace systems." Within this subgoal, each program within ARMD supports an associated outcome:

- The Aviation Safety Program supports Outcome 3E.1, "By 2016 identify and develop tools, methods, and technologies for improving overall aircraft safety of new and legacy vehicles operating in the Next Generation Air Transportation System (projected for the year 2025).";
- The Airspace Systems Program supports Outcome 3E.2, "By 2016, develop and demonstrate future concepts, capabilities, and technologies that will enable major increases in air traffic management effectiveness, flexibility, and efficiency, while maintaining safety, to meet capacity and mobility requirements of the Next Generation Air Transportation System.";
- The Fundamental Aeronautics Program supports Outcome 3E.3, "By 2016, develop multidisciplinary analysis and design tools and new technologies, enabling better vehicle performance (e.g., efficiency, environmental, civil competitiveness, productivity, and reliability) in multiple flight regimes and within a variety of transportation system architectures.";
- The Aeronautics Test Program supports Outcome 3E.4, "Ensure the continuous availability of a portfolio of NASA-owned wind tunnels/ground test facilities, which are strategically important to meeting national aerospace program goals and requirements."; and
- The Integrated Systems Research Program supports Outcome 3E.5, "For vehicle and propulsion technologies that simultaneously reduce fuel burn, noise, and emissions, by 2016 develop a well-informed trade space, document performance potential, and identify technical risks to a level that enables incorporation of the technologies into the design of new aircraft". Additionally, there are 13 Annual Performance Goals (APGs) linked to these five outcomes. See the performance section of this document for additional details.

Relevance to education and public benefits:

NASA's aeronautics program ensures long-term focus in fundamental research in both traditional aeronautical disciplines and relevant emerging fields for integration into multidisciplinary system-level capabilities for broad application. This approach will enable revolutionary change to both the airspace system and the aircraft that fly within it, leading to a safer, more environmentally friendly, and more efficient national air transportation system. Furthermore, ARMD will disseminate all of its research results to the widest practicable extent.

ARMD uses the NASA Research Announcement (NRA) process to foster collaborative research partnerships with the academic and private sector communities. The NRA process encourages awardees to spend time at NASA centers in order to enhance the exchange of ideas and expand the learning experience for everyone involved. Furthermore, ARMD has focused its educational activities to better attract the Nation's best and brightest students to aeronautics. These activities include design competitions and the establishment of graduate and undergraduate scholarships and internships.

Performance Achievement Highlights:

Each ARMD program made significant contributions to the advancement of aeronautics research in FY 2008.

A series of human-in-the-loop experiments that explored advanced concepts and technology for separation assurance was conducted by NASA researchers in the Airspace Systems Program in concert with San Jose State University and the Federal Aeronautics Administration. Such technology is critical to relieving air-traffic controller workload, the primary constraint on airspace capacity. At Indianapolis Center, studies examined the performance of six controllers, 20 pilots and separation-assurance automation in the face of nominal and dramatically increased traffic demand. Varying levels of automation support were provided to the controllers and pilots, including automated conflict detection, automated strategic conflict resolution and automated tactical conflict resolution. The test scenarios included routine operations and off-nominal conditions.

Within the Aviation Safety Program, the Integrated Resilient Aircraft Control project successfully designed and implemented two improved adaptive control architectures, known as Gen2A and Gen2B, addressing stability-improvement implementation barriers identified from analysis of aircraft flight tests of an initial direct adaptive control scheme. Both systems have been extensively tested in a high-fidelity, nonlinear piloted simulation and have been cleared through the airworthiness review board. Flight evaluation of the stability and performance characteristics of both designs continues.

NASA's Fundamental Aeronautics Program, in partnership with AFRL, Boeing, and Northrop Grumman, successfully completed testing of several promising powered-lift concepts, which included blowing on and active flow control of flaps, as well as increasing lifting force on an aircraft at slow speeds, such as during takeoff and landing, without increasing drag under cruise conditions. Lift performance was verified in wind tunnel tests at NASA's Langley Research Center, and flow fields characterized to validate computational fluid dynamics tools. Successful deployment of powered-lift concepts will enable short take-off and landings on 3,000-foot runways, increasing capacity through the use of shorter fields and improved low-speed maneuverability in the terminal area.

In 2008, NASA's Aeronautics Test Program (ATP) exceeded its goal of substantially reducing NASA's deferred-maintenance liability for ground test facilities through an ambitious investment project. ATP also commissioned a comprehensive, independent facility condition assessment of its ground test facilities and related infrastructure. Findings and recommendations will be factored into a new program management strategy under development.

For more information, see Sub-goal 3E in the FY 2008 Annual Performance Report at http://www.nasa.gov/pdf/301836main_291255main_NASA_FY08_Performance_and_Accountability_Report.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	Expert	10/2008	An independent assessment of NASA's aeronautics research portfolio was performed by the National Research Council (NRC) to determine how NASA is addressing the research challenges and requirements identified in the NRC Decadal Survey Of Civil Aeronautics. Their recommendations and findings are detailed in the final report, titled "NASA Aeronautics Research: An Assessment", which was released in mid 2008.	N/A

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Aviation Safety

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	66.5	89.3	60.1	59.6	59.2	61.7	62.5
Integrated Vehicle Health Management	21.5	22.2	19.8	18.2	18.3	18.9	18.9
Aircraft Aging and Durability	9.1	13.4	11.4	11.2	11.7	12.1	12.1
Integrated Resilient Aircraft Control	21.8	37.3	16.4	17.0	17.6	18.2	18.2
Integrated Intelligent Flight Deck Technologies	14.1	16.3	12.5	13.3	11.6	12.6	13.4
FY 2009 President's Budget Request	66.5	62.6	65.9	65.0	64.5	66.5	--
Integrated Vehicle Health Management	22.0	19.7	19.9	18.8	18.6	19.2	--
Aircraft Aging and Durability	10.0	10.6	11.3	11.2	12.0	12.4	--
Integrated Resilient Aircraft Control	15.3	17.1	18.5	19.0	18.2	18.8	--
Integrated Intelligent Flight Deck Technologies	19.3	15.2	16.3	16.0	15.7	16.1	--
Changes from FY 2009 Request	0.0	26.7	-5.8	-5.4	-5.3	-4.8	--

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Aviation Safety

Program Overview

By 2025, air traffic within American airspace may double or triple. Radical innovation will be required to meet such demand. The goal of the NextGen is to make passage through increasingly crowded skies efficient and speedy while maintaining or increasing safety. NextGen will achieve its mandates with state-of-the-art networking technology, continually updating its data and sharing that information with pilots and controllers. Aircraft will be able to immediately adjust to changing factors such as weather, traffic congestion, the position of other aircraft, flight trajectories and any terrestrial or airborne security concerns.

NASA's Aviation Safety Program (AvSP) helps to realize NextGen's full potential by examining concerns to further reduce risk in any complex, dynamic operating domain. AvSP's contribution ranges from providing fundamental research in known safety concerns, to working with partners to address the challenges created as we transition to NextGen, where we expect significant increases in air traffic, introduction of new vehicle concepts, continued operation of legacy vehicles, increased reliance on automation, and increased operating complexity.

Four AvSP projects are looking at hardware and software systems that will operate in the NextGen. The projects seek to provide increasing capabilities to predict and prevent safety issues, to monitor for safety issues in-flight and mitigate against them should they occur, to analyze and design safety issues out of complex system behaviors, and to constantly analyze designs and operational data for potential hazards. These technologies can be leveraged to support safety in other complex systems, such as NASA long-duration missions in space science and exploration. The program is also initiating an effort to examine key challenges in verifying and validating that flight-critical systems meet the extremely high levels of safety required for NextGen operations.

For example, the goal of AvSP's Integrated Vehicle Health Management project is to develop validated tools, technologies and techniques for automated detection, diagnosis and prognosis of adverse events that occur in flight. A second project, Integrated Intelligent Flight Deck, is pursing flight-deck-related technologies to ensure crew workload and situational awareness are both safely optimized and adapted to the NextGen operational environment.

The AvSP Integrated Resilient Aircraft Control project advances state-of-the-art designs for enhanced stability and maneuverability margins to protect against loss-of-control due to potential adverse events including atmospheric factors, actuator and sensor faults or failures, and complex damage to structures and control components. AvSP's Aircraft Aging and Durability project develops advanced capabilities for detection and mitigation of aging-related hazards before they become critical.

For more information, see http://www.aeronautics.nasa.gov/programs_avsp.htm.

Plans For FY 2010

AvSP is comprised of four projects. All four projects have developed 5-year project plans with milestones and metrics. Highlighted here are key performance deliverables for FY 2010.

Researchers in the Integrated Vehicle Health Management (IVHM) Project will demonstrate, on a representative 2008 baseline current generation electro-mechanical system testbed, improved IVHM via Bayesian methods and/or models for varying operating conditions and demonstrate fault detection/diagnosis on at least three faults types and examine tradeoff between accuracy and diagnosis time. In 2010, this technology will demonstrate (through experimentation) a 95% accuracy in diagnosing faults.

Researchers in the Aircraft Aging and Durability (AAD) Project will develop an atomistically-based model capable of predicting within 25%, the degradation caused by environmental effects on interfaces in selected polymer matrix composite materials. In 2010 the model will be used to predict within 25% the interfacial strength/toughness degradation of at least 2 resin/fiber combinations under a range of environmental exposures.

Researchers in the Integrated Resilient Aircraft Control (IRAC) Project will be developing a tool suite that provides an order of magnitude reduction in analysis time over current Monte-Carlo simulation methods that would be used to locate failure points in the flight envelope for a chosen adaptive control system and a set of adverse events. In 2010 the project will demonstrate confidence levels as good as what can be achieved using direct Monte-Carlo simulation techniques with a factor of ten reduction in computing time over direct Monte Carlo techniques.

Researchers in the Integrated Intelligent Flight Deck (IIFD) Project will deliver (through analysis) flight deck guidelines, information, and display requirements that meet NextGen operational needs as established in 2007 baseline assessment, and without a measurable increase to safety risk. In 2010, simulation studies will indicate improvements in performance, situational awareness, and workload while operating in NextGen-based environments of higher traffic densities, 4D trajectory negotiations, and Aeronautical Information Service/Meteorological Information Service datalink provisions, using advanced flight deck technologies and operations, with no degradation of safety margin over 2007 state of the art.

Project Descriptions and Explanation of Changes

Integrated Vehicle Health Management

The goal of the IVHM Project is to conduct research to advance the state of highly integrated and complex flight-critical health management technologies and systems. These technologies will enable nearly continuous onboard situational awareness of the vehicle health state for use by the flight crew, ground crew, and maintenance depot. Improved safety and reliability will be achieved by onboard systems capable of performing self-diagnostics and self-correction of anomalies that could otherwise go unattended until a critical failure occurs in structures, propulsive systems, avionics hardware, or software. A key enabling technology will be the ability for sharing and processing large amounts of information among the various vehicle subsystems to more accurately diagnose the system health state and execute the logic to self-correct any critical anomalies detected. This data mining capability can also be applied to operational data about both aircraft and airspace.

Aircraft Aging and Durability

The goal of the AAD Project is to develop advanced diagnostic and prognostic capabilities for detection and mitigation of aging-related hazards. The research and technologies to be pursued will decrease the susceptibility of current and next generation aircraft and onboard systems to premature deterioration, thus greatly improving vehicle safety and mission success. Emerging civilian and military aircraft are introducing advanced material systems, fabrication techniques, and structural configurations for which there is limited service history. There will be an emphasis in the AAD project on new material systems/fabrication techniques and the potential hazards associated with aging-related degradation. The intent is to take a proactive approach to identifying aging-related hazards before they become critical, and to develop technology and processes to incorporate aging mitigation into the design of future aircraft. Foundational research in aging science will ultimately yield multidisciplinary subsystem and system-level integrated methods for detection, prediction, and mitigation/management of aging-related hazards for future civilian and military aircraft.

Integrated Resilient Aircraft Control

The goal of the IRAC Project is to conduct research to advance our ability to model and prevent loss-of-control in flight. Taking into account the advanced automation and autonomy capabilities as envisioned by NextGen, the research will pursue methodologies to enable an aircraft to automatically detect, mitigate, and safely recover from an off-nominal condition that could lead to a loss of control. A key component of the research will be to develop technologies that would enable an aircraft control system to automatically adapt or reconfigure itself in the event of a failed or damaged component and the rigorous verification and validation of such adaptive, software-based flight-critical systems.. These adaptive control concepts will likely have applications to future space exploration missions where vehicles will be required to operate and adapt to unknown flight. Likewise, research seeks to better understand causes of upset flight conditions, including icing and structural degradation, and to plan and execute safe trajectories to landing in degraded conditions

Integrated Intelligent Flight Deck Technologies

The goal of the IIFD Project is to develop tools, methods, principles, guidelines, and technologies for revolutionary flight deck systems. In doing so, IIFD seeks to expand our ability to predict and create the comprehensive set of developments (technologies, procedures, and specifications for crew training) demanded for truly novel concepts of operation, such as those proposed for the Next Generation Air Transportation System (NextGen). Trajectories may be defined in distinctly new ways, pilots' tasks may expand to include collaboration and negotiation with other aircraft and with air traffic controllers, and may require managing large disparate sets of information to support a wide range of decisions made both individually and collaboratively. Current projections for NextGen operations also prescribe an increased use of automation, much of which will need to interact with, and support, the cognitive activities of pilots and air traffic controllers. The scope of IIFD also includes the development of a comprehensive surveillance system design that enables robust detection of external hazards with sufficient time-to-alarm for safe maneuvering to avoid the hazards. The products of the IIFD Project should enable system designers to eliminate the safety risk of unintended consequences when introducing new and advanced systems into an operational environment.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
In 2011, demonstrate self-healing material concepts to mitigate damage in structural elements	IVHM	Same
In 2012, demonstrate forecasting technology that can predict known anomalies in large data sources	IVHM	Added future commitment
Demonstrate sensors, software and guidelines that will enable implementation of onboard IVHM by 2016	IVHM	Same
In 2011, develop aging mitigation technique that demonstrates 50% improvement over the 2007 baseline	AAD	Same
Deliver validated tools and methods that enable implementation of aircraft aging mitigations by 2016	AAD	Same
In 2011, validate selected part-task simulation in NextGen-based simulator or flight environment	IIFD	The performance measures for the Program were refined in 2008
In 2012, compare test results to models of human-automation interaction concepts for NextGen	IIFD	Added future commitment
In 2016, deliver tools and flight deck technologies to enable advanced automation to support NextGen	IIFD	Same
In 2011, assess control strategies for aircraft recovery from upset stall conditions	IRAC	Same
In 2012, assess flight planning and control strategies for aircraft recovery from adverse conditions	IRAC	Added future commitment
Deliver multidisciplinary adaptive control design tools for loss-of-control and recovery by 2016	IRAC	Same

Program Management

The ARMD Associate Administrator is responsible for approval of all projects within the program. The Program Director oversees program portfolio formulation, implementation, evaluation, and integration of results with other ARMD/NASA programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Integrated Vehicle Health Management (IVHM)	Principle Investigator and Project Manager who report to the Program Director	LARC, GRC, ARC, DFRC	FAA, Joint Planning and Development Office (JPDO), Commercial Aviation Safety Team (CAST), NOAA, DoD, Moog, and Boeing
Aircraft Aging and Durability (AAD)	Principle Investigator and Project Manager who report to Program Director	LARC, GRC, ARC	FAA, CAST, DoD, Joint Council on Aging Aircraft (JCAA), Center for Rotorcraft Innovation, Alcoa, Williams International and Luna Innovations.
Integrated Intelligent Flight Deck (IIFD)	Principle Investigator and Project Manager who report to Program Director	LARC, ARC, GRC	FAA, JPDO, CAST, and Boeing
Integrated Resilient Aircraft Control (IRAC)	Principle Investigator and Project Manager who report to Program Director	LARC, DFRC, GRC, ARC	FAA, JPDO, CAST, Air Force Research Lab (AFRL) , American Kestrel Company, and Goodrich

Acquisition Strategy

The Aviation Safety Program spans research and technology from foundational research to integrated system-level capabilities. This broad spectrum necessitates the use of a wide array of acquisition tools relevant to the appropriate work awarded externally through full and open competition. Teaming among large companies, small businesses, and universities is highly encouraged for all procurement actions.

A full and open NASA Research Announcement is used as the means to solicit innovative proposals in key research areas that compliment NASA expertise. One of the main objectives of the NRA investment is to stimulate close collaboration among NASA researchers and NRA award recipients to ensure effective knowledge transfer. The AvSP will award approximately $8.0 million in FY 2010 in grants, contracts, and cooperative agreements, including renewals of multi-year awards made under previous NRAs, primarily with industry, academia and non-profit institutions. These awards will also help to strengthen the research capabilities that are of interest to NASA within the recipient organizations and institutions.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Expert Review	11/2008	The 12-month review is a formal independent peer review. Experts from other government agencies will report on their assessment of technical and programmatic risk and/or program weaknesses. Their recommendations will be received in a timely fashion and a response will be developed no later than the next quarterly review.	11/2009
Relevance	National Research Council	n/a	The review will assess whether the program: (a) has well-defined, prioritized, and appropriate research objectives; (b)is properly coordinated with the safety research programs of the Federal Aviation Administration and other relevant Federal agencies; (c)has allocated appropriate resources to each of the research objectives; and (d)has suitable mechanisms for transitioning the research results from the program into operational technologies and procedures and certification activities.	12/2009

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Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Airspace Systems

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	100.1	121.5	81.4	82.9	83.9	87.2	88.3
NextGen Concepts and Technology Development	83.3	105.3	53.3	54.5	55.3	57.8	58.7
NextGen Systems Analysis, Integration, and Evaluation	16.8	16.2	28.1	28.4	28.5	29.5	29.6
FY 2009 President's Budget Request	100.1	74.6	72.7	74.2	75.4	78.4	--
NextGen Airspace	83.3	61.3	56.0	57.3	58.5	60.8	--
NextGen Airportal	16.8	13.3	16.7	16.9	16.9	17.5	--
Changes from FY 2009 Request	0.0	46.9	8.7	8.6	8.5	8.9	--

Program Overview

The Airspace Systems Program (ASP) focuses on mastery, intellectual stewardship, and technical excellence in fundamental air traffic management research. The ASP directly addresses the air traffic management research needs of the Next Generation Air Transportation System (NextGen) in collaboration with the member agencies of the Joint Planning and Development Office (JPDO). NASA is working closely with the JPDO as well as other government, industry, and academic partners to enable the formation, development, integration, and demonstration of revolutionary concepts, capabilities, and technologies allowing significant increases in capacity, efficiency, and flexibility of the National Airspace System (NAS). These goals are in direct support of the guidelines in the National Aeronautics Research and Development Policy and Plan.

Increasing the capacity and efficiency of the air transportation system in a manner that does not negatively impact the environment or safety is critically important for the Nation's economic well-being. More than half of the Nation's busiest airports are already at capacity or will reach capacity limits in the next 10-20 years. Creating new capacity en route or on the airport surface is extraordinarily expensive and can take decades to complete, particularly if environmental constraints and safe separation standards are at issue. Specifically, environmental concerns forced 12 major commercial airports to cancel or indefinitely postpone expansion projects since the 1990s. Despite these constraints, air traffic is expected to continue to increase substantially in the next 20 years. All other factors remaining constant, increases will mean longer delays at airports already experiencing delays and create congestion delays at airports not currently experiencing any. The associated environmental impact and economic inefficiencies have been predicted by some to cost the Nation tens of billions of dollars annually. The risk of loss of aircraft separation both during airborne and ground operations could increase as the volume of air traffic exceeds the capacity of the airspace and airports to safely and efficiently accommodate the increased growth.

For more information, please see http://www.aeronautics.nasa.gov/programs_asp.htm.

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Airspace Systems

Plans For FY 2010

Beginning in FY 2010, ASP will be restructured into two new projects. Previously, the projects in ASP were the NextGen Airspace Project and the NextGen Airportal project. It was determined that the distinctions between airport operations, terminal-area operations and en-route operations were sometimes confusing, leading to time expended determining the line of demarcation between the responsibilities of the two projects. A more significant distinction is the development of air traffic management concepts and the technologies that enable air traffic management improvements and the evaluation of these concepts and technologies at a system level. Accordingly, ARMD has re-organized ASP to rename the two projects the NextGen Concepts and Technology Development project and the NextGen Systems Analysis, Integration and Evaluation project. The previously planned work on airspace concepts, technologies and systems will continue, but the project structure is now better aligned to the nature of the work being performed.

The NextGen Concepts and Technology Development Project will focus on developing capabilities in traffic flow management, dynamic airspace configuration, separation assurance, super density operations, and airport surface operations. Specifically, in FY 2010, the Project will conduct simulations of automated separation assurance subject to sequencing, spacing, and scheduling constraints. The simulations will evaluate a range of controller and pilot roles and responsibilities. Experiments will be designed with common assumptions, scenarios, uncertainty and metrics such that the experimental results generated by different concepts can be directly compared. Additionally, the Project will expand traffic flow management concepts to address weather modeling uncertainty to promote higher predictability and efficiency. In addition, in FY 2010, the Project will develop algorithms to generate robust, optimized solutions for surface traffic planning and control, and initial algorithms for airportal arrival and departure balancing. This will include evaluations of benefits in both nominal and off-nominal conditions with increased airportal traffic density and consideration of environmental constraints. The project will also determine research issues that are on a critical path to airportal metroplex capabilities. Important to all above research activities is the development of human/automation information requirements and decision making guidelines for human-human and human-machine airportal decision making.

The NextGen Systems Analysis, Integration, and Evaluation Project will focus on transition from the laboratory to the field of key systems concepts currently being pursued within the NextGen Concept and Technology Development Project (i.e., surface, terminal, transitional airspace, and en route domains) that will provide operational benefits, and demonstrate these integrated capabilities in relevant flight environments. Through systems analysis, key concepts will be down-selected based on their potential benefit towards improving operational efficiency, and then matured and tested in both fast-time and real-time full mission simulations to determine their technical viability. From this testing, a sub-set of these integrated concepts will be further demonstrated and evaluated through field tests integrating both air and ground capabilities. This work will commence in FY2010 with analysis elements, advancing over several years to culminate in relevant field experiments and demonstrations. This work will be coordinated with the FAA, the JPDO, and the Research Transition Teams of the JPDO to ensure transition of NASA concepts, technologies and procedures to the field to help enable the transition of today's air transportation system to NextGen. Detailed project planning activities are currently underway.

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Airspace Systems

Project Descriptions and Explanation of Changes

NextGen Concepts and Technology Development

The NextGen Concepts and Technology Development Project will develop and explore fundamental concepts that address the optimal allocation of ground and air automation technologies necessary for NextGen . The project will focus NASA's technical expertise and world-class facilities to address the question of where, when, how, and the extent to which automation can be applied to moving aircraft safely and efficiently through the National Airspace System (NAS) including airport surfaces. Research in this project will address Four-Dimensional Trajectory Operations, including advances in the science and applications of multi-aircraft trajectory optimization that solves the demand/capacity imbalance problem while taking into account weather information and forecast uncertainties, and keeping aircraft safely separated. The project's research will develop and test concepts for advanced traffic flow management to provide trajectory planning and execution across the spectrum of time horizons from "strategic planning" to "separation assurance." The project will also conduct research to explore dynamic airspace configuration that addresses the technical challenges of migrating from the current structured, static homogenous airspace to a dynamic, heterogeneous airspace that adapts to user demands and meets changing constraints of weather, traffic congestion, and a highly diverse aircraft fleet. Ultimately, the roles and responsibilities of humans and automation influence every technical area and will be addressed thoroughly. The Project will respond to the need to achieve the maximum possible productivity in the combined use of gates, taxiways, runways, terminal airspace, and other airportal resources. Since every airport is a unique environment, and demand is not expected to increase equally at each airport as the system grows.

Specific technical goals include:

- Increasing capacity through dynamic allocation of airspace structure and controller resources;
- Effectively allocating demand through departure-time management, route modification, adaptive speed control, etc., in the presence of uncertainty;
- Developing algorithms, automation prototypes, and procedures that relieve the capacity constraints imposed by human-controlled separation of aircraft in transition and cruise airspace;
- Quantifying the performance-enhancing effects of emerging airborne technologies;
- Optimizing surface traffic operations to enable capacity enhancements;
- Exploring transformational approaches, enabled by NextGen capabilities, for increasing airportal throughput;
- Maximizing the capacity of individual runways and multiple runways with airspace and taxi interactions (closely-spaced parallel and converging/intersecting runways);
- Minimizing runway incursion threats in all weather conditions; and
- Balancing arrival and departure traffic management to enable capacity improvements.

NextGen Systems Analysis, Integration, and Evaluation

The high-level goal of the NextGen Systems Analysis, Integration, and Evaluation Project is to conduct systems analysis, integration, and evaluation of key concepts currently being pursued within the surface, terminal, transitional airspace, and en route domains that will provide operational benefits, and demonstrate these integrated capabilities in a relevant environment. Through system analysis, key concepts will be down-selected based on their potential benefit towards increasing efficiency, and then matured and tested in both fast-time and real-time full mission simulations to determine their technical viability. From this testing, a sub-set of these integrated concepts will be further demonstrated and evaluated through field tests integrating both air and ground capabilities. To accomplish this goal, the following technical objectives will be satisfied:

- Define operational issues, factors and concerns that must be considered in conducting system analysis;
- Assess collective impact of these technologies using fast-time modeling and simulation and feed back results into the baseline program to enhance and validate research concepts;
- Examine the feasibility of the integrated concepts and technologies using human performance models and human-in-the-loop simulations;
- Demonstrate the impact of the integrated concepts and technologies using field trials;
- Assess alternate fleet implications on trajectory based operations; and
- Collaborate with industry and government partners to transition technologies that enable increases in capacity and efficiency, while maintaining safety and environmental conditions.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
In 2010, conduct simulations of automated separation assurance with sequencing, spacing, and scheduling constraints.	NextGen Concepts and Technology Development Project	Same
In 2011, evaluate Air Navigation Service Provider-based and airborne-based automated separation assurance in the presence of complex traffic, hazardous weather, and sequencing, spacing, and scheduling constraints.	NextGen Concepts and Technology Development Project	Wording change to be consistent with adjustments in program plans to align with NextGen goals
In 2011, validate initial super-density concepts including a set of culminating experiments	NextGen Systems Analysis, Integration, and Evaluation	Same
By 2016, develop future concepts, capabilities, and technologies for NextGen operations.	NextGen Concepts and Technology Development Project	Changed commitment to reflect project restructure.
In 2010, determine the feasibility and benefits of one or more candidate Multi-Sector Planner concepts.	NextGen Systems Analysis, Integration, and Evaluation	New
By 2016, develop and evaluate future airportal concepts, capabilities, and technologies	NextGen Systems Analysis, Integration, and Evaluation	Same

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Airspace Systems

Program Management

The ARMD Associate Administrator is responsible for approval of all projects within the program. The Program Director oversees Program portfolio formulation, implementation, evaluation, and integration of results with other ARMD/NASA programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
NextGen Concepts and Technology Development	Principal Investigator and Project Manager, who report to the Program Director.	ARC, LARC	FAA, JPDO, DOT, Air Force Research Lab (AFRL), Lockheed Martin, Air Services Australia and Eurocontrol
NextGen Systems Analysis, Integration, and Evaluation	Project Manager and Resources Manager, who report to the Program Director	LARC, ARC	FAA, JPDO, and DoT

Acquisition Strategy

The Airspace Systems Program spans research and technology from foundational research to integrated system capabilities. This broad spectrum necessitates the use of a wide array of acquisition tools relevant to the appropriate work awarded externally through full and open competition. Teaming among large companies, small businesses, and universities is highly encouraged for all procurement actions.

A full and open NASA Research Announcement (NRA) is used as the means to solicit innovative proposals in key research areas that complement NASA expertise. One of the main objectives of the NRA investment is to stimulate close collaboration among NASA researchers and NRA award recipients to ensure effective knowledge transfer. The Airspace Systems Program will award approximately $13.6 million in FY 2010 in grants, contracts, and cooperative agreements, primarily with industry, academia and non-profit institutions. These awards will also help strengthen the research capabilities that are of interest to NASA within the recipient organizations and institutions.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Expert Review	10/2008	The 12-month review is a formal independent peer review. Experts from other government agencies will report on their assessment of technical and programmatic risk and/or program weaknesses. Their recommendations will be received in a timely fashion and a response will be developed no later than the next quarterly review.	10/2009

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FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	269.6	307.6	228.4	230.0	233.6	239.0	245.9
Subsonic - Rotary Wing	30.8	38.9	26.1	26.1	26.3	27.4	27.9
Subsonic - Fixed Wing	119.6	155.2	101.6	103.7	105.4	107.3	110.8
Supersonics	53.0	55.6	40.6	40.0	40.7	42.0	42.8
Hypersonics	66.2	57.9	60.0	60.2	61.1	62.3	64.4
FY 2009 President's Budget Request	269.9	235.4	233.2	235.2	238.6	244.6	--
Subsonic - Rotary Wing	30.8	25.8	26.6	26.7	26.9	28.0	--
Subsonic - Fixed Wing	119.9	108.4	105.3	107.6	109.1	111.5	--
Supersonics	53.0	44.0	44.9	44.3	45.2	46.6	--
Hypersonics	66.2	57.3	56.4	56.5	57.4	58.4	--
Changes from FY 2009 Request	-0.3	72.2	-4.8	-5.2	-5.0	-5.6	--

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Fundamental Aeronautics

Program Overview

Research within NASA's Fundamental Aeronautics Program (FAP) focuses on conducting cutting edge research that addresses many of the the main problems of air transportation including concerns over noise and emissions, sustainability of affordable air travel with increasing cost and availability of jet fuel, airspace mobility to meet increasing demand for air transportation, and lack of progress towards faster means of transportation. The FAP is also dedicated to the mastery and intellectual stewardship of the core competencies of aeronautics for the Nation across all flight regimes. Research in revolutionary aircraft configurations, lighter and stronger materials, improved propulsion systems, and advanced concepts for high lift and drag reduction all target the efficiency and environmental compatibility of future air vehicles. The Program also develops physics-based, multidisciplinary design, analysis and optimization tools to enable evaluation of new vehicle designs and to assess, with known uncertainties, the potential impact of design innovations on a vehicle's overall performance. All of these advances will one day realize revolutionary improvements in noise, emissions and performance that enable a new generation of air vehicles to meet the challenges of the NextGen air transportation system.

Fundamental Aeronautics is organized around four projects that focus on research and challenges within a specific flight regime. The Subsonic Fixed Wing Project conducts research on new aircraft configurations and advanced propulsion systems that could dramatically reduce noise, emissions, fuel burn, and runway field length for a variety of subsonic fixed wing vehicles, The Subsonic Rotary Wing Project conducts research on speed and range increases, payload capacity, noise reduction, and propulsive efficiency to enable development of new rotorcraft configurations that enhance mobility of the future air transportation system. Technologies to meet the environmental challenges specifically associated with supersonic flight, such as sonic boom and gaseous emissions, are being addressed by the Supersonics Project. Elimination of these barriers will help realize practical commercial supersonic cruise vehicles that can fly over land. Finally, the Hypersonics Project focuses on long-range, fundamental and multidisciplinary research to enable new air-breathing launch vehicle architectures with more reliability for low-cost access to space.

In addition, the program is conducting planetary entry, descent and landing (EDL) research to address aeronautics-related challenges in both hypersonic and supersonic regimes. Research focusing on areas critical to EDL will result in the development of technologies and design tools that will enable landing of large payloads on other planets in support of NASA's human and robotic exploration missions.

For more information, please see http://www.aeronautics.nasa.gov/fap/

Plans For FY 2010

The Subsonic Rotary Wing (SRW) Project will demonstrate control concepts through flight simulation that will contribute to development of a flight control optimization tool for variable speed engine and transmission systems with no negative handling qualities. Current rotorcraft feature drivetrain components and main rotors which operate at nearly constant speed from hover through forward flight and current control systems are tailored to those operational attributes. Higher forward flight speeds are needed in order to make rotorcraft competitive with fixed wing aircraft for short and medium range missions in the NextGen. Higher flight speeds and optimum aerodynamic performance of main rotors from hover through forward flight require a wide variation in drivetrain and main rotor speed. This effort will explore through flight simulation the new control concepts needed to safely operate rotorcraft with such variable-speed drive systems.

The Subsonic Fixed Wing (SFW) Project will complete and validate the first generation of a multidisciplinary analysis and design toolset to evaluate the trades between noise, emissions, and performance of future aircraft. Accuracy of the toolset will be assessed by comparing predictions of noise, emissions, fuel-burn, takeoff/landing performance, and aircraft weight to known characteristics from single-aisle (B737/CFM56) and twin-aisle (B777/GE90) aircraft. The toolset will then be used to predict the performance benefits of unconventional aircraft configurations (such as hybrid wing-body) to guide the Project in development of enabling technologies for such configurations.

The Supersonics Project will develop and assess the accuracy of Computational Fluid Dynamics (CFD) tools for predicting the performance and operability of engine inlets for low-boom supersonic aircraft designed to significantly reduce the annoyance from sonic booms during flights over land. The design of engine inlets for commercial supersonic aircraft with cruise Mach numbers below Mach 2 challenges current design practice. Such inlets must not generate any large regions of separated flow since these regions create pressure distortions that impact stable engine operation. Traditional development practice is to develop and test inlets and engines separately, yet they must work in concert on the aircraft. Computational tools capable of simulating coupled inlet/engine systems, of predicting the severity of flow separations in the inlet, and predicting the impact of those separations on stable engine operation are critical enablers to the design of low-boom aircraft. This effort will assess the accuracy of such CFD tools against available data from inlet/engine tests in order to identify any deficiencies in predictive capability that requires further improvement.

The Hypersonics Project will complete CFD predictions of ramjet-to-scramjet mode-transition and compare the predictions to available wind tunnel and/or flight data. The ability to accurately predict combustor performance under mode-transition fueling levels is a key enabler for the design of reliable high-speed propulsion systems. This CFD assessment activity will validate and verify the accuracy of two CFD codes (WIND and VULCAN) against available data from X-51 wind tunnel tests and an upcoming X-51 flight test.

Project Descriptions and Explanation of Changes

Subsonic Rotary Wing

Advanced rotorcraft can alleviate the capacity problems in the air transportation system by using simultaneous, non-interfering (SNI) approaches that includes non-primary runways, taxiways, and aprons. This approach would require a large, high-speed rotorcraft configuration with capability for 300+ knots cruise. The limiting factor for the cruise speed of tiltrotors has been propeller efficiency, as the designer trades cruise efficiency for hover performance, with a speed reduction of nominally 15 percent from hover to cruise. The Subsonic Rotary Wing Project has set aggressive goals to develop technologies for a variable/multi-speed propulsion system that will enable a 50 percent reduction in main rotor rotational speed from hover to forward flight, without adverse impact on the efficiency of the propulsion system and with minimal weight penalty. Other technical issues related to a variable-speed rotor, such as dynamics, aeroelastic stability, low-frequency noise effects, and flight control, are also being addressed in the Program. In order for the rotorcraft to be able to operate from smaller airports in a metroplex concept, significant reduction of external noise will be required.

The goal of the Subsonic Rotary Wing Project is to conduct long-term, cutting-edge research in the core competencies of the subsonic rotary wing regime, thereby producing knowledge, data, capabilities, technologies, and design tools at the foundational, discipline, multidiscipline, and system levels that will enable improved prediction methods and technologies for lower noise, lower emissions, and higher performance for rotary wing aircraft. Research in the Subsonic Rotary Wing Project includes the following goals:

- Enable variable-speed rotor concepts that incorporate the ability to change rotor rotational speed by 50% without performance or handling qualities penalties to enable optimum rotor aerodynamic performance in both hover and higher forward flight speeds than currently attainable, making rotorcraft competitive with fixed wing aircraft for short and medium-range missions within the NextGen.
- Contain the external noise within the landing area and reduce internal noise by 77 dB, and develop design capabilities for low-noise rotorcraft that include the accurate calculation of blade vortex interaction noise, high-speed impulsive noise, and blade/wake interaction noise.
- Develop acoustic propagation techniques that account for atmospheric effects, terrain, and shadowing so that rotary wing vehicles can be optimized for minimal noise impact while retaining performance and handling quality standards.

Subsonic Fixed Wing

The projected growth of the air transportation system by a factor of two or three over the next 20 years will increase emissions of greenhouse gases, such as carbon dioxide (CO2), nitrogen oxide (NOX), water vapor, and particulates, and the number of people exposed to airport noise. To meet the mobility needs of the future, the Next Generation Air Transportation System (NextGen) will also rely on the expanded use of secondary and reliever airports and employ a new class of vehicles that are capable of short take-off and landing (STOL). The goal of the Subsonic Fixed Wing Project is to conduct long-term, cutting-edge research in the core competencies of the subsonic fixed wing regime, thereby producing knowledge, data, capabilities, technologies, and design tools at the foundational, discipline, multidiscipline and system levels that will enable improved prediction methods and technologies for lower noise, lower emissions (including NOx, CO2, water vapor, volatiles, unburned hydrocarbons, particulate matter, and soot), and higher performance for subsonic aircraft. Higher performance includes energy efficiency to reduce fuel burn and operability technologies that enable takeoff and landing on shorter runways. The 10-year strategy includes providing technologies, novel test methods, and validated prediction tools that can be used to improve system trades for advanced concepts capable of meeting longer-term noise, emissions, and performance targets. The following objectives address the overall project goals:

- Improvements in prediction tools and new experimental methods that provide fundamental properties and establish validation data;
- Noise prediction and reduction technologies for airframe and propulsion systems enabling -42 dB cumulative, below Stage IV (Stage IV refers to a limit imposed by the International Civil Aviation Organization on the maximum allowable noise levels for current aircraft.);
- Emissions reduction technologies and prediction tools enabling 80 percent reduction in landing and take-off NOx below the second state of regulation recommended by the Committee on Aviation Environmental Protection;
- Improved vehicle performance through design and development of lightweight, multifunctional and durable structural components, high-lift aerodynamics, and higher bypass ratio engines with efficient power plants, and advanced aircraft configurations enabling a 40 percent reduction in fuel burn as compared to the Boeing 737 with the CFM56 engine;
- Reduce field length by 50 %; and
- Multidisciplinary design and analysis tools and processes to enable design of advanced aircraft configurations with greater degree of confidence.

Since NASA does not design or manufacture aircraft that can operationally show these improvements, we will use demonstrated component technologies and system-level assessments to show that our goals could be operationally achieved.

Supersonics

Supersonic air travel has been possible for decades, but has not been commercially viable because of the significant environmental and performance challenges inherent in this speed regime including overland sonic boom annoyance, high fuel consumption, and NOx emission at high altitudes. The goal of the Supersonics Project is to conduct long-term, cutting-edge research in the core competencies of the supersonic regime, thereby producing knowledge, data, capabilities, technologies, and design tools at the foundational, discipline, multidiscipline and system levels that will address the technical challenges for supersonic vehicles.

The Supersonics Project is organized along the following major technical challenges: efficiency (supersonic cruise, light weight and durability at high temperature); environmental challenges (airport noise, sonic boom, high altitude emissions); performance challenges (aero-propulso-servo-elastic analysis and design, cruise lift/drag ratio); and multidisciplinary design, analysis and optimization challenges.

The Supersonics Project will develop technologies to enable overland supersonic cruise with civilian and military applications at acceptable environmental impacts (no greater than subsonic fixed wing aircraft). Research in the Supersonics Project includes the following 10-year goals:

- Cruise efficiency improvements in the airframe and propulsion system leading to approximately 30 percent improvement in aircraft range factor vs. the final NASA High-Speed Research (HSR) Program baseline;
- Approximately 15 EPNdB (effective perceived noise, in decibels) of jet noise reduction relative to an unsuppressed jet;
- A reduction of loudness on the order of 30 PLdB (perceived loudness, in decibels) relative to typical military aircraft sonic booms;
- Elimination or minimized impact from high-altitude missions.

Hypersonics

The Hypersonics Project is motivated by the fact that all access to Earth or planetary orbit, and all entry from orbit into Earth's atmosphere or any planet with an atmosphere, requires flight through the hypersonic regime. The goal of the project is to conduct long-term, cutting-edge research in the core competencies of the hypersonic regime, thereby producing knowledge, data, capabilities, and design tools at the foundational, discipline, multidiscipline, and system levels that will address the technical challenges for two high-payoff NASA-unique missions: Highly Reliable Reusable Launch Systems (HRRLS) and High-Mass Mars Entry Systems (HMMES).

Cutting-edge hypersonics research on HRRLS will enable sustained hypersonic flight through the atmosphere with space-access applications. The research focused on HMMES will result in the development of technologies and concepts that can enable the safe and accurate delivery of large payloads to the surface of Mars. This effort will facilitate the entry, descent, and landing (EDL) phase of both human and robotic planetary missions and is closely aligned with the long-term goals of NASA's space exploration activities.

The Hypersonics Project will focus its research on addressing some of the hardest challenges in hypersonics including:

- The development of materials for airframe and propulsion applications that can withstand the severe temperatures encountered in hypersonic flight for extended periods of time;
- The development of predictive models for compressible flow, turbulence, heating, ablation, combustion, and their interactions in order to reduce the uncertainty in predictions of aerodynamic heat loads during the design of hypersonic vehicles, with the benefit of lower vehicle weight resulting from reduced design margins for thermal structures and thermal protection systems;
- Realizable propulsion systems that operate efficiently over a very wide speed range by integrating high-speed turbine engines or rockets and scramjets; and
- Tying together all of the close interactions among the airframe, inlet, nozzle, and propulsion systems using a physics-based multidisciplinary design analysis and optimization approach.

The HRRLS mission class will provide new air-breathing launch vehicle architectures with increased reliability such as Two-Stage-to-Orbit Turbine-Based Combined-Cycle systems to eventually enable routine low-cost access to space. The HMMES mission research will push technology beyond the state of the art in hypersonic atmospheric entry to successfully land payloads on Mars with masses up to two orders of magnitude greater than is practically realizable today. The emphasis will be on concepts for reduced weight, atmospheric maneuverability, and safety.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
In 2010 finish suite of integrated multidisciplinary analysis tools to predict aircraft performance	Subsonics Fixed Wing	Same
By 2011 develop an integrated tool set to accurately predict performance of subsonic aircraft	Subsonics Fixed Wing	Same
In 2010 demonstrate through flight simulation a control optimization tool to control a variable speed engine & transmission	Subsonics Rotary Wing	Wording change to be consistent with current program plans.
In 2011 validate the ability to predict the effects of active rotor systems for level flight	Subsonics Rotary Wing	Same
By 2012 demonstrate a rotor concept incorporating the ability to change rotor speed without penalty	Subsonics Rotary Wing	Same
In 2010 develop computational models to predict integrated inlet and fan performance and operability	Supersonics	Same
In 2011 use a design optimization study to show a 2-week MDAO cycle time for cruise efficiency	Supersonics	Same
By 2013 develop framework for analysis and design of supersonic aircraft that are efficient with low noise and emissions	Supersonics	Added words for clarification. Commitment is the same.
In 2010 complete CFD predictions of ramjet-to-scramjet mode-transition, compare to test data from supersonic wind tunnel tests	Hypersonics	Same
In 2011 evaluate accuracy of models by comparing CFD prediction with test data from wind tunnel hardware	Hypersonics	Same
In 2011 validate combustor wall thermal-structural performance and critical failure modes	Hypersonics	Same
In 2012 develop simulation tool with accuracy to enable highly reliable reusable launch systems	Hypersonics	Same

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Fundamental Aeronautics

Program Management

The ARMD Associate Administrator is responsible for approval of all projects within the FA Program. The Program Director oversees Program portfolio formulation, implementation, evaluation, and integration of results with other ARMD/NASA programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Subsonics Fixed Wing	Principal Investigator and Project Manager who report to the Program Director	ARC, DFRC, GRC, LaRC	Air Force Research Lab (AFRL), Boeing, Pratt & Whitney, Northrop Grumman, A.R. Associates, ENrG Inc., General Electric Aviation, Gulfstream Aerospace, and United Technologies Corporation
Subsonics Rotary Wing	Principal Investigator and Project Manager who report to the Program Director	ARC, GRC, LaRC	U.S. Army, U.S. Air Force, U.S. Navy, Center for Rotorcraft Innovation (CRI), Bell Helicopter, Sikorsky, ZFL, Helowerks, Inc., Boeing, DARPA, FAA, Polyumac, Technocore, and Gulfstream Aerospace
Supersonics	Principal Investigator and Project Manager who report to the Program Director	ARC, DFRC, GRC, LaRC	Gulfstream Aerospace, Lockheed Martin, AFRL, Aerion Corporation and DARPA
Hypersonics	Principal Investigator and Project Manager who report to the Program Director	ARC, DFRC, GRC, LaRC	AFRL, U.S. Air Force Office of Scientific Research (AFOSR), U. S. Navy, Deputy Undersecretary of Defense for Science and Technology, DARPA, ATK, and Dover ILC

Acquisition Strategy

Acquisitions within the program provide the basic elements for fundamental research, tools and methods development, enabling technologies, and validation and verification of research results. This broad spectrum necessitates the use of a wide array of acquisition tools relevant to the appropriate work awarded externally through full and open competition. Teaming among large companies, small businesses, and universities is highly encouraged for all procurement actions.

A full and open NASA Research Announcement (NRA) is used as the means to solicit innovative proposals in key research areas that compliment NASA expertise. One of the main objectives of the NRA investment is to stimulate close collaboration among NASA researchers and NRA award recipients to ensure effective knowledge transfer. The Fundamental Aeronautics Program will award approximately $40.0 million in FY 2010 in grants, contracts, and cooperative agreements, primarily with industry, academia and non-profit institutions. These awards will also help to strengthen the research capabilities that are of interest to NASA within the recipient organizations and institutions.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Expert Review	11/2008	The 12-month review is a formal independent peer review. Experts from other government agencies will report on their assessment of technical and programmatic risk and/or program weaknesses. Their recommendations will be received in a timely fashion and a response will be developed no later than the next quarterly review.	11/2009

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Aeronautics Test Program

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	75.1	131.6	74.7	77.1	77.2	76.6	78.7
Aero Ground Test Facilities	50.0	100.0	48.6	50.1	50.2	49.8	51.2
Flight Operations and Test Infrastructure	25.1	31.6	26.1	27.0	27.0	26.8	27.5
FY 2009 President's Budget Request	75.1	73.9	75.8	78.0	78.2	78.2	--
Aero Ground Test Facilities	50.0	48.2	49.4	50.8	51.0	51.0	--
Flight Operations and Test Infrastructure	25.1	25.6	26.4	27.2	27.2	27.2	--
Changes from FY 2009 Request	0.0	57.7	-1.1	-0.9	-1.0	-1.6	--

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Aeronautics Test Program

Program Overview

NASA's Aeronautics Test Program (ATP) was created to preserve and promote the testing capabilities of one of the largest, most versatile, and comprehensive set of research facilities in the world. Ames Research Center, Dryden Flight Research Center, Glenn Research Center and Langley Research Center operate ATP facilities that provide an extensive array of services in their respective areas of expertise.

ATP offers government agencies, corporations, and academic institutions unmatched basic and applied research and experimental opportunities that reflect four generations of accumulated aerospace skill and experience. ATP is built upon a nationwide team of highly trained and skilled staff whose backgrounds and education encompass every aspect of aerospace testing and engineering.

ATP was instituted in FY 2006, as an element of the Strategic Capabilities Assets Program (SCAP) but funded by and officially reporting through ARMD, to establish corporate management of NASA's aeronautics ground test facilities. The goals were to optimize the utilization of NASA's wind tunnels and air-breathing propulsion for efficiency and cost effectiveness, to sustain and improve NASA's core capabilities, and to ensure that a minimum core capability was maintained.

In FY 2007, the Western Aeronautical Test Range (WATR), Support Aircraft, Test Bed Aircraft, and the Simulation and Loads Laboratories at the Dryden Flight Research Center were added to ATP.

ATP is a long-term, funded commitment by NASA to retain and invest in test capabilities that are considered to be important to the agency and the Nation. Through ATP, NASA will adopt consistent processes and procedures across all agency research centers for operations and maintenance of the major wind tunnels/ground test facilities and flight operations/test infrastructure.

Looking to the future, ATP will move to the next phase of program maturity through the implementation of a new strategic plan that will have three thrusts: (1) provide vision and leadership for the use of ATP assets in meeting national goals; (2) provide sustained financial support for workforce, capability improvements, test technology development, maintenance, mothballing, and divestiture; and, (3) provide strategic planning, management, and coordination within NASA and between NASA and other government and industry stakeholders. This strategic plan will guide ATP investments and will provide the vision for how the ATP can fully support the current and long-term missions of NASA, the Department of Defense, and American aerospace industry.

For more information, see http://www.aeronautics.nasa.gov/atp.

Plans For FY 2010

As part of ATP's continuous efforts to improve facility operational efficiencies, the ATP-sponsored National Strain Gage Balance Team completed a technical review and concluded that NASA's capability to utilize strain gage balances in wind tunnel testing has severely eroded. These instruments are critical since they are required to measure model forces and moments while simultaneously holding the model in the wind tunnel. Implementation of the National Force Measurement Technology Capability (NFMTC), a multi-year project to address gaps and deficiencies in the Government and industry's state-of-the-art strain gage balance technology capability, began in FY 2009, and the NFMTC will achieve continuous, collaborative operations across NASA and the Air Force's Arnold Engineering and Development Center (AEDC) in FY 2010.

In FY 2009, ATP completed a comprehensive assessment of the current condition and reliability of ATP facilities and their ability to meet current and future (five-year horizon) ground test requirements. The assessment identified a set of facility projects that should be executed to ensure availability and operational status and, from this set, a five-year investment project schedule for each facility was developed. In FY 2010, ATP will start implementing these recommended recapitalization and maintenance projects.

In its first three years, ATP was intentionally tactical in nature, and investments were focused primarily on stabilizing aeronautics test facility condition, charge rates, and workforce competency. In FY 2009, ATP will complete and implement a new strategic plan that will have three main thrusts: (1) provide vision and leadership for the use of ATP assets in meeting national goals; (2) provide sustained financial support for workforce, capability improvements, test technology development, maintenance, mothballing, and divestiture; and, (3) provide strategic planning, management, and coordination within NASA and between NASA and other government and industry stakeholders. This strategic plan will also guide the recapitalization and maintenance investments, starting in FY 2010, identified through the comprehensive facility assessment.

In collaboration with the National Partnership for Aeronautical Testing (NPAT), ATP initiated an assessment of the Nation's hypersonic wind tunnel capabilities in FY09 and will initiate an assessment of the Nation's subsonic wind tunnel capabilities in FY10. These assessments will identify wind tunnels in both speed regimes that are critical to the Nation, and therefore will require continued investment. Wind tunnels that are not critical will become candidates for consolidation.

In 2010, the ATP will continue to implement its Flight Operations Test Infrastructure investment strategy. Usage rates for flight test assets will be established at the beginning of the fiscal year to recover the required infrastructure investment funds.

Also, ATP will conduct and participate in several significant meetings and collaborative activities, including quarterly reviews with the NASA Research Centers (ARC, DFRC, GRC, and LaRC) and the Air Force's AEDC and semi-annual meetings with the NPAT.

Project Descriptions and Explanation of Changes

Aero Ground Test Facilities

The Aero Ground Test Facilities project is made up of different classes of facilities including low speed wind tunnels, transonic wind tunnels, supersonic wind tunnels, and hypersonic wind tunnels. The project includes four primary efforts to support the long term viability of the facilities and to continually improve on the efficiency and effectiveness of operations. These efforts include:

- Facility Operations Support which provides a portion of the facility fixed costs for ground test facilities to ensure facility and staff availability and user price stability;

- Facility Maintenance and Upgrades which provides funding for maintenance and upgrades that correct known deficiencies in facility safety, reliability, and productivity and enables the facilities to meet near-term and future testing requirements. These activities will result in improved facility productivity and reduced operational cost;

- Facility Test Technology which provides funding to develop and implement new technologies that increase test capability, improve productivity and efficiency, and improve data quality; and

- Facility Related Research whose activities are competed openly with a strong desire to involve universities with experimental work in major facilities. It is anticipated that one or more ATP assets will be utilized to develop technologies that will support either the facility operation or the other ARMD research programs.

Flight Operations and Test Infrastructure

The Flight Operations and Test Infrastructure Project is made up of an integrated set of elements consisting of the Western Aeronautical Test Range (WATR), support aircraft maintenance and operations, and testbed aircraft that provide the resources required for research flight and mission support projects. The goal is to provide up to 100 percent of the facility fixed costs for these flight facilities to ensure facility and staff availability and user price stability.

The project also includes the Simulation and Flight Loads Laboratories, a suite of ground based laboratories that support research flight and mission operations. The goal is to provide up to 20 percent of the fixed costs for labs to ensure facility and staff availability and user price stability.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
In 2010-2012, deliver at least 96% of on-time availability for operations and research facilities	Aero Ground Test Facilities Project	Same

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Aeronautics Test Program

Program Management

The ARMD Associate Administrator is responsible for approval of all projects within the program. The Program Director oversees program portfolio formulation, implementation, evaluation, and integration of results with other ARMD/NASA programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Aero Ground Test Facilities	Senior managers of ATP facilities at ARC, LaRC, & GRC have key implementation responsibilities	ARC, GRC, and LaRC	DoD and Boeing
Flight Operations and Test Infrastructure Project	Senior managers of ATP facilities at DFRC have key implementation responsibilities	DFRC	DoD

Acquisition Strategy

Acquisitions supporting ATP activity will be performed at each of the test sites consistent with the Federal Acquisition Regulation (FAR) and the NASA FAR Supplement (NFS). Each Center will be responsible for coordinating major acquisitions supporting ATP activities through the ATP Office as required by the ATP Director. Acquisitions that support the ATP facilities are usually less than $0.5 million and are initiated as early in the fiscal year as possible. This is inclusive of the annual NASA Research Announcement (NRA) activities within ARMD. These acquisitions are executed at the Center level, and the resulting contracts are subject to open competition and are typically fixed price, fixed fee. Larger ATP acquisitions are typically facility investments, and the funds are usually converted to Construction of Facilities (CoF) funds.

A full and open NASA Research Announcement (NRA) is used to solicit innovative proposals in key research areas that complement NASA expertise. One of the main objectives of the NRA investment is to stimulate close collaboration among NASA researchers and NRA award recipients to ensure effective knowledge transfer. The ATP will award approximately $2.0 million in FY 2010 in grants, contracts, and cooperative agreements, primarily with industry, academia, and non-profit institutions. These awards will also help to strengthen the research capabilities that are of interest to NASA within the recipient organizations and institutions.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	Expert Review	09/2008	Periodic reviews are carried out by the NASA Advisory Council (NAC) and the U.S. users of ATP facilities. The last ATP review was carried out by the Aeronautics Committee of the NAC in Feb. 2007; no major findings were reported. The last major community outreach meeting was held in September 2008 with NASA, DoD and U.S. aerospace industry users. The next meeting with the ATP users is planned for March 2010.	03/2010
Performance	Expert Review	11/2008	The 12-month review is a formal independent peer review. Experts from other government agencies will report on their assessment of technical and programmatic risk and/or program weaknesses. Their recommendations will be received in a timely fashion and a response will be developed no later than the next quarterly review.	11/2009

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Integrated Systems Research

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	0.0	0.0	62.4	64.4	67.1	64.4	60.5
Environmentally Responsible Aviation Project	0.0	0.0	62.4	64.4	67.1	64.4	60.5
Changes from FY 2009 Request	0.0	0.0	62.4	64.4	67.1	64.4	--

Program Overview

As the number of flight operations at many of the largest airports in the Nation continues to increase, environmental concerns over noise and emissions will limit the capacity of those airports, and therefore limit the capacity of the entire system. Recently, several recommendations have been issued to NASA by the National Research Council and the NASA Advisory Council. These recommendations cite the need for NASA to develop vehicle technologies to decrease the significant environmental impacts of the aviation system. These recommendations clearly point out the need for NASA to take the initiative to conduct system research and experiments of promising vehicle concepts and technologies that will simultaneously reduce fuel burn, noise and emissions.

The Integrated Systems Research Program (ISRP), a new program effort beginning in FY10, has been organized to support the Environmentally Responsible Aviation (ERA) Project and will take an integrated system-level approach to reduce the environmental impact of aviation (in terms of noise, local and global emissions, and local air quality) in the area of air vehicle technologies. As the NextGen evolves to meet the projected growth in demand for air transportation, the environmental impacts of noise and emissions are a growing concern and could limit the ability of the system to accommodate growth. The integrated system-level research in this program will be coordinated with on-going long-term, foundational research within the three other research programs, and will focus specifically on maturing and integrating technologies in major vehicle systems and subsystems for accelerated transition to practical application.

Plans For FY 2010

The Integrated Systems Research Program will use enhanced measurement capability in the Langley 14x22 Low Speed Wind Tunnel to investigate the ability of a Hybrid Wing Body (HWB) aircraft architecture to shield aircraft engine noise during simulated takeoff and approach conditions. The program will develop combustor concepts that offer the potential of reducing NOx emissions levels below those attainable with current technologies. Propulsion and airframe integration issues and the trade-off between acoustic and fuel burn performance of ultra-high bypass and open-rotor propulsion systems will be explored in the 9x15 Propulsion Wind Tunnel at Glenn by mounting Ultra-High Bypass (UHB) and open-rotor models in close proximity to simulated pylons and aircraft surfaces. Natural laminar flow wind tunnel models and hybrid laminar flow flight test articles will be fabricated for use in exploring the ability to maintain laminar flow at flight Reynolds number as a means of reducing aircraft drag and thereby improving fuel burn. The program will also award a NASA Research Announcement (NRA) in FY 2010 to conduct N + 2 (the generation beyond the next generation aircraft) vehicle systems-studies in order to assess the potential benefits that technologies within the existing research programs can contribute toward simultaneously reducing aircraft noise, emissions, and fuel burn. The NRA will also identify additional technologies that should be considered for further maturation and develop enabling technology roadmaps to further inform ISRP investment decisions.

Project Descriptions and Explanation of Changes

Environmentally Responsible Aviation (ERA)

The goal of the ERA project is to explore and document the feasibility, benefits, and technical risks of vehicle concepts and enabling technologies identified to have the potential to mitigate the impact of aviation on the environment. Through system-level analysis, promising N+2 vehicle and propulsion concepts and technologies will be down-selected based on their potential benefit towards simultaneously reducing fuel burn, noise and emissions. These concepts and technologies will then be matured and their performance will be evaluated at the system and sub-system level in relevant environments. Among the technologies to be explored are the following:

- Non-conventional aircraft architectures that enable reduced drag and shielding of propulsion system noise
- Drag reduction through laminar flow
- Advanced composite structural concepts for weight reduction
- Low NOx combustors
- Propulsion and airframe integration for noise reduction and fuel burn improvements

The ERA project will expand the well-informed design trade space for these types of technologies. The project will transfer knowledge outward to the aeronautics community so that aircraft and propulsion system manufacturers can confidently transition these technologies into new products. The project will transfer knowledge inward to the Fundamental Aeronautics Program so that concepts and technologies which do not yield predicted performance benefits can be further investigated and developed at a foundational level in order to mature to their full potential benefit.

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Integrated Systems Research

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
In FY 2010, award a NRA to conduct N+2 vehicle systems-studies.	Environmentally Responsible Aviation Project	New

Program Management

The ARMD Associate Administrator is responsible for approval of all projects within the program. The Program Director oversees program portfolio formulation, implementation, evaluation, and integration of results with other NASA or ARMD programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Environmentally Responsible Aviation	Project Manager and Resources Manager, who report to the Program Director	ARC, DFRC, GRC, and LaRC	None

Acquisition Strategy

The Integrated Systems Research Program will develop and further mature promising technologies to the integrated system-level. This necessitates the use of a wide array of acquisition tools relevant to the appropriate work awarded externally through full and open competition. Teaming among large companies, small businesses, and universities is highly encouraged for all procurement actions.

A full and open NASA Research Announcement (NRA) is used as the means to solicit innovative proposals in key research areas that complement NASA expertise. One of the main objectives of the NRA investment is to stimulate close collaboration among NASA researchers and NRA award recipients to ensure effective knowledge transfer. The Integrated Systems Research Program will award approximately $10 million in FY 2010 in grants, contracts, and cooperative agreements, primarily with industry, academia and non-profit institutions. These awards will also help strengthen the research capabilities that are of interest to NASA within the recipient organizations and institutions.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	Subject Matter Experts	N/A	The National Research Council of the National Academies is convening a meeting of experts to review NASA's plans for system-level research in Environmentally Responsible Aviation. The purpose of the review is for NASA to collect comments and observations from subject matter experts in the areas of aviation operations, vehicles and environmental impact. NASA will consider the comments and observations it receives in future refinement of its plans.	05/2009
Performance	Expert Review	N/A	The 12-month review is a formal independent peer review. Experts from other government agencies will report on their assessment of technical and programmatic risk and/or program weaknesses. Their recommendations will be received in a timely fashion and a response will be developed no later than the next quarterly review.	11/2010

Overview

Five years ago, NASA took on the challenge of reshaping America's leadership in human space exploration by implementing a robust policy to advance the Nation's scientific, security, and economic interests. Reigniting the public's engagement in this bold endeavor, the Agency set out once again to leave low Earth orbit, and is developing the capabilities required to take humans to the Moon, other near-Earth destinations, and eventually to Mars.

During the six Apollo lunar landings, we spent a total of 39 days on the lunar surface. With the International Space Station, we have over ten years experience supporting crews for up to six months at a time, relying on a significant infrastructure, with deliveries of supplies, in low Earth orbit. NASA will eventually develop capabilities to sustain humans beyond low Earth orbit for long periods. Our return to the Moon may be for stays of up to six months, conducting surface operations, learning how to "live off the land", testing new technologies including life support systems, and exploring the lunar surface. The farther we travel beyond the Moon, the more complex the operation, and the more self-sufficient we need to become. Each step will be used to demonstrate capabilities that will increase our capacity to travel beyond Earth and its Moon. These activities combine to form a necessary step in our preparation to explore new worlds.

The Exploration Systems Mission Directorate (ESMD) is leading this effort by forging new capabilities for sustained and affordable human and robotic missions. Within ESMD, two themes encompass the mandate for a new architecture to transport humans into space, as well as the technology development and human research to make it possible. The Constellation Systems Theme focuses on developing NASA's next generation of human exploration spacecraft designed to carry crew and cargo to low Earth orbit in the near term, and then beyond. Also within Constellation Systems, NASA has begun an important partnership with industry via the Commercial Crew and Cargo Program, aimed at spurring private industry to provide cost-effective cargo and crew delivery to the International Space Station (ISS) and expanding the commercial technology sector, while allowing NASA to focus its internal resources on exploration.

The second Theme, Advanced Capabilities, focuses on two essential areas: Human Research, and Exploration Technology Development. The Lunar Reconnaissance Orbiter (LRO) project, ESMD's first step in returning humans to the Moon, was also developed within this Theme. Advanced Capabilities activity reduces the cost and risk of human exploration by mapping potential lunar landing sites, developing and testing critical technologies, and conducting research to increase our understanding of the effects of space on human performance.

Summer 2009 Review of Human Space Flight Activities

In order for the United States to maintain and advance its international leadership in space, NASA will initiate an independent review of ongoing U.S. human space flight development activities as well as alternatives to ensure that the Nation is pursuing the best solution for future human space flight – one that is safe, innovative, sustainable and affordable. The review will develop suitable options for consideration by the Administration regarding a U.S.-led human space flight architecture.

The review will be led by an independent, blue-ribbon team of experts who will work closely with a NASA team. This independent review will provide options and supporting analyses to involved Administration agencies and offices in sufficient time to support an August 2009 decision on the way forward.

The review will evaluate the status and capabilities of the agency's current human space flight development program, as well as other potential architectures. It will examine the capabilities of these architectures (including supporting R&D and complementary robotic activities) to support the International Space Station and exploration missions and will consider options to extend International Space Station operations beyond 2016. The review will address international cooperation and account for US industrial base considerations and US competitiveness implications. The architectures assessed will fit within the current exploration budget topline and not rely upon extending Space Shuttle operations.

Following the human spaceflight review, the Administration will provide an updated request for Exploration activities reflecting the review's results. FY 2010 and outyear funding levels for Exploration activities shown in this document represent the budget request if there were no changes to ongoing activities.

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010*	FY 2011*	FY 2012*	FY 2013*	FY 2014*
FY 2010 President's Budget Request	**3,299.4**	**3,905.5**	**3,963.1**	**6,076.6**	**6,028.5**	**5,966.5**	**6,195.3**
Constellation Systems	2,675.9	3,433.2	3,505.4	5,543.3	5,472.0	5,407.6	5,602.6
Program Integration and Ops	610.4	645.5	642.5	1,423.9	1,405.4	1,501.5	1,813.9
Orion Crew Exploration Vehicle	889.5	1,387.2	1,383.5	1,938.9	2,056.1	1,931.0	1,751.7
Ares I Crew Launch Vehicle	1,030.5	1,067.4	1,415.4	2,143.3	1,985.5	1,950.1	2,012.0
Ares V Cargo Launch Vehicle	15.0	30.0	25.0	25.0	25.0	25.0	25.0
Commercial Crew and Cargo	130.5	303.0	39.1	12.2	-	-	-
Advanced Capabilities	623.5	472.3	457.7	533.3	556.5	558.9	592.7
Human Research Program	149.6	151.9	151.5	151.9	157.4	161.4	166.2
Exploration Technology Develop.	286.9	264.1	287.0	381.2	399.0	397.5	426.5
Lunar Precursor Robotic Pgm	187.1	56.3	19.1	0.2	0.1		
FY 2009 President's Budget Request	**3,143.1**	**3,500.5**	**3,737.7**	**7,048.2**	**7,116.8**	**7,666.8**	**-**
Constellation Systems	2,471.9	3,048.2	3,252.8	6,479.5	6,521.4	7,080.5	-
Advanced Capabilities	671.1	452.3	484.9	568.7	595.5	586.3	-
Total Change from FY2009 President's Budget Request	**156.3**	**405.0**	**225.4**	**-971.6**	**-1,088.3**	**-1,700.3**	

***Following the human spaceflight review, the Administration will provide an updated request for Exploration activities reflecting the review's results. FY 2010 and outyear funding levels for Exploration activities shown here represent the budget request if there were no changes to ongoing activities.**

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems

Theme Overview

The Constellation Systems Theme, consisting of the Constellation Systems Program and the Commercial Crew and Cargo Program, aims to develop capabilities to transport humans to the Moon and back, as well as to low Earth orbit, in a sustainable, safe, and affordable manner as the U.S. prepares for future missions to Mars and other destinations.

Within the Constellation Program are four major project budgets: the Orion crew exploration vehicle, the Ares I launch vehicle designed to lift Orion to low Earth orbit, the Ares V launch vehicle to propel crew and support systems out of low Earth orbit, and Program Integration and Operations, which includes the systems to support ground and mission operations, extravehicular activity, a lunar lander, and lunar surface systems.

After the Space Shuttle retires in 2010, resupply missions to the International Space Station will still be required. NASA's Commercial Crew and Cargo Program is in place to encourage private sector development of a cost-effective, U.S. commercial space transportation capability. At present, the Agency has two funded Space Act Agreement (SAA) partners: Space Exploration Technologies Corporation (SpaceX) of Hawthorne, CA, and Orbital Sciences Corporation of Dulles, VA, as well as unfunded SAA partnerships with PlanetSpace of Chicago, IL and SpaceDev of Poway, CA.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

The U.S. Space Exploration Policy (NP-2004-01-334-HQ) commits the Nation to extend human presence across the solar system, starting with a human return to the Moon by the year 2020, in preparation for human exploration of Mars and other destinations. Congress then enacted the NASA Authorization Act of 2005 (P.L. 109-155), providing that the Agency "shall establish a program to develop a sustained human presence on the Moon, including a robust precursor program, to promote exploration, science, commerce, and United States preeminence in space, and as a stepping-stone to future exploration of Mars and other destinations."

The Commercial Space Act of 1998 was implemented to stimulate the development of a commercial space industry in the United States. NASA's Commercial Crew and Cargo Program accomplishes this by awarding pre-determined funding for specific commercial demonstrations. Encouraging the growth of a new competitive market will help reduce launch costs and provide the Nation with safe, reliable and economical service to low Earth orbit.

Relevance to the NASA Mission and Strategic Goals:

By developing new space transportation capabilities and supporting systems for human missions to the Moon and other destinations, NASA continues to pioneer the future of space exploration and scientific discovery. Specifically, through development of Orion and Ares I, the Constellation Program supports NASA Strategic Goal 4: "Bring a new Crew Exploration Vehicle into service as soon as possible after Shuttle retirement."

NASA's Commercial Orbital Transportation Services (COTS) project is an investment by NASA to spur development of a cost-effective, U.S. commercial capability to carry cargo to the ISS, with future options for transporting crew. The Commercial Crew and Cargo Program directly supports NASA Strategic Goal 5: "Encourage the pursuit of appropriate partnerships with the emerging commercial space sector." See FY 2010 Performance Plan, under Management and Performance, for specific annual goals for this Theme.

Relevance to education and public benefits:

As it has throughout NASA's history, human presence in space will continue to serve as a public symbol of the Nation's leadership in space exploration. The Agency's renewed efforts to leave low Earth orbit, and to explore the Moon and other destinations, will accelerate the development of technologies critical to the economy and national security, while providing a training ground for the next generation of scientists and engineers. Through existing contracts, NASA's exploration initiatives continue to nurture a strong aerospace industry; by enabling emerging enterprises to achieve commercial viability, U.S. technology sectors will expand, providing opportunities that will inspire the Nation's youth to pursue careers in science, technology, engineering, and mathematics.

Performance Achievements Highlights:

During FY 2008, Constellation concluded intensive reviews to determine whether defined requirements of key system elements were adequate to begin the design phase. Some hardware has now transitioned into hardware fabrication and test, including parachute, wind tunnel, and engine component testing. Ares I completed integrated launch vehicle design reviews in September, and the upper stage engine (J-2X) passed Critical Design Review, authorizing fabrication. Orion completed manufacture of the crew module for the first pad test of the launch abort system.

Constellation also completed a lunar capability concept review to capture performance and cargo requirements of the lunar transportation system, the Ares V launch vehicle, and a lunar lander. The team considered five options for lunar surface systems, including surface elements, operations concepts, and nuclear and solar power systems. The review was carried out in parallel with Ares V and lander vehicle development, allowing real-time design refinement for the lunar outpost, including habitats, rovers, and other systems needed to live on the Moon for extended periods.

J-2X tests continued to support upper stage engine development for Ares I and the Ares V Earth departure stage. In addition, Orion and Ares performed parachute drop tests in Yuma, AZ, and Orion initiated component testing of the launch abort system, successfully firing the jettison motor at the Aerojet facility in Sacramento, CA. Hardware manufacturing for Orion's first pad abort test was completed to meet a 2009 test launch. The Ares I-X demonstration flight is also on track to meet a mid-2009 launch, with hardware delivery to Kennedy Space Center underway.

Major facility construction activity also took place, including launch control center firing room one renovation, and work on a new test stand needed to verify J-2X engine performance at altitude conditions. NASA has also begun renovation of the dynamic test stand to support the Ares I ground vibration test.

The Commercial Crew and Cargo Program also made significant progress in 2008. SpaceX achieved all milestones on time, including successful completion of major design reviews for the first two missions, first stage integrated engine testing in November, and manufacture of the Dragon capsule qualification unit to support qualification in late 2008, early 2009. Activation of the Cape Canaveral launch site also progressed, with installation of primary ground systems required to support launch.

Also in 2008, NASA entered into a funded SAA with Orbital Sciences Corporation, following a competitive selection process. Orbital completed major readiness and design reviews between June and October.

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Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Constellation Systems Program

Program Overview

The U.S. Space Exploration Policy calls for a sustained and affordable exploration program to explore the solar system, including a return to the Moon by the end of the next decade, to establish a human presence there, and to open the path to other destinations including Mars. NASA's exploration activity is now in a period of transition, as the Agency works to complete the International Space Station and retire the Shuttle fleet by 2010, while developing the next generation of spacecraft to support human space flight.

The Constellation Program is developing and testing a set of space exploration systems that includes the Orion crew exploration vehicle, the Ares I launch vehicle that is intended to propel Orion to low Earth orbit, and the Ares V, which is intended to carry a lunar lander to low Earth orbit to dock with Orion and deliver the crew and cargo to the Moon. These vehicle designs were conceived during the FY 2005 Exploration Systems Architecture Study, and have continued to undergo refinement as plans for a new space exploration transportation system take shape.

For more information see http://www.nasa.gov/exploration/home/index.html

Project Descriptions and Explanation of Changes

The Constellation Program budget for FY 2010 is divided into four major funding areas: Program Integration and Operations, Orion, Ares I, and Ares V. No major configuration changes have taken place since the FY 2009 request, except as specifically noted.

Program Integration and Operations

Additional project activity is carried within the Program Integration and Operations budget, including development of ground and mission operations, extravehicular activity systems, the lunar lander, and lunar surface systems.

Ground operations systems provide support to vehicle processing, mission planning, crew training, launch, flight control, and crew and return vehicle recovery. Systems include launch site ground processing, integrated testing, logistics services, and launch services for Orion, Ares I, Ares V, lunar lander, and cargo; post landing, recovery and de-integration services for the Orion crew module and cargo, including search and rescue; and Orion refurbishment and maintenance. Also included are post-landing and recovery services for the Ares I first stage and Ares V boosters, as well as facilities, equipment, and software required to perform these tasks.

Mission operations systems include the mission control center in Houston and its interfaces with the flight systems for flight operations; crew and flight controller training facilities; mission planning and flight design tools; personnel for planning, training, and flight operations; and mission operations facilities development and maintenance.

The extravehicular activity (EVA) system and flight crew equipment provide the elements necessary to protect crew members, allowing them to work effectively in pressure and thermal environments that exceed human capability. EVA includes the pressure suits, life support systems, umbilicals, tools and mobility aids, vehicle interfaces, servicing equipment, suit avionics, individual crew survival equipment, and ground support systems. Flight crew equipment includes items interior to the spacecraft for use by the crew, such as restraint and mobility aids, tools, and stowage items.

Orion Crew Exploration Vehicle

The Orion Project (currently in formulation) is responsible for developing NASA's next-generation piloted spacecraft. For missions to the Moon, Orion is designed to carry up to four astronauts to low Earth orbit, where it will link up with a lunar lander for the trip to lunar orbit. It also will be capable of ferrying up to four astronauts (plus additional cargo) to and from the International Space Station (ISS). Orion consists of a crew module, a service module, a spacecraft adapter, and a launch abort system, which will transport crew and cargo to orbit and back, and also serve as a crew rescue vehicle while docked at the ISS. The Orion spacecraft will be used in all phases of the Program.

Additional detail can be found in the Orion Crew Exploration Vehicle Project section of this document.

Ares I Crew Launch Vehicle

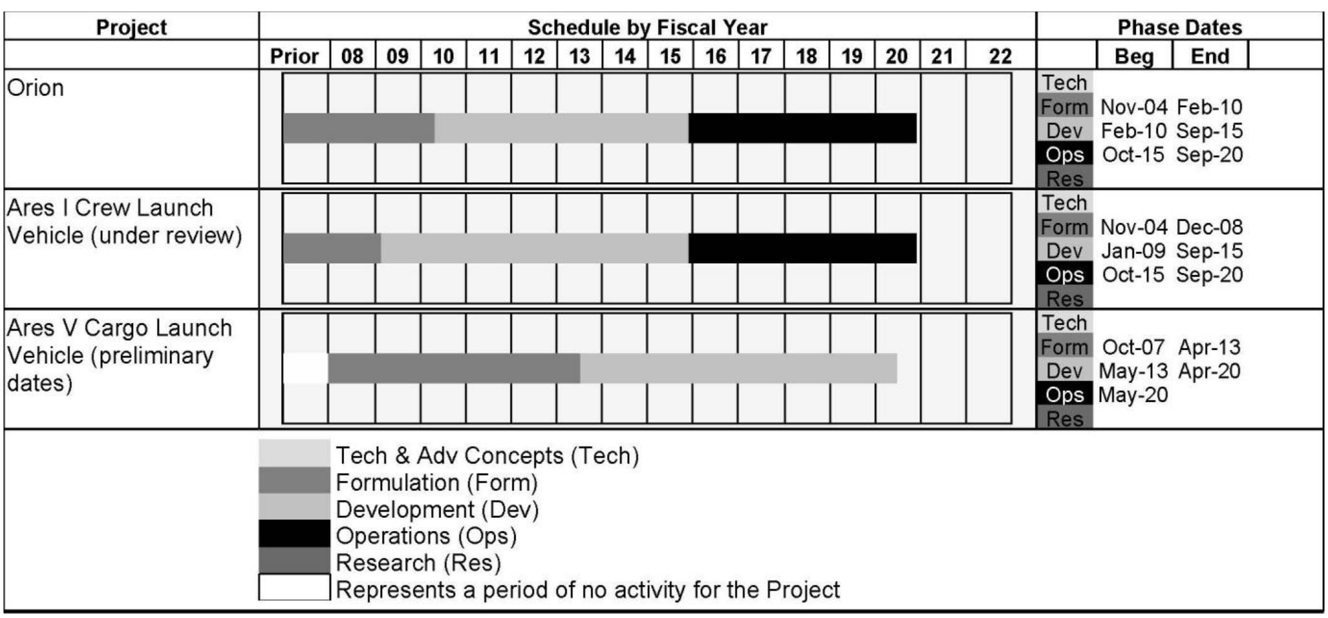
The mission of the Ares I (currently in formulation) is to deliver a safe, reliable, and affordable launch system that supports the Nation's space exploration goals. Ares I is the launch vehicle for Orion, and provides transportation to low Earth orbit. It consists of a 5-segment solid rocket booster first stage, and a cryogenic liquid hydrogen/oxygen fueled upper stage, consisting of a structural tank assembly and a J-2X engine. The first stage is reusable, and the upper stage is discarded after Orion has separated during ascent. Ares I will deliver crew to the International Space Station and to low Earth orbit for missions to the Moon.

Additional detail can be found in the Ares I Crew Launch Vehicle Project section of this document.

Ares V Cargo Launch Vehicle

Ares V (currently in formulation) is designed to provide the heavy lift capability for the Constellation architecture. The vehicle consists of a 6-engine core stage, two five-and-half segment solid rocket boosters, and an Earth departure stage (EDS) powered by a restartable J-2X engine. The EDS serves as the vehicle's second stage, and is key to injecting the lunar lander and EDS stack into the low Earth orbit staging for rendezvous and dock with Orion. After the EDS performs the trans-lunar Injection burn for the lander and Orion, it will be jettisoned.

Implementation Schedule



Program Management

Projects within the Constellation Program reside at Johnson Space Center (Orion, extra-vehicular activity, mission operations), Marshall Space Flight Center (Ares I and Ares V) and Kennedy Space Center (ground operations). Program management responsibility is located at Johnson Space Center.

Acquisition Strategy

Constellation's implementation approach is based on the Agency's goal to balance competition with the health of NASA institutions. Competition is used as a tool to promote best approaches and solutions, and to encourage innovation and efficiency, with the constraint that competition should not undercut the essential competency of the NASA organization.

The acquisition strategy for Constellation includes a combination of sole source and full and open competition opportunities; the overall goal, however, is to maximize competition whenever possible. To date, the only sole source contracts awarded are related to the Ares I project, which include development activities for the reusable solid rocket motor first stage and J-2X upper stage engine. These sole source contracts were awarded because no other providers were available for the capabilities identified by NASA. For example, ATK-Thiokol was awarded the Ares I first stage contract because they are the only provider in the Nation that can manufacture solid rocket motors of the size needed for the Ares I. The J-2X sole source contract was awarded to Pratt Whitney Rocketdyne, because they are the designers of the J-2 and J-2S engines from which the J-2X evolves.

All other contracting activities for Constellation have been, and will be, awarded through full and open competition. Competitive contracts awarded to date include the Orion development contract to Lockheed Martin, the manufacturing contract for the Ares I upper stage to the Boeing Company, and the Ares I upper stage instrument unit avionics production contract to the Boeing Company. The extravehicular activity systems contract will be awarded by mid-2009 through full and open competition. The Program continues to develop its integrated acquisition strategy for ground and mission operations projects, as well as the follow-on production contracts for Orion and Ares I, and development contracts for lunar capability.

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Constellation Systems Program
Project in Formulation:	Orion Crew Exploration Vehicle

Project Purpose

For missions to the Moon, Orion will carry up to four astronauts to low Earth orbit, where it will link up with a lunar surface access module for the trip to lunar orbit. The access module will descend to the Moon's surface while Orion orbits, awaiting its return. At the conclusion of the surface mission, the two vehicles will rendezvous and Orion will transport the astronauts back to Earth, where the capsule will re-enter the atmosphere and descend on parachutes.

Orion will also have the capability to service the International Space Station (ISS). The vehicle will be capable of transporting up to four crew to and from the ISS, and remaining docked for up to six months as a rescue return vehicle.

For more information, please visit:
http://www.nasa.gov/mission_pages/constellation/orion/index.html

Project Preliminary Parameters

Orion will be a five meter-diameter vehicle, capable of transporting four astronauts to the Moon and to the ISS, then returning them safely to Earth. The combined crew and service modules will provide power, life support, and propulsion for rendezvous, orbit correction, and de-orbit. In the event of a launch mishap, a launch abort system will separate the crew module from the launch vehicle and deliver the crew to safety. A thermal protection system will protect the crew during re-entry, and the vehicle is designed to provide for a safe landing nominally on water, and for contingencies on land.

Estimated Project Deliverables

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
Crew Module	Lockheed-Martin (Prime Contractor Selected August 2006)	Piloted vehicle	Crew of 6 to ISS	Crew of 4 to ISS
Service Module	Lockheed-Martin (Prime Contractor Selected August 2006)	Provides power, propulsion, and other support services for the Crew Module	same	same
Launch Abort System	Lockheed-Martin (Prime Contractor Selected August 2006)	Separates Crew Module from launch vehicle in the event of a launch mishap	same	same

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Constellation Systems Program
Project in Formulation:	Orion Crew Exploration Vehicle

Estimated Project Schedules

Preliminary design review for Orion is planned for the 4th quarter of FY 2009.

Project Management

Orion is managed by the Orion Project Office located at Johnson Space Center in Houston, Texas, with support from Langley Research Center in Virginia and Glenn Research Center in Ohio.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Crew Module	Orion Project Office and Crew Module Office, JSC	JSC	None
Service Module	Orion Project Office and Crew Module Office, JSC; Service Module Office, GRC	GRC	None
Launch Abort System	Orion Project Office, JSC; Launch Abort System Office, LaRC	LaRC	None

Acquisition Strategy

The contract for Schedule A Orion design, development, test, and evaluation was awarded to Lockheed Martin in August 2006. Optional Schedules B and C, for additional production, sustaining engineering and lunar development, are also part of the contract. Lockheed Martin's subcontractors include Hamilton Sundstrand, Honeywell, Orbital Sciences Corporation, and United Space Alliance.

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Constellation Systems Program
Project in Formulation:	Ares I Crew Launch Vehicle

Project Purpose

The mission of the Ares I project is to deliver a safe, reliable, and affordable crew launch system that expands America's scientific reach through space exploration, dedicated to enabling human trips to the Moon, Mars and other destinations beyond low Earth orbit. An integral part of the Constellation Program, Ares I is currently scheduled for operation no later than 2015.

Ares I is designed to provide the launch capability for a versatile transportation system to carry crew to low Earth orbit for exploration missions to the Moon and other destinations in the solar system, as well as delivering crew and cargo to the International Space Station after the Shuttle retirement. The Ares I design utilizes NASA heritage systems, with a modified Space Shuttle solid rocket booster as the first stage, and a clean sheet design upper stage, using a J-2X engine derived from the J-2, which was flown on the Saturn launch vehicle.

During the first two minutes of flight, the first stage booster will power the vehicle to an altitude of about 190,000 feet and a speed of Mach 5.7. After its propellant is spent, the reusable booster will separate, and the upper stage's J-2X engine with 294,000 pounds of thrust, will ignite and power the crew vehicle to an altitude of ~80.6 miles. At that point, the upper stage will separate, and Orion's service module propulsion system will complete the trip to a circular orbit.

For more information, please visit:
http://www.nasa.gov/mission_pages/constellation/ares/aresI/index.html

Project Preliminary Parameters

The Ares I is a two-stage series-burn launch vehicle with interfaces for the Orion capsule and the ground systems at the launch site. Ares I hardware elements include the first stage, upper stage, and upper stage engine. The first stage is a 5-segment reusable solid rocket motor that utilizes polybutadiene acrylonitrile propellant. The second, or upper stage, is a self-supporting cylindrical system that houses the liquid oxygen and liquid hydrogen tanks that feed propellant to the J-2X engine, along with the vehicle's avionics, roll control, and the upper stage thrust vector control system.

Ares I will be able to lift an estimated 50,000 pounds to low Earth orbit for International Space Station (ISS) missions, and 56,000 pounds for exploration missions. Utilizing Constellation's Orion/Ares I configuration will provide a significant improvement in crew safety relative to the Space Shuttle, due to its in-line design and launch abort system for crew escape.

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Constellation Systems Program
Project in Formulation:	Ares I Crew Launch Vehicle

Estimated Project Deliverables

The Ares I project is intended to address Constellation Program requirements by developing safe, affordable, and sustainable launch systems to support human exploration missions. The initial operational capability for Ares I is currently scheduled for no later than March 2015, with the first unmanned test flight planned no earlier than August 2009.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
Vehicle Integration (VI)	NASA (Gov't-led)	Systems Engineering & Integration (SE&I) function for the Ares I Project	Integrated Vehicle Systems Engineering & Integration (SE&I)	Integrated Vehicle Systems Engineering & Integration (SE&I)
First Stage	ATK-Thiokol	Initial phase of the launch ascent configuration	Ares 1-X motor, 2 demonstration motors (DMs), 2 qualification motors 3 flight test motors	Added DM 3 and DM 4 to DDT&E contract
Upper Stage engine	Pratt & Whitney Rocketdyne	Propulsion source for second phase of the launch ascent configuration	6 development engines, 2 certification engines	Added 38 sea level tests, 27 altitude tests,1 test eng, 4 sets of long lead h/w, & 1 unassembled eng
Upper Stage	NASA-led design/Boeing production	Ares I second stage propellant tank and support systems (MPS, avionics, etc.)	Includes 3 test flight units, 6 flight units, & up to 4 additional flight units/year in yrs 2014-16	Additional Roll Control System Support
Flight and Integrated Test	NASA (Gov't-led)	Includes activation and test development capabilities required to test Ares system	Includes Integrated Vehicle Ground Vibration Test, managing Ares Projects activities for Ares I-X	Includes Integrated Vehicle Ground Vibration Test, managing Ares Projs activities for Ares I-X

Estimated Project Schedule

The Ares I project was authorized to proceed in September 2005; the Preliminary design Review was conducted in August, 2008. Critical Design Review is planned for March 2011.

Mission Directorate: Exploration Systems
Theme: Constellation Systems
Program: Constellation Systems Program
Project in Formulation: Ares I Crew Launch Vehicle

Project Management

The Ares I Project Office located at the Marshall Space Flight Center in Huntsville, AL has project management responsibility for Ares I.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Vehicle Integration	Ares Project Office at Marshall Space Flight Center	Marshall Space Flight Center	None
First Stage	Ares Project Office at Marshall Space Flight Center	Marshall Space Flight Center	None
Upper Stage	Ares Project Office at Marshall Space Flight Center	Marshall Space Flight Center	None
Upper Stage Engine	Ares Project Office at Marshall Space Flight Center	Marshall Space Flight Center	None
Flight and Integrated Test	Ares Project Office at Marshall Space Flight Center	Marshall Space Flight Center	None

Acquisition Strategy

The Ares I launch vehicle will be developed using a combination of NASA and contractor effort. NASA is responsible for overall Ares I vehicle integration, while individual element strategies and responsibilities are outlined below.

The first stage, derived from the Space Shuttle reusable solid rocket motor, was selected as a non-competitive acquisition, performed by Alliant Techsystems Inc. under a cost plus award fee contract.

J-2X upper stage engine was selected as a non-competitive acquisition, performed by Pratt & Whitney Rocketdyne under a cost plus award fee contract. The J-2X predecessors from which the J2X will be derived (J-2 and J-2S, designed and built by Pratt & Whitney) are the exclusive property of NASA. The Agency's decision to select the J-2X engine in effect selected the contractor as well.

NASA's Marshall Space Flight Center leads the team responsible for upper stage design, development, test and evaluation (DDT&E) efforts and, therefore, owns the upper stage design. Additionally, NASA is designing the instrument unit and is responsible for DDT&E efforts related to Ares I avionics. The instrument unit avionics production and the upper stage production were awarded via full and open competition to the Boeing Company; both contracts are cost plus award fee.

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Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Commercial Crew Cargo

Program Overview

One of NASA's strategic goals is to encourage the pursuit of appropriate partnerships with the emerging commercial space sector. The Agency's major activity in this area is the Commercial Orbital Transportation Services (COTS) effort, overseen by the Commercial Crew and Cargo Program. Rather than developing a system that could be operated by NASA or its contractors, this Program is aimed at encouraging the development of commercial space transportation services and an associated market, with multiple suppliers and customers. NASA would be one of these customers, purchasing transportation services on the open market.

This effort is being executed in two phases. The first is a period of private industry development and demonstration of the various space transportation capabilities to and from low Earth orbit determined to be most desirable for government and other customers. During this phase, NASA is providing $500 million of seed capital and technical assistance to promising space firms via funded and unfunded Space Act Agreements (SAA) to stimulate the commercial space transportation market. These COTS partners are to demonstrate capabilities that can be used for ISS resupply: Capability A, delivery of unpressurized cargo; Capability B, delivery of pressurized cargo; and Capability C, delivery and return of cargo to and from orbit. The second phase is a competitive procurement of orbital transportation services to supply ISS, and is the responsibility of the Space Operations Mission Directorate. In addition, with Recovery act funding in FY 2009, NASA initiated development activities to enable future commercial crew launches to the ISS.

The Space Act Agreements NASA has in place with the COTS partners are written to maximize the flexibility of private development efforts. Partners are paid when the Agency certifies that they have passed a series of discrete developmental milestones; if they fail to make progress, they are not paid. Government requirements are kept to a minimum, and are only concerned with assuring safe interaction with the ISS. The partners are not required to follow the standard NASA Program and Project Management Processes and Requirements, NPR 7120.5. Rather, the relationship is intended to encourage innovation and allow partners to use alternatives to the standard NASA program management approaches, while still being held accountable for safety and ISS visiting vehicle requirements that NASA would impose were that partner being utilized for commercial transportation services.

In addition to providing a conduit for funding, the Commercial Crew and Cargo Program coordinates the COTS Advisory Team, made up of over 100 technical experts located throughout NASA. Funded and unfunded partners can utilize these experts as necessary; if a partner requires extensive assistance, NASA helps them arrange reimbursable agreements with NASA centers to acquire the expertise they need.

Plans for FY 2010

SpaceX is currently planning to perform demonstration missions 2 and 3 during FY 2010, aimed at validating their capability to provide cargo transportation to and from the ISS. Orbital is planning to start service module and launch vehicle assembly during FY 2010, with a demonstration flight scheduled for FY 2011. If all goes according to the current schedule for both partners, NASA will have commercial cargo resupply capability to the Space Station.

In FY 2010, the Program will continue to execute the funded Space Act Agreements signed with

SpaceX in August 2006 and Orbital Sciences Corporation in February 2008, and the unfunded agreements signed in FY 2007 and subsequent. Currently, there is no budget or final acquisition strategy for Capability D (crew transport). However NASA will be applying Recovery Act funds to stimulate efforts within the private sector to develop and demonstrate human spaceflight capabilities. The activities supported through Recovery Act funding will help support enhanced technical activities to meet current objectives and milestones, which include development of commercial crew transportation enabling technologies and capabilities, acceleration of the ISS docking system and communications interface, testing and enhancement of cargo launch systems to improve reliability of commercial crew capabilities, and human rating requirements development.

Project Descriptions and Explanation of Changes

Commercial Orbital Transportation Services (COTS)

The Commercial Orbital Transportation Services (COTS) partner agreements are not projects by the standard NASA definition of the term, but individual firms that have entered into Space Act Agreements with the Agency. "Funded partners" are those receiving progress payments and technical assistance from NASA, while "unfunded partners" receive technical assistance, but are not paid.

NASA's funded COTS partners are SpaceX, of Hawthorne CA, and Orbital Sciences Corporation of Dulles, VA.

SpaceX is developing new launch vehicles with the goal of providing reliable, globally cost competitive U.S. space transportation capabilities. Their Falcon 9 launch vehicle is an evolution of their clean sheet design of the Falcon 1 launch vehicle. Their "Dragon" spacecraft and launch vehicle are being designed for either cargo or crew transport. Both launch vehicle and spacecraft offer flexible configurations based on mission requirements, and are currently planned to be recoverable for refurbishment and reuse. SpaceX has chosen Cape Canaveral's launch complex 40 as the site for their launches, with the first ISS demonstration flight planned for completion by May 2010. For Phase 1, SpaceX will demonstrate cargo transportation Capabilities A-C. Additionally, SpaceX currently has an unfunded SAA option to demonstrate Capability D.

Orbital Sciences Corporation is developing a launch system concept comprised of a Taurus II launch vehicle, a new medium class booster using two Aerojet AJ-26 engines and an ATK Castor 30 second stage. Taking advantage of heritage systems, Orbital will use a standard service module derived from the STAR and Dawn spacecraft for all missions and the pressurized cargo module will be based on the ISS multi-purpose logistics module. The Wallops Flight Facility will serve as Orbital's launch site for an ISS demonstration flight, currently scheduled for March 2011. For Phase 1, Orbital will demonstrate cargo transportation Capability B.

In addition, NASA has unfunded Space Act Agreements with PlanetSpace of Chicago, IL and SpaceDev of Poway, CA.

Mission Directorate:	Exploration Systems
Theme:	Constellation Systems
Program:	Commercial Crew Cargo

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Two successful demonstration flights by SpaceX for unpressurized and pressurized cargo.	COTS Projects	Realignment of SpaceX Demo Flight Milestones; Addition of Orbital Sciences as the second funded partner

Program Management

The Commercial Crew & Cargo Program Office (C3PO), located at the Johnson Space Center, is responsible for implementing the Program in support of the U.S. Space Exploration Policy.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Commercial Crew & Cargo COTS Partners	Johnson Space Center will manage the effort	Technical support from all NASA centers as needed	Funded partners: SpaceX and Orbital Sciences Corporation. Unfunded SAAs signed with: SpaceDev, and Planetspace.

Acquisition Strategy

The Commercial Crew and Cargo Program is being implemented through the COTS projects in two phases. The first is being carried out via Space Act Agreements (SAA), while the second will employ standard NASA procurements. The Agency is using its Space Act authority to enter into the funded agreements, which will result in Earth-to-orbit space flight demonstrations of any combination of the following capabilities:

- Capability A: External (unpressurized) cargo delivery and disposal
- Capability B: Internal (pressurized) cargo delivery and disposal
- Capability C: Internal (pressurized) cargo delivery and return

Demonstrations will culminate in cargo transportation missions to/from the ISS.

SAAs with the funded COTS partners are different from traditional NASA development contracts, as they are firm fixed-price arrangements providing a detailed record of pre-negotiated performance milestones and fixed payment schedule to be made upon successful completion of each milestone. Failure to meet a milestone can lead to termination of the SAA, after consultation with the partner. Unfunded partners have similar relationships and agreements with NASA, but do not receive milestone payments. They participate through the COTS Advisory Team in order to draw on NASA technical knowledge, and the Agency acknowledges their progress.

NASA also has an option to exercise a Capability D, which would consist of one or more missions to low Earth orbit and the ISS as necessary to satisfy the Agency's human rating requirements for future NASA crew transportation missions. While this option is not currently funded, NASA will be applying Recovery Act funds to stimulate efforts within the private sector to develop and demonstrate human spaceflight capabilities. The activities supported through Recovery Act funding will help support enhanced technical activities to meet current objectives and milestones, which include development of commercial crew transportation enabling technologies and capabilities, acceleration of the ISS docking system and communications interface, testing and enhancement of cargo launch systems to improve reliability of commercial crew capabilities, and human rating requirements development..

Theme Overview

The Advanced Capabilities Theme is composed of Exploration Technology Development (ETDP), Human Research (HRP), and the Lunar Precursor Robotics Program (LPRP). Effort within these programs is geared to provide advanced technologies and knowledge to implement the U.S. Space Exploration Policy through the use of ground and space flight activities.

ETDP provides new technologies that will enable NASA to conduct future human missions and reduce risk and lifecycle cost. Primary customers for this effort are the designers and developers of flight systems in the Constellation Program. ETDP investments reduce the risk of infusing new technologies into flight projects by maturing them to the level of demonstration in a relevant environment, in time to support the Preliminary Design Review of the target flight system.

HRP investigates and mitigates the highest risks to astronaut health and performance in support of NASA exploration missions. The Program's primary goal is to develop and provide human health and performance countermeasures, knowledge, technologies, and tools to enable safe, reliable and productive human space exploration.

LPRP includes the Lunar Reconnaissance Orbiter (LRO) and Lunar Crater Observing and Sensing Satellite (LCROSS) spacecraft, which are scheduled to launch in June 2009. LRO's topographic mapping, resource identification and mapping, and radiation characterization is important to Constellation efforts to return humans to the Moon by 2020. Data from these activities will be integrated by a lunar mapping and modeling activity and will support astronaut safety, landing site selection, and engineering requirements for lunar surface hardware. LCROSS will gather information about volatiles, possibly including water ice, in permanently shadowed polar craters.

Relevance

Relevance to national priorities, relevant fields, and customer needs:
In accordance with the U.S. Space Exploration Policy (NP-2004-01-334-HQ), the Advanced Capabilities Theme provides the knowledge, technology, and innovation that will enable current and future exploration missions. As astronauts journey to the Moon and beyond, they will be exposed to microgravity, radiation, and isolation for long periods of time. Keeping crews physically and mentally healthy and productive during such long-duration missions will require new technologies and capabilities. NASA studies how the space environment, close quarters, heavy workloads, and long periods of time away from home contribute to physical and psychological stresses, and will develop technologies that can prevent or mitigate these effects. The Agency pursues innovative ways to meet the basic needs of oxygen, water, food, and shelter with exploration systems that can operate dependably for weeks on the Moon, and eventually, for months on Mars.

The Advanced Capabilities Theme uses the International Space Station (ISS) as a research and technology demonstration location, supporting ISS's designation as a national laboratory. NASA leverages the microgravity environment of the facility to conduct human, life and microgravity research, demonstrate countermeasures to maintain human health and performance during exploration missions, and demonstrate vital technologies in the space environment.

Relevance to the NASA Mission and Strategic Goals:
Advanced Capabilities activity supports NASA's mission to pioneer the future in space exploration and scientific discovery by acquiring new and vital knowledge and by identifying, developing, and transitioning new technologies that enable the systems concepts and capabilities needed to expand and sustain human presence in space. The Advanced Capabilities Theme supports the following Agency Strategic Goals:

Strategic Goal 2: "Complete the International Space Station in a manner consistent with NASA's International Partner commitments and the needs of human exploration". The Advanced Capabilities Theme supports this goal with continued delivery and operation of scientific payloads and research facilities on the ISS in order to conduct biological and physical research support.

Strategic Goal 3: "Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration." Activities in the areas of life support, environmental monitoring, and ground and flight research, which help reduce the probability and consequences of adverse human health effects for long-duration space missions, support this goal.

Strategic Goal 4: "Bring a new Crew Exploration Vehicle into service as soon as possible after shuttle retirement." Efforts related to thermal protection systems, carbon dioxide and moisture removal amine system technology, and development of habitability standards support Goal 4.

Strategic Goal 6: "Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations." ESMD supports this goal by developing the LRO and LCROSS to provide information about potential human exploration sites on the Moon.

See FY 2010 Performance Plan, under Management and Performance, for specific annual goals for this Theme.

Relevance to education and public benefits:

Programs within the Advanced Capabilities Theme support educational outreach activity at K-12, undergraduate, and graduate levels. NASA's Fit Explorer project trains students (in grades 3 through 5) like astronauts by completing physical activities modeled after the real-life physical requirements of humans traveling in space. Students track their progress while recording goals, data, experiences and observations in a journal. Students also gain an understanding of the science behind nutrition and physical fitness by participating in structured hands-on activities that relate physical Earth-based needs to the requirements of exploring space. By providing ideas for Space Grant and Graduate Student Research Programs, NASA promotes educational opportunities for students at colleges and universities across the nation.

To implement these programs, NASA will leverage the expertise of academia, government agencies, and industry to carry out research and development efforts. By advancing diverse, novel technologies through projects with non-traditional research partners, small businesses and others, public benefits will include new technologies such as power generation, communications, computing, robotics, and improved materials from space exploration research and execution for industry and general public use.

In addition, HRP will further advance medical knowledge and diagnostic and treatment technologies NASA uses to keep humans healthy and productive in space, improving the medical treatment and health of humans on Earth. Research into human adaptation to microgravity has helped scientists better understand changes that come with aging, such as bone loss, muscle atrophy, and loss of balance. NASA-developed telemedicine technologies that help doctors on Earth monitor and treat astronauts in space through computer-assisted imaging and diagnostics, video, and telecommunications, will help deliver quality medical care to people in underserved areas of the world.

Performance Achievement Highlights:

Programs within the Advanced Capabilities Theme accomplished significant milestones in FY08. The HRP reduced the probability and consequences to the health of humans in long-term space environment exposure for the following biomedical risks: inability to adequately treat an ill or injured crew member; compromised EVA performance and crew health due to inadequate EVA suit systems; inadequate nutrition; and, space radiation exposure. As part of an operational evaluation, renal stone countermeasure experiments have been completed on the ISS and reports published at the ISS science website. The final report for NASA internal use was delivered in September 2008. HRP also completed the EVA human-suit interface requirements to avoid biomechanical injury, support metabolic thermal load, and minimize risk of decompression sickness; an Antarctic study on efficacy of vitamin D supplementation in an Antarctic ground analog of space flight; development of computational tools and models to assess crew exploration vehicle design for radiation protection; and, the risk model for acute radiation sickness.

The LRO project successfully met the critical milestones for the performance period. Both the LRO and LCROSS spacecraft have been delivered to the launch site and are on-track for June 2009 launch.

ETDP demonstrated a proof-of-concept small pressurized rover for transporting astronauts. Spacesuits attached to exterior of rover cabin via suit-port interface allowed crew to perform rapid EVA. The Program also performed end-to-end testing of two proof-of-concept in-situ resource utilization (ISRU) systems for producing oxygen from lunar regolith which allowed for a systems level demonstration of the excavation, mobility and the reactor systems. The Scarab rover with on-board sampling drill and ISRU package designed to prospect for ice in lunar craters was also used as a part of this test.

ETDP tested a deep throttling liquid hydrogen-liquid oxygen rocket engine for the lunar lander descent stage, as well as performed a human-in-the-loop test of the prototype carbon dioxide and moisture removal system for Orion. Development of this system for both moisture and carbon dioxide removal eliminates the need for a condensing heat exchanger. A flash lidar sensor for autonomous landing and hazard avoidance system was tested on a helicopter.

The Program also launched the "electronic nose" instrument for monitoring atmospheric contaminants as an example of development and deployment of advanced monitoring technologies on the ISS. Additional activity included delivery of the combustion integrated rack microgravity research facility to the ISS, offering the capability to conduct fundamental and applied research in combustion sciences.

For more information, see Strategic Goals 2, 3 (Sub-goal 3F), 4 and 6 in the FY 2008 Annual Performance Report, included in this budget.

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Human Research Program

Program Overview

The Human Research Program (HRP) is focused on investigating and mitigating the highest risks to human health and performance to enable safe, reliable, and productive human space exploration. Documents developed by the Exploration Systems Mission Directorate and Constellation Program provide mission architecture definitions, mission concepts of operations, vehicle, habitat, and space suit performance requirements, and other technical information needed to focus HRP efforts for specific exploration missions. HRP conducts research, develops countermeasures, and undertakes technology development to inform and support compliance with NASA's health, medical, human performance, and environmental standards.

HRP activities are designed to:

-Develop capabilities, necessary countermeasures, and technologies in support of human space exploration, focusing on mitigating the highest risks to crew health and performance.

-Enable the definition and improvement of human spaceflight medical, environmental, and human factors standards.

-Develop technologies that serve to reduce medical and environmental risks, to reduce human systems resource requirements (mass, volume, power, data, etc.) and to ensure effective human-system integration across exploration mission systems.

-Ensure maintenance of Agency core competencies necessary to enable risk reduction in the areas of space medicine; physiological and behavioral effects of long duration spaceflight on the human body; space environmental effects, including radiation, on human health and performance; and space human factors.

This Program supports performance goals that will: deliver a Human Interface Design Handbook for use in designing exploration vehicles; deliver and publish an initial version of the acute radiation risk projection model for lunar missions; and deliver a device for launch to the ISS to test the technology of producing medical grade water on a spacecraft.

For more information, please see http://humanresearch.jsc.nasa.gov.

Plans for FY 2010

The ISS Medical Project (ISSMP) will provide planning, integration, and implementation services for HRP research tasks and evaluation activities requiring access to space or related flight resources on the ISS, Shuttle, Soyuz, Progress, or other spaceflight vehicles and platforms. It will support experiments during six-crew operation, develop alternative sample preservation techniques to reduce downmass requirements, and enable cooperative science with Russian collaborators.

The Research Infusion projects will continue using the NASA Space Radiation Laboratory at Brookhaven National Lab to evaluate the increased risk of cancer as a function of age, age at exposure, radiation quality, latency, and gender. These efforts will support more accurate prediction of risks and facilitate longer stays in space. In addition, space radiation research will increase efforts to evaluate central nervous system and degenerative tissue risks as well as develop computational tools to project health risks and evaluate vehicle designs for radiation protection.

Ongoing technology activity will allow NASA to meet the level of care standards for space exploration missions including: medical kit requirements, medical-grade water production system, ventilation system that uses cabin oxygen instead of stored oxygen, capability to analyze blood and saliva-borne biomarkers, and tools for medical decision-making during exploration missions. Ground based analog models will be used to optimize human systems performance in the design of the Orion crew vehicle and other exploration systems; develop a permissible exposure limit for lunar dust, and develop food-packaging systems to ensure safe storage and delivery of food on long-term missions.

HRP will also use ground-based analog and ISS flight-based studies to evaluate contributing factors to health or performance degradation, errors, or failures during critical mission operations. These studies will evaluate sleep loss and circadian rhythm, medication side effects, fatigue, team cohesion, and training protocols. Additional studies will be performed to reduce both the crew health risks during exploration missions and long-term health risks afterward, including cardiac structure and function, stability of pharmaceuticals and nutrients in a space environment, development of a food system that meets all nutrition requirements for long-duration missions, and bone demineralization monitoring techniques.

The Program will also release two joint NASA/ National Space Biomedical Research Institute (NSBRI) research solicitations in support of space exploration, focused on health effects from space radiation and human physiological changes associated with exploration. NSBRI will also implement approximately sixty exploration-focused research grants.

Project Descriptions and Explanation of Changes

Research Infusion

Activities within the Research Infusion projects include: space radiation; behavioral health and performance; exploration medical capability; space human factors and habitability; human health countermeasures; and, program science management/ NSBRI.

Anti-oxidants represent a potential countermeasure for several human risks as documented in the research plan. Based on a focused anti-oxidant workshop, HRP funding has been leveraged by working with NIH through a joint anti-oxidant research solicitation. To facilitate negotiations and collaboration on a joint NIH/NASA anti-oxidant solicitation in 2010, funding to support human health countermeasures was required.

ISS Medical Project

The ISSMP includes current ISS biomedical research capabilities and on-orbit validation of next generation on-orbit equipment, medical operations, procedures, and crew training concepts.

Efficient and effective utilization of the ISS is essential in meeting the objectives of the HRP. Activity in this area supports experiments during six-crew operation, develops alternative sample preservation techniques to reduce downmass requirements, and enables cooperative science with Russian collaborators.

Program Management

The Program is managed by the Human Research program office, located at the Johnson Space Center (JSC) in Houston, Texas.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Research Infusion	Human Research Program Office - JSC	JSC, LRC, ARC, GRC, KSC	National Space Biomedical Research Institute, Department of Energy (Brookhaven National Laboratories), National Institutes of Health (University of Texas Medical Branch), Numerous National Universities
ISS Medical Project	Human Research Program Office - JSC	JSC, KSC, ARC	European Space Agency, Japanese Aerospace Exploration Agency, German Aerospace Center, Canadian Space Agency, Numerous National Universities

Acquisition Strategy

NASA Research Announcements (NRA) will be used to further efforts in human research. In FY 2010, the Space Radiation NRA will focus on better understanding and reducing risks that crews could face from space radiation on exploration missions. The Joint NASA/NSBRI NRA to support crew health and performance in space exploration missions will focus on: bone loss; cardiovascular alterations; human performance factors, sleep, and chronobiology; muscle alterations and atrophy; neurobehavioral and psychosocial factors; nutrition, physical fitness, and rehabilitation; sensorimotor adaptation; smart medical systems; biomedical technology development; and lunar analog bed rest investigations. Directed research projects will focus on exercise, musculoskeletal, and cardiovascular countermeasures; behavioral health; immunology; nutrition; extravehicular activity physiology; food and drug stability; and space radiation health.

Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Exploration Technology Development

Program Overview

The Exploration Technology Development Program (ETDP) develops new technologies that will enable NASA to conduct future human and robotic exploration missions, while reducing mission risk and cost. ETDP's primary customers are the designers of flight systems in the Constellation Program. By maturing new technologies to the level of demonstration in a relevant environment early enough to support a flight system's Preliminary Design Review (PDR), NASA can significantly reduce both cost and risk. ETDP is currently maturing near-term technologies to enable Orion IOC in 2015, and developing long-lead technologies needed for the lunar exploration missions no later than 2020.

ETDP includes the International Space Station Research and the Technology Infusion projects. Space Station research includes ISS flight experiments, free-flyer experiments, and ground-based research that investigate the effects of microgravity on fluid physics, combustion, and fundamental biology for both exploration and non-exploration research. The Technology Infusion project was formulated to address the high priority technology needs for lunar exploration identified by the Exploration Systems Architecture Study (ESAS). Content has evolved since that time to reflect better system requirements definition in the Constellation Program, and to incorporate new technology needs for the lunar outpost identified by the Lunar Architecture Team (LAT).

To ensure that technology development is meeting mission requirements, technical performance goals have been established for all projects with the Constellation Program. Once technology products have reached the required level of maturity, the Constellation Program assumes management responsibility for inserting them into the design of its flight projects.

For more information, please see http://www.nasa.gov/exploration/acd/technology_dev.html.

Plans for FY 2010

The ISS Research project will deliver two fluid physics and two life science payloads for launch to ISS, as well as conduct four microgravity research experiments on board ISS, and one life science experiment on a free-flyer (Bion M1).

Technology Infusion activity will include evaluation of candidate filtration units for removal of lunar dust from the cabin atmosphere, as well as candidate technologies for carbon dioxide reduction; development of manufacturing concepts for 10-meter diameter composite structures for the Ares V launch vehicle; develop and test several candidate technologies for production of high pressure oxygen to recharge extra vehicular activity (EVA) portable life support systems; test a prototype main engine for a lunar lander ascent stage using liquid oxygen and liquid methane propellants; and demonstrate an autonomous hazard avoidance system for a lunar lander in a helicopter flight test, a prototype linear induction pump suitable for circulating liquid metal coolant through a 40 KW reactor, and the experimental on orbit operation of instruments that monitor air quality on the ISS.

Project Descriptions and Explanation of Changes

Technology Infusion

Activities in the Technology Infusion project include: structures, materials, and mechanisms; advanced composites technology; thermal protection systems; dust mitigation; propulsion and cryogenics advanced development; cryogenic fluid management; energy storage; thermal control; intelligent software design; automation for operations; high performance and radiation hardened electronics; autonomous landing and hazard avoidance technology; integrated systems health management; advanced environmental monitoring and control; fire prevention, detection, and suppression; exploration life support; EVA technologies; in-situ resource utilization; human robotic systems; fission surface power systems; mini-RF (miniature radio frequency); and surface power systems.

Content was realigned to support technical capabilities, and reprioritized to support three high priority efforts to maintain critical capabilities in entry, descent, and landing; optical communications; and photovoltaic technology. Funding was transferred from the Lunar Precursor Robotic Program to ETDP to support lunar mapping and modeling.

Work in advanced composites technology began in 2009 in response to new Ares V and lander requirements. In addition, technology demonstration of a lunar fission surface power system using a reactor simulator was delayed one year to FY 2013.

ISS Research

The ISS Research project performs fundamental microgravity research in biology, materials, fluid physics, and combustion using facilities on the International Space Station (ISS). It includes using the ISS as a test bed for exploration technology development, and non-exploration research that has been mandated by Congress to sustain U. S. capabilities in microgravity science.

Mission Directorate: Exploration Systems
Theme: Advanced Capabilities
Program: Exploration Technology Development

Program Management

The Program is managed by the Exploration Technology Development program office, located at the Langley Research Center in Hampton, Virginia.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Technology Infusion (Autonomous Landing & Hazard Avoidance Technology)	ETD Program Office - LRC	JSC, LRC	APL (Applied Physics Laboratory)
ISS Research	NASA Headquarters and ETD Program Office - LRC	GRC, ARC, MSFC, KSC	European Space Agency, Russian Space Agency
Technology Infusion (Propulsion and Cryogenics Advanced Development)	ETD Program Office - LRC	GRC , MSFC, JSC	Northrop Grumman, Aerojet, Pratt & Whitney Rocketdyne
Technology Infusion (In-Situ Resource Utilization)	ETD Program Office - LRC	JSC, GRC, KSC	Canadian Space Agency, Lockheed Martin, and NORCAT (Northern Centre for Advanced Technology)
Technology Infusion (miscellaneous areas)	ETD Program Office - LRC	LRC, GRC, ARC, JSC, JPL, MSFC, HQ, KSC, GSFC	
Technology Infusion (Human Robotic Systems)	ETD Program Office - LRC	JSC, ARC, GRC, LRC, JPL, GSFC, KSC	Michelin, MDA (MacDonald, Dettwiler and Associates Ltd.)
Technology Infusion (Fission Surface Power Systems)	ETD Program Office - LRC	GRC, MSFC, HQ	Department of Energy
Technology Infusion (Advanced Composites Technology)	ETD Program Office - LRC	LRC, GRC, ARC, MSFC	Northrop Grumman, Boeing, ATK (Alliant Techsystems Inc.)
Technology Infusion (High Performance and Radiation Hardened Electronics)	ETD Program Office - LRC	MSFC, LRC, GSFC, JPL	Sandia National Lab
Technology Infusion (Energy Storage)	ETD Program Office - LRC	GRC, JPL, JSC, KSC	DARPA (Defense Advanced Research Projects Agency), ABSL (AEA Battery Systems, Ltd.)

Acquisition Strategy

All projects are managed at NASA Centers, which issue competitive contracts for research and development support. The ISS Research Project issues competitive NASA Research Announcements to select grants for microgravity research in life and physical sciences.

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Mission Directorate:	Exploration Systems
Theme:	Advanced Capabilities
Program:	Lunar Precursor Robotic Program

Program Overview

LPRP contains the Lunar Reconnaissance Orbiter (LRO) and Lunar Crater Observing and Sensing Satellite (LCROSS) missions, which are currently scheduled for a June 2009 launch. The LCROSS mission will be completed with lunar impact in late 2009 with data analysis occurring through early 2010. LRO will complete its primary Exploration mission by the fourth quarter of 2010, with data analysis occurring through early 2011. LRO management for the extended mission will transition to the Science Mission Directorate. Lunar mapping and modeling activities carried under LPRP will transition to ETDP, and the Lunar Precursor Robotic Program will be closed out.

Plans for FY 2010

In FY 2009, LRO and LCROSS completed instrument and subsystem integration and environmental testing, and are preparing to launch in June 2009. The LCROSS spacecraft will complete its flight mission in 2009 by impacting the lunar surface and investigating the possible presence of water in a permanently shadowed crater. Data analysis and closeout of the LCROSS project will occur in early 2010. LRO's primary Exploration mission continues into the fourth quarter 2010, after which the mission will be managed by the Science Mission Directorate.

Mission Directorate: Exploration Systems
Theme: Advanced Capabilities
Program: Lunar Precursor Robotic Program

Project Descriptions and Explanation of Changes

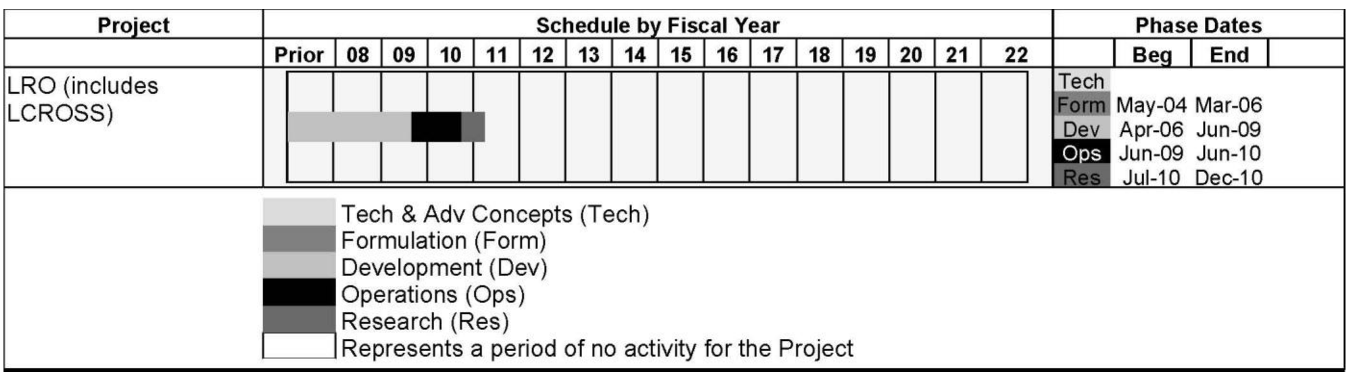
Lunar Reconnaissance Orbiter (LRO)

The Lunar Reconnaissance Orbiter project consists of the two spacecraft, LRO and LCROSS. The LRO spacecraft is a lunar orbiter with six instruments and a technology demonstration payload, which will perform reconnaissance of the Moon in order to map and image the lunar surface, take high-resolution images of areas of interest, assess light, thermal, and radiation environments, and map resources. The LCROSS impactor and shepherding spacecraft, which are co-manifested with LRO on the same launch vehicle, will attempt to identify water in a permanently shadowed crater.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Launch LRO/LCROSS mission in FY2009	LPRP/LRO	No Change

Implementation Schedule



Program Management

The Lunar Precursor Robotic Program is managed at Marshall Space Flight Center; the LRO and LCROSS spacecraft are managed by project offices at Goddard Space Flight Center and Ames Research Center, respectively.

Acquisition Strategy

Acquisitions are completed.

Overview

NASA's Space Operations Mission Directorate (SOMD) is responsible for providing mission critical space exploration services to both NASA customers and to other partners within the United States and throughout the world: flying the Space Shuttle to assemble the International Space Station (ISS); operating the ISS; ensuring safe and reliable access to space; maintaining secure and dependable communications between platforms across the solar system; and ensuring the health and safety of our Nation's astronauts.

At the heart of SOMD is nearly half a century of experience at safely and reliably building, flying, and maintaining some of the world's most advanced and complex aerospace systems. The U.S. Space Exploration Policy and the NASA Strategic Plan recognize the role of the ISS as a unique orbital outpost for carrying out the scientific and engineering research needed for prolonged stays on the Moon and Mars. The lessons being learned during the construction and operation of the ISS are directly applicable to the challenges that may be faced by explorers on the lunar and Martian surfaces.

Completing assembly of the ISS orbiting facility in a manner consistent with NASA's International partner commitments and the needs of human exploration will enable its full use. The Space Shuttle plays an important role as the only vehicle that can launch the remaining elements of the ISS and serve as a platform for joint human and robotic assembly operations at the ISS. SOMD is responsible for ensuring the safety and continued success of the Space Shuttle Program (SSP). Though the fleet of Space Shuttle orbiters will be retired once their role in ISS assembly is complete in 2010, portions of the Space Shuttle's legacy (including manufacturing facilities, ground operations equipment, launch pads, flight hardware, workforce skills, and experience) will be the foundation for the exploration vehicles being developed by the NASA Exploration Systems Mission Directorate (ESMD). This budget provides for careful planning, optimized utilization, and responsive disposition of processes, personnel, resources, and real and personal property, focused upon leveraging legacy assets for Exploration programs' safety and mission success.

In addition to these high-profile programs, SOMD is also responsible for adhering to the U.S. Space Transportation Policy by ensuring that the critical infrastructure needed for space access and space communications is available to meet the needs of NASA's customers. The Launch Services Program (LSP) facilitates access to space by providing leadership, expertise and cost-effective launch services for NASA's Expendable Launch Vehicle (ELV) missions. The Rocket Propulsion Test (RPT) Program maintains NASA's wide variety of test facilities for use by both the Space Shuttle and Constellation Systems Programs. The Crew Health and Safety (CHS) Program ensures that NASA's astronauts are fully prepared for current and future missions. The Space Communications and Navigation (SCaN) Program operates NASA's extensive network of terrestrial and orbiting communications nodes, as well as all of the associated hardware and software needed to pull down the terabytes of data generated by NASA's fleet of crewed vehicles and robotic spacecraft.

As the SSP comes to closure in 2010 with the accompanying completion of the ISS, there are a number of unique human spaceflight capabilities and facilities that have primarily supported the Space Shuttle and ISS assembly which NASA will sustain to support human space flight operations into the future. These capabilities are required for ongoing ISS operations and support of the Constellation program.

In FY 2010, NASA is consolidating the funding for the Flight Crew Operations Directorate from ESMD and SOMD under the newly established Human Space Flight Operations (HSFO) Program. HSFO was established as a single integrated program that will consolidate capabilities in support of multiple human space flight programs. The projects that will be included in the future will be those deemed to be discrete multi-program functions that support the agency's Human Space Flight Operations required regardless of the vehicle being supported.

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**5,427.2**	**5,764.7**	**6,175.6**	**3,663.8**	**3,485.3**	**3,318.6**	**3,154.8**
Space Shuttle	3,295.4	2,981.7	3,157.1	382.8	87.8	0.0	0.0
International Space Station	1,685.5	2,060.2	2,267.0	2,548.2	2,651.6	2,568.9	2,405.9
Space and Flight Support (SFS)	446.2	722.8	751.5	732.7	745.9	749.7	748.9
FY 2009 President's Budget Request	**5,526.2**	**5,774.7**	**5,872.8**	**2,900.1**	**3,089.9**	**2,788.5**	**--**
Space Shuttle	3,266.7	2,981.7	2,983.7	95.7	0.0	0.0	--
International Space Station	1,813.2	2,060.2	2,277.0	2,176.4	2,448.2	2,143.1	--
Space and Flight Support (SFS)	446.3	732.8	612.1	628.0	641.7	645.4	--
Total Change from FY 2009 President's Budget Request	**-99.0**	**-10.0**	**302.8**	**763.7**	**395.4**	**530.1**	**--**

Note: In all budget tables, the FY 2010 President's Budget Request depicts the September 2008 Operating Plan for the 2008 Actuals and the 2009 Omnibus Appropriations Act (P.L. 111-8) and the American Recovery and Reinvestment Act (P.L. 111-5) for the 2009 enacted.

Plans for FY 2010

Space Operations

Space Shuttle

New Initiatives:

None.

Major Changes:

The FY 2010 budget includes increases in FY 2011 and FY 2012 to reflect costs for both Shuttle Transition and Retirement along with severance and retention. This increase is a result of a comprehensive assessment conducted during the last year, and was accommodated in the existing budget.

Major Highlights for FY 2010

In FY 2010, NASA will fly six Space Shuttle missions which will complete the Space Shuttle manifest. After twenty-eight years, 133 missions, over 650 days spent working in orbit, and over 500 million miles traveled in space, the Space Shuttle will be retired.

International Space Station

New Initiatives:

None.

Major Changes:

None.

Major Highlights for FY 2010

The FY 2010 budget completes assembly of the ISS, flying six missions to deliver hardware, supplies, and an international scientific laboratory to the ISS.

Space and Flight Support (SFS)

New Initiatives:

None.

Major Changes:

The Space and Flight Support theme will have two major changes in the FY 2010 budget. The first change is the transfer of Flight Crew operations from Constellation, Space Shuttle, and International Space Station programs to the newly created Human Space Flight Operations line item under the Space and Flight Support theme. The second change in the FY 2010 budget is an increase to the Space Communications and Navigation Program to continue the Optical Communications Flight Demonstration Project.

Major Highlights for FY 2010

In FY 2010, the Space Flight Support theme has several major highlights for the Space Communications and Navigation program, the Launch Services program, and Human Space Flight Operation programs. The Space Communication and Navigation Program provides Deep Space Network sustainment, Space Network Ground Segment sustainment, and the Tracking and Data Relay Satellites K/L. Flexible and common communication technologies such as Software Defined Radio and antenna arraying are being pursued. The Optical Communications Flight Demonstration Project will continue to support the development of small and medium optical payloads for demonstration on three Near Earth flights in 2012, 2013, and 2016, with the overall goal to be suitable for deep space optical communications. The Launch Services Program will continue to work with alternative launch providers to fill the current gap in medium-class lift capability left by the retirement of the Delta II launch vehicle. The Human Space Flight Operations has been established to fund required multi-program capabilities which support the Space Shuttle Program and the International Space Station now as well the Constellation Program in the future.

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Mission Directorate:	Space Operations
Theme:	Space Shuttle

Theme Overview

Thirty-seven years ago, NASA was charged with developing the world's first reusable space transportation system, a vehicle capable of astonishing power and versatility that would revolutionize humanity's ability to operate regularly in near-Earth space. It was a breathtaking challenge, one that tested the technical leadership of the nation every bit as much as the Apollo Program, and one that was worthy of a nation bold enough to be the first to send its citizens beyond the cradle of the home planet. The result was the Space Shuttle, a vehicle that to this day remains the most advanced and capable aerospace system ever built. For twenty-eight years, the Space Shuttle has been the foundation of U.S. preeminence in space exploration. The Space Shuttle has carried more people (over 320) and more cargo (almost four million pounds) on more (and many different types), of missions than any other launch system in history. At the same time, two tragic accidents serve as a continuing reminder that while we have come far since the earliest days of the space program, the Space Shuttle is still a first-generation system, and flying in space remains at the absolute cutting edge of what is humanly possible.

For the past eleven years, the full capabilities of the Space Shuttle have been applied to the mission for whom the system was originally conceived and uniquely designed - assembly of a large, advanced research station and technology test bed in low-Earth orbit. In FY 2010, that assembly mission, and with it one of the most extraordinary periods in the history of space exploration, will come to a close. As NASA prepares to retire the Space Shuttle, the Agency also continues to transition key workforce, technology, facilities, and operational experience from this remarkable vehicle to a new generation of safer, even more capable systems. Through these new systems, the legacy of the Space Shuttle will live on in future exploration missions that will also be essential for maintaining U.S. leadership in critical areas of advanced technology well into the twenty-first century.

For more information, please visit www.nasa.gov/shuttle.

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**3,295.4**	**2,981.7**	**3,157.1**	**382.8**	**87.8**	**0.0**	**0.0**
Space Shuttle Program	3,295.4	2,981.7	3,157.1	382.8	87.8	0.0	0.0
FY 2009 President's Budget Request	**3,266.7**	**2,981.7**	**2,983.7**	**95.7**	**0.0**	**0.0**	**--**
Space Shuttle Program	3,266.7	2,981.7	2,983.7	95.7	0.0	0.0	--
Total Change from FY 2009 Request	**28.7**	**0.0**	**173.4**	**287.1**	**87.8**	**0.0**	**--**

Plans for FY 2010

Space Shuttle Program

In FY 2010, NASA will complete assembly of the International Space Station with the last six flights planned for the Space Shuttle Program. Those missions will deliver the last of the U.S. pressurized elements (Node 3/Cupola) as well as environmental control and life support equipment and hardware and logistics needed to safely support and fully utilize the International Space Station once the Space Shuttle is retired. Planning for the sixth flight in FY 2010 is to deliver and install the Alpha Magnetic Spectrometer payload onto the International Space Station. At the same time, transition and retirement plans are in place or nearing completion for all Space Shuttle Program hardware elements as well as primary supporting Centers and all organizations with a substantial role in ensuring a safe and efficient phase-out of Space Shuttle Program capabilities. Significant sharing of workforce, facilities, and operational experience is already taking place between Space Shuttle Program and the Constellation Program, and will accelerate as major capabilities are made available once they are no longer needed to support safe Space Shuttle Program flyout.

Finally, after twenty-eight years, 133 missions, over 650 days spent working in orbit, and over 500 million miles travelled in space, the Space Shuttle will be retired.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

NASA's primary objective is to advance U.S. national scientific, security, and economic interests by ensuring the success of the Nation's exploration goals as enunciated in U.S. Space Exploration Policy. The next step in the U.S. Space Exploration Policy is to complete assembly of the International Space Station in a manner that meets NASA's exploration research needs and international commitments. The Space Shuttle is uniquely qualified to carry out this mission. At the same time, Space Shuttle transition activities will be undertaken in a manner that, where necessary, safeguards the long-term viability of key U.S. technical capabilities.

Relevance to the NASA Mission and Strategic Goals:

The Space Shuttle Theme supports the achievement of NASA's Strategic Goal 1 that states "Fly the Shuttle safely as possible until its retirement, not later than 2010". The Space Shuttle provides the Nation's only capability for launching humans into Earth orbit and delivering the major elements of the ISS. The Space Shuttle is also forming a bridge between current and future operations. NASA is taking advantage of the remaining Space Shuttle flights to conduct detailed data collection and analysis of Shuttle systems in support of Constellation and commercial cargo design and development activities. These include installation of upgraded pressure transducers on the Space Shuttle solid rocket boosters to collect combustion and performance data relevant to Ares I development, measuring g-loads and vibration dynamics within the Shuttle crew cabin to assess crew performance for the Orion cockpit, modifying Space Shuttle tiles to measure boundary layer transitions at high-Mach numbers during re-entry, and demonstrating new ISS rendezvous and docking sensors being assessed by commercial cargo providers. While accomplishing these missions, Space Shuttle transition activities will be undertaken in a manner that, where necessary, safeguards the long-term viability of key U.S. technical capabilities.

Relevance to education and public benefits:

For twenty-eight years, the Space Shuttle has been the foundation of U.S. preeminence in advanced technology and space exploration. The Space Shuttle has carried more people (over 320) and more cargo (almost four million pounds) on more (and more different types of) missions than any other launch system in history. For the past eleven years, the full capabilities of the Space Shuttle have been applied to the mission for which the system was originally conceived and uniquely designed: assembly of a large, advanced research station in low-Earth orbit, one which can serve as a critical international research technology test bed for further missions out to the Moon, to Mars, and beyond. The Space Shuttle's final series of missions are essential to the completion of the ISS, a facility with potential for addressing essential national priorities like energy, the environment, education, international cooperation, and economic competitiveness. SSP is also a highly visible activity that promotes education in math, science, and engineering careers, which are critical to U.S. national security and the future of U.S. economic competitiveness.

Mission Directorate:	Space Operations
Theme:	Space Shuttle

Performance Achievement Highlights:

Space Shuttle Program successfully completed four missions (STS-120, STS-122, STS-123, and STS-124) in FY 2008. All primary mission objectives were completed.

Robust plans are in place or nearly complete to ensure a safe and smooth transition from Space Shuttle to Constellation in 2010. The NASA Transition Management Plan was updated in December 2008, and documents the Agency-level processes, interfaces, and organizations responsible for managing the transition or retirement of Space Shuttle Program assets, capabilities, and workforce. Strategic real property management is tightly integrated between the Centers, programs, and Headquarters, with Space Shuttle Program and Constellation Program now regularly sharing major production and operations facilities at the Stennis Space Center in Mississippi, the Michoud Assembly Facility in Louisiana, Marshall Space Flight Center in Alabama, and the Kennedy Space Center in Florida. A comprehensive assessment of the more than 1.2 million line items of Space Shuttle Program personal property has been completed in preparation for transfer or disposal. Both these real and personal property assessments included determination of relevant environmental, export control, and historic preservation requirements. A Request for Information was released in November 2008 to solicit ideas for how interested organizations could support permanent display of Space Shuttle Orbiters and Main Engines once their primary missions were complete. Strategic workforce activities include sharing of civil servants and contractors between Space Shuttle and Constellation, providing assistance to employees displaced by the transition from Space Shuttle to Constellation, capitalizing on critical capabilities across all NASA Centers, conducting regular surveys of the human spaceflight workforce, promoting open communication, and providing regular updates to the Congress through the NASA Workforce Transition Strategy report. Space Shuttle missions have also provided Constellation Program with opportunities to gain essential vehicle performance data and conduct high-fidelity tests of critical systems in a number of areas, including solid rocket motor performance, ascent vibration loads, rendezvous and docking techniques, and boundary layer transition effects during re-entry.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	NASA Advisory Council	04/2009	Provides independent guidance for the NASA Administrator. No recommendations were provided to SSP at this time.	07/2009
Other	ASAP	04/2009	Provides independent assessments of safety to the NASA Administrator. In their 2008 Annual Report, the ASAP stated that they "strongly endorse the NASA position on not extending Shuttle operations beyond successful execution of the December 2008 manifest, completing the ISS". NASA will fly the Space Shuttle to complete the International Space Station and then retire the Shuttle in 2010.	07/2009

Mission Directorate:	Space Operations
Theme:	Space Shuttle
Program:	Space Shuttle Program

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	3,295.4	2,981.7	3,157.1	382.8	87.8	0.0	0.0
Program Integration	516.6	489.6	678.1	152.0	22.7	0.0	0.0
Flight and Ground Operations	1,124.9	1,031.2	1,035.1	109.5	49.1	0.0	0.0
Flight Hardware	1,653.9	1,460.9	1,443.9	121.3	16.0	0.0	0.0
FY 2009 President's Budget Request	3,266.7	2,981.7	2,983.7	95.7	0.0	0.0	--
Program Integration	470.3	489.6	614.8	95.7	0.0	0.0	--
Flight and Ground Operations	1,121.8	1,031.2	955.9	0.0	0.0	0.0	--
Flight Hardware	1,674.6	1,460.9	1,413.0	0.0	0.0	0.0	--
Changes from FY 2009 Request	28.7	0.0	173.4	287.1	87.8	0.0	--

Mission Directorate:	Space Operations
Theme:	Space Shuttle
Program:	Space Shuttle Program

Project Descriptions and Explanation of Changes

Program Integration

The Program Integration budget includes the following: funds for flight software; system engineering, flight operations, and management integration; safety and mission assurance; business management; propulsion system integration; safety and sustainability; and all Shuttle support accounts that are performed for the Space Shuttle Program. Program Integration includes payload integration into the Space Shuttle and systems integration of the flight hardware elements through all phases of flight. It provides for the engineering analysis needed to ensure that payloads are safe and meet Space Shuttle interface requirements. Finally, Program Integration includes the necessary mechanical, aerodynamic and avionics engineering tasks to ensure that the launch vehicle can be safely launched, fly a safe ascent trajectory, achieve planned performance and descend to a safe landing.

Flight and Ground Operations

Flight Operations assures the successful accomplishment of pre-flight planning, mission training, operations control activities, and life sciences operations support for each mission to efficiently and effectively meet our customer requirements. Flight operations funding also provides for the maintenance and operation of critical mission support facilities including the Mission Control Center, Integrated Training Facility, Integrated Planning System, and the Software Production Facility.

Ground Operations provides final integration and checkout of all hardware elements for launch. It also includes coordination with other government agencies and foreign entities for Shuttle landing capabilities. The major launch site operational facilities at the Kennedy Space Center include three Orbiter Processing Facilities, two launch pads, the Vehicle Assembly Building, the Launch Control Center and three Mobile Launcher Platforms. Ground operations support capability include launch countdown and landing for Shuttle missions. Ground support for Shuttle landing includes both the Kennedy Space Center and Edwards Air Force Base runways and multiple contingency landing sites in the United States and other countries. Ground Operations also includes the maintenance and operations of ground infrastructure to support launch and landing.

In FY 2010, NASA consolidated and transferred the Flight Crew Operations Directorate project funding to the Human Space Flight Office under the Space and Flight Support Theme. These capabilities include the training of crew members for all of NASA human space flight endeavors.

Flight Hardware

Space Shuttle Flight Hardware ensures the vehicle hardware and software are designed, developed, manufactured, and tested for safe and reliable transportation. Five major flight elements make up the Space Shuttle system: the Orbiter, the Space Shuttle Main Engines, the External Tank, the Reusable Solid Rocket Motors, and the Solid Rocket Boosters.

The Orbiter, the winged vehicle that carries the payload and a crew of up to seven astronauts, is the principal element of the Space Shuttle system. Each Orbiter measures 122 feet long, 57 feet high, with a wingspan of 78 feet, and can carry approximately 35,000 to 41,000 pounds of payload to the International Space Station depending on the configuration of the Space Shuttle, rendezvous altitude, and other mission-specific requirements. There are three reusable Orbiters in the fleet: Discovery (Orbital Vehicle (OV)-103), Atlantis (OV-104), and Endeavour (OV-105).

The Space Shuttle Main Engines were developed in the 1970s and are the most efficient liquid-fueled rocket engines ever built. Each Block II main engine can produce 418,000 pounds of thrust at sea level. The main engines are throttle-able, reusable, and have a high degree of redundancy. Three main engines are mounted in a triangular configuration at the aft end of the Orbiter and provide about 29 percent of the total thrust at liftoff. Critical engineering skills are being maintained to ensure safe mission flyout, and sufficient Space Shuttle Main Engine component spares are being produced to support the program through FY 2010.

The External Tank is the largest and heaviest (approximately 1.7 million pounds when fully loaded with liquid oxygen fuel and liquid hydrogen) element of the Space Shuttle system. The External Tank serves two functions: to carry the fuel and oxidizer that feeds the main engines during ascent, and to act as the structural "backbone" to which the Orbiter and Solid Rocket Boosters are attached. Because the liquid hydrogen and liquid oxygen need to be stored at temperatures of hundreds of degrees below zero, the External Tank is covered with foam insulation to keep the propellants cold on the launch pad and during ascent and prevent formation of ice from atmospheric condensation. After the main engines are shut down at an altitude of about 70 miles above Earth, the External Tank is jettisoned, reenters the atmosphere at high velocity, and breaks up harmlessly over a remote ocean area.

Two Reusable Solid Rocket Boosters provide the main thrust that lifts the Space Shuttle off the launch pad up to an altitude of about 150,000 feet. Each is composed of three major assemblies: a forward nose cone, a four-segment Reusable Solid Rocket Motor, and an aft nozzle. The Reusable Solid Rocket Boosters for the Space Shuttle are the largest ever flown, and are designed for reuse. Each is 149 feet long, 12 feet in diameter, and weighs approximately 1.3 million pounds when loaded with propellant. The sea-level thrust of each booster is approximately 3.3 million pounds. They are fired after the thrust level of the three main engines is verified during the first few seconds of the ignition sequence. Together, they provide about 71 percent of the total thrust at liftoff.

Transition and Retirement

NASA continues to ensure a smooth transition from the Space Shuttle to the next generation of exploration vehicles. Appropriate Space Shuttle flight and ground hardware, technology, people and practices are being identified for transfer, retirement, or reassignment. NASA's Human Space Flight Transition Plan is guided by three fundamental principles: (1) emphasize safety and mission success; (2) complete assembly of the International Space Station (ISS) by the end of 2010 using as few Space Shuttle flights as possible; and (3) support Constellation Systems development objectives without interfering with Space Shuttle safety and mission success. The goals of Human Space Flight Transition are to: (1) evolve from current operations to future operations; (2) evolve the workforce, ensuring that NASA has the right levels and mix of skills for Space Shuttle, International Space Station and Constellation; (3) achieve multi-program objectives at the best value to the Agency; and (4) conduct an efficient and safe closeout of the SSP through the transfer of assets needed for follow -on programs and decommissioning and disposing of the rest.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Safely complete manifest and retire by Dec 2010.	The Space Shuttle Program	Added an additional flight for AMS Payload.

Implementation Schedule

Project	Schedule by Fiscal Year															Phase Dates		
	Prior	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22		Beg	End
Program Integration																	Tech Form Dev Ops Res	 Dec-04	 Dec-10
Flight and Ground Operations																	Tech Form Dev Ops Res	 Dec-04	 Dec-10
Flight Hardware																	Tech Form Dev Ops Res	 Dec-04	 Dec-10

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Space Operations
Theme:	Space Shuttle
Program:	Space Shuttle Program

Program Management

The Space Shuttle Program Manager reports to the Associate Administrator for Space Operations at NASA Headquarters.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Program Integration	Johnson Space Center	Johnson Space Center	n/a
Flight and Ground Operations	Kennedy Space Center	Kennedy Space Center and Johnson Space Center	n/a
Flight Hardware	Johnson Space Center	Johnson Space Center and Marshall Space Flight Center	n/a

Acquisition Strategy

The Space Program Operations Contract (SPOC) prime contractor is United Space Alliance. Other prime contractors providing flight hardware are ATK Thiokol (Reusable Solid Rocket Motor), Lockheed Martin (External Tank), and Pratt & Whitney Rocketdyne (Space Shuttle Main Engines).

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Mission Directorate:	Space Operations
Theme:	International Space Station

Theme Overview

The ISS orbits the Earth 16 times a day at an altitude that ranges from 230 to 286 miles and at a speed of 17,500 miles per hour. The ISS is a research and development (R&D) test bed. It is an experiment in the design, development and assembly of an orbital space facility. It serves as a habitat for its crew, a command post for orbital operations, and a port for the rendezvous and berthing of smaller orbiting vehicles. It functions as an orbital microgravity and life sciences laboratory, a test bed for new technologies in areas like life support and robotics, and a platform for astronomical and Earth observations. ISS has been continuously crewed since early-2001. Through 2008, there have been over 80 flights to the ISS, including flights for assembly, crew rotation, and logistical support. When assembly is complete in 2010, the ISS will be composed of approximately 1,000,000 pounds of hardware brought to orbit in approximately 40 separate launches over the course of more than a decade.

The ISS Program represents an unprecedented level of international cooperation. The ISS International Partnership is composed of NASA, the Russian Federal Space Agency (Roskosmos), the Canadian Space Agency (CSA), the European Space Agency (ESA), and the Japanese Aerospace Exploration Agency (JAXA). International participation in the program has significantly enhanced the capabilities of the ISS.

NASA has secured partnerships with other United States (US) government agencies and private firms to utilize a portion of the ISS as a National Lab, as designated by the NASA Authorization Act of 2005. NASA's plan for the ISS National Laboratory, the National Lab Report, was submitted to Congress in May 2007. Approximately 50 percent of planned US utilization resources on ISS could be available for non-NASA use. Firm interest in ISS use has been demonstrated in the areas of education, human, plant and animal biotechnologies, aerospace technologies, and defense sciences research. NASA has signed Memoranda of Understanding (MOUs) for use of the ISS with the National Institutes of Health and the US Department of Agriculture, and has pre-existing agreements with Department of Energy, Department of Defense and Veterans Affairs. In addition, NASA issued an announcement of "Opportunity for Use of the ISS by Non-Government Entities for R&D and Industrial Processing Purposes" on August 14, 2007, and entered into Space Act Agreements (SAA) with 3 private firms and a university in 2008.

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**1,685.5**	**2,060.2**	**2,267.0**	**2,548.2**	**2,651.6**	**2,568.9**	**2,405.9**
International Space Station Program	1,685.5	2,060.2	2,267.0	2,548.2	2,651.6	2,568.9	2,405.9
FY 2009 President's Budget Request	**1,813.2**	**2,060.2**	**2,277.0**	**2,176.4**	**2,448.2**	**2,143.1**	**--**
International Space Station Program	1,813.2	2,060.2	2,277.0	2,176.4	2,448.2	2,143.1	--
Total Change from FY 2009 Request	**-127.6**	**0.0**	**-10.0**	**371.8**	**203.4**	**425.7**	**--**

Plans for FY 2010

International Space Station Program

In FY 2010, NASA will complete assembly of the ISS, having fulfilled its international partner agreements to launch and accommodate their modules. Logistics supply will continue with Utilization Logistics Flight (ULF) 3, which will deliver "Expedite the Processing of Experiments to Space Station" (ExPRESS) Logistics Carriers (ELC) 1 and 2. The Cupola and Node 3 will be launched on Flight 20 A. Logistics and resupply continues with Flight 19A which brings the Multi-Purpose Logistics Module (MPLM) and the Lightweight Multi-Purpose Experiment Support Structure (MPESS) Carrier (LMC) to ISS. The next flight, ULF4, will bring a Russian Mini Research Module -1 (MRM-1), another laboratory to perform research in space, and more logistics on the Integrated Cargo Carrier - Vertical Light Deployable (ICC-VLC). Flight ULF 5 brings additional utilization and logistics via an MPLM and an external carrier, ELC 3. The final Shuttle mission to the ISS, ULF 6, will deliver the Alpha Magnetic Spectrometer (AMS) and an external carrier, ELC 4, with spares.

By the end of FY 2010, ISS assembly and outfitting will be complete and resupply by the Space Shuttle will end. The ISS will be a fully functioning laboratory in space.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

The ISS objective is to support scientific research for human space exploration and other activities requiring the unique attributes of humans in space. Consistent with the US Space Exploration Policy, ISS research is focused on science and technology development that will prepare human explorers and spacecraft to travel beyond low-Earth orbit (LEO). Research aboard the ISS is critical to understand the effects of space environments on the human body and develop mitigation techniques, minimize the logistical burden of supporting humans far from Earth, address remote medical emergencies, and demonstrate enabling technologies for human exploration.

NASA and the International Partners are applying the information learned to plan for future human and robotic missions. Techniques demonstrated in robotics, assembly, and maintainability on the ISS will guide development of next-generation space vehicles that will fly farther, faster, and for longer duration. Research conducted on ISS in its role as a national laboratory by other US government agencies, private firms and universities will yield important new data applicable to their respective missions. The ISS also promotes the commercial space transportation industry by providing a market to supply needed crew supplies and logistics. The ISS partnership also provides a successful example of peaceful and constructive international cooperation that provides tangible benefits here on earth.

Relevance to the NASA Mission and Strategic Goals:

This Theme supports Strategic Goal 2 of NASA's Strategic Plan which states: "Complete the International Space Station consistent with NASA's international commitments and use the Station as a National Laboratory for scientific research, engineering development and operational experience for exploration." The ISS Theme supports the US Space Exploration Policy "to advance U.S. scientific, security, and economic interest through a robust space exploration program," by completing assembly of the ISS by the end of the decade, focusing NASA research and use of the ISS on supporting space exploration goals, and conducting ISS activities in a manner consistent with international commitments.

Relevance to education and public benefits:

The benefits of ISS research cross all areas of American life, including public health, energy, environment, education, and promoting international cooperation. Specific examples include new uses of ultrasound technology, embedded Web technology to allow remote monitoring and control of devices through a computer and Web browser, and work to help researchers understand and mitigate muscle, balance, and bone problems.

Research performed on the ISS will contribute to a broader understanding of injury and disease in support of Earth-based medical applications. For example, a new vaccine for salmonella-induced infectious disease has been developed on the ISS and will be entering human trials under Food and Drug Administration (FDA) approval. The ISS, an exploration research and technology test bed, will be used to develop and demonstrate, among other things, closed loop life support systems and remote medical care capabilities. Both technologies can be used to benefit people here on Earth. For example, water recycling technology is being used to provide potable water to places devastated by natural disasters. NASA will also demonstrate technologies on the ISS necessary for future space systems such as thermal control, environmental control, and power generation. As an earth observing platform, the onboard crew utilizes the ISS as an excellent platform to monitor and record natural and human-driven changes and events on earth.

Mission Directorate:	Space Operations
Theme:	International Space Station

Performance Achievement Highlights:

In November 2008, ULF2 was launched with the equipment necessary to double the crew size of the ISS. A Galley, Crew Quarters, Waste and Hygiene Compartment, and a Water Recovery System were delivered. The Water Recovery System brings with it the capability to recycle urine and condensate into drinking and coolant water. This capability is critical to weaning the ISS from dependence on the Space Shuttle for water resupply. Once the equipment is operational the ISS will be able to support 6 crewmembers. Spring of 2009 is the target for beginning 6 crew operations on the ISS. In addition, the crew performed 4 space walks to restore functionality to the Starboard Solar Array and increase the available power on the ISS. To add to the significance of this mission, on November 20, 2009 the ISS celebrated its 10th anniversary of on-orbit operations.

In FY 2009, NASA continues ISS assembly. The truss and solar array assembly is complete with delivery of the S6 Solar Array on Flight 15A, bringing the ISS to its full power capability. The final JAXA segments, Exposed Facility (EF) and the Experiment Logistics Module-Exposed Section (ELM-ES) will be delivered on Flight 2J/A completing JAXA's laboratory complex on the ISS. Flight 17A will deliver pressurized cargo via a MPLM. JAXA will also launch the first H-II Transfer Vehicle (HTV), which will contribute to the effort of resupplying the ISS when the Space Shuttle retires. The ISS program will continue processing activities, ground testing, and integration of flight hardware for future missions, while operating and monitoring the health of the vehicle systems, and conducting operations on 30 to 40 research experiments. During this period ISS crews are supported by re-supply and crew rotation using the Space Shuttle, and Russian Progress and Soyuz vehicles. Ground training is ongoing for future flight crews, and ISS will continue to conduct ISS-based Extravehicular Activities (EVAs) for ISS maintenance, science, and assembly. More detailed information maybe found at http://www.nasa.gov/mission_pages/station/main/index.html.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	ISS Advisory Committee	10/2008	Assess ISS operational readiness to support new crew, assess Russian flight team preparedness to accommodate the Expedition 15 mission, and assess health and flight readiness of Expedition 15 crew.	Ongoing
Other	NASA Advisory Council (NAC)	04/2009	Provides independent guidance for the NASA Administrator. The NAC was briefed by the JSC Safety and Mission Assurance Office on NASA Lessons Learned program. The Space Operations committee made two recommendations on NASA utilization of known Lessons Learned, including expanding the teaching aspect.	07/2009
Other	ASAP	04/2009	Provides independent assessments of safety to the NASA Administrator. No recommendations nor inquiries issued relating to the ISS.	07/2009
Other	Program Implementation Review	08/2008	Provides an independent review of ongoing ISS and SSP operations.	2010

Mission Directorate:	Space Operations
Theme:	International Space Station
Program:	International Space Station Program

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**1,685.5**	**2,060.2**	**2,267.0**	**2,548.2**	**2,651.6**	**2,568.9**	**2,405.9**
ISS Operations	1,603.2	1,755.4	1,639.0	1,717.3	1,513.9	1,437.8	1,449.0
ISS Cargo Crew Services	82.3	304.8	628.0	830.9	1,137.7	1,131.1	956.9
FY 2009 President's Budget Request	**1,813.2**	**2,060.2**	**2,277.0**	**2,176.4**	**2,448.2**	**2,143.1**	**--**
ISS Operations	1,713.1	1,755.4	1,750.2	1,754.2	1,697.2	1,528.5	--
ISS Cargo Crew Services	100.1	304.8	526.8	422.2	751.0	614.6	--
Changes from FY 2009 Request	**-127.6**	**0.0**	**-10.0**	**371.8**	**203.4**	**425.7**	**--**

Mission Directorate:	Space Operations
Theme:	International Space Station
Program:	International Space Station Program

Project Descriptions and Explanation of Changes

Operations

The ISS Program brings together international flight crews; globally distributed launch, operations, training, engineering, and development facilities; communications networks; and the international scientific research community. Operating ISS is even more complicated than many other space flight endeavors because it is an international program. Each ISS partner has the primary responsibility to manage and run the hardware it provides, but the various elements provided by the partners are not independent and they must be operated as an integrated system.

ISS Operations encompasses several key functions necessary to plan, control and execute the ISS. ISS Systems Engineering, Analysis and Integration function entails optimization of the system architecture, integrated system performance and verification analyses, assembly sequence, vehicle configuration, interface requirements, and mission design. The Spacecraft function is responsible for developing and sustaining the on-orbit ISS. The Safety & Mission Assurance function implements safety, reliability, maintainability, and quality assurance requirements to ensure that all significant risks are reviewed, tracked, and mitigated so that ISS is safe, reliable, and maintainable.

Multi-User Systems Support (MUSS) is responsible for management of the ISS integrated research plan and utilization resources. MUSS manages all payload operations activities. With the completed delivery of IP elements and the establishment of six-person crew capability, ISS research opportunities will be expanded to conduct research in life sciences, materials sciences, fluid physics, as well as its primary focus to serve as a test bed for future exploration missions in a weightless environment.

Space Flight Crew Operations provides trained crew members for all of NASA human space flight endeavors. In FY 2010, ISS related Flight Crew Operations were consolidated into the Human Space Flight Operations line item. Other key ISS operational activities include Mission Integration and Operations, Medical Support, and Launch Site Processing. Prior to launch, NASA and the IPs will complete building, conduct testing, and perform integration of each element into the Shuttle orbiters at the Kennedy Space Center for launch to orbit. For FY 2010, NASA will perform those activities for the ELCs, Cupola, Node 3, MPLM's, LMC, the IC-VLD, and MRM.

ISS Cargo Crew Services

The ISS Cargo Crew Services budget consists of International Partners and commercial purchases. NASA has contracted with Roskosmos to purchase cargo transportation through 2011 and crew transportation through spring of 2012. The ISS Program plans to purchase crew transportation services from international partners as needed until a domestic capability is available. NASA has also contracted with domestic companies to provide cargo supply and return services beginning in 2011 via the Commercial Resupply Services (CRS) contract. NASA does not plan to purchase any cargo services from its International Partners after 2011.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
ISS Assembly complete by 2010	International Space Station (ISS)	None

Mission Directorate:	Space Operations
Theme:	International Space Station
Program:	International Space Station Program

Implementation Schedule

Project	Schedule by Fiscal Year																Phase Dates		
	Prior	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22		Beg	End
ISS* *Potential continuation of ISS operations after 2016 will be reviewed this summer as an element of the NASA human space flight review																	Tech Form Dev Ops Res	 Oct-93 Oct-07	 Sep-07 Sep-16

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

The ISS Program Manager reports to the Associate Administrator for Space Operations at NASA Headquarters.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
On-orbit assembly and operations	NASA Johnson Space Center	NASA Johnson Space Center	Russian Federal Space Agency, European Space Agency, Japan Aerospace Exploration Agency, Canadian Space Agency, and Italian Space Agency (ASI).

Acquisition Strategy

NASA extended the Boeing US On-Orbit Segment (US0S) contract until September 30, 2010. NASA also exercised the first option under the Cargo Mission Contract (CMC), the Program Integration Contract (PIC) and the Mission Integration Contract (MIC) until September 2009. The government has issued a competitive request for proposal for the PIC services beyond 2009. A contract strategy is in work for the extension of the other contracts and should be released in spring 2009.

NASA awarded commercial cargo transportation services to Space Exploration Technologies Corporation (Space X) and Orbital Sciences Corporation through the CRS contract on December 23, 2008. Cargo services are expected to begin in 2011 with initial start of activities in the 2nd or 3rd quarter of FY 2009. The service period is through 2016. NASA has also extended its contract with Roskosmos to purchase crew transportation through spring of 2012 and plans to continue to purchase Russian crew transportation services until commercial crew capability or Ares I/Orion is operational.

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Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)

Theme Overview

As explorers, pioneers and innovators, NASA boldly expands frontiers to inspire and serve America and to benefit the quality of life on Earth. Space and Flight Support enables exploration and science through multiple capabilities.

One such capability is the Space Communications and Navigation (SCaN) Program, a vital element of the underlying support structure needed to conduct exploration and science. Whether NASA missions are providing data about our home planet, focusing science instruments on cosmic phenomena or exploring far regions in space, reliable communication with Earth-based control centers is critical to mission success. As new spacecraft with different objectives and advanced technology are launched, the communication needs of flight missions change. In response, NASA modifies and evolves its space communications capabilities to ensure Agency mission needs are fulfilled.

In addition, NASA has assigned responsibility for understanding the full range of civil space launch needs to the Launch Services Program (LSP). LSP works closely with other government agencies and the launch industry, seeking to ensure that safe, reliable, on-time and cost-effective commercial launch opportunities are available on a wide range of launch systems.

The Rocket Propulsion Test (RPT) Program reviews, approves and provides direction on rocket propulsion test assignments, capital asset improvements, test facility modernization and refurbishments, integration for multi-site test activities, identification and protection of core capabilities and the advancement and development of test technologies.

Also, the care of the Astronaut Corps is the responsibility of space medical operations at the Johnson Space Center. A portion of the responsibilities for that care is managed within the Crew Health and Safety (CHS) Program. CHS enables healthy and productive crew during all phases of space flight missions; implementation of a comprehensive health care program for astronauts; and the prevention and mitigation of negative long-term health consequences of spaceflight.

Finally, Human Space Flight Operations currently has one project, the Space Flight Crew Operations (SFCO) that provides trained crew members for all NASA human space flight endeavors and brings expertise to help resolve issues within the programs. SFCO is responsible for all JSC aircraft operations including aircrew training.

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**446.2**	**722.8**	**751.5**	**732.7**	**745.9**	**749.7**	**748.9**
Space Communications and Navigation	303.9	582.9	496.6	506.9	520.3	524.0	524.0
Human Space Flight Operations	0.0	0.0	114.7	88.5	88.6	88.7	89.0
Launch Services	91.8	89.6	85.9	84.1	83.9	83.9	82.8
Rocket Propulsion Test	41.9	41.8	45.8	44.6	44.5	44.5	44.5
Crew Health & Safety	8.7	8.6	8.6	8.5	8.5	8.5	8.5
FY 2009 President's Budget Request	**446.3**	**732.8**	**612.1**	**628.0**	**641.7**	**645.4**	**--**
Space Communications and Navigation	303.9	582.9	475.2	491.3	504.8	508.5	--
Launch Services	91.7	99.6	84.0	83.4	83.8	83.8	--
Rocket Propulsion Test	41.9	41.8	44.3	44.7	44.6	44.6	--
Crew Health & Safety	8.7	8.6	8.6	8.5	8.5	8.5	--
Total Change from FY 2009 Request	**0.0**	**-10.0**	**139.4**	**104.8**	**104.2**	**104.4**	**--**

Plans for FY 2010

Space Communications and Navigation

In FY 2010, the SCaN Program will continue to successfully provide space communications and navigation capabilities to all missions and continue to define Lunar communications requirements. SCaN will also continue to advance cross support opportunities with international space agencies through the definition and adoption of common standards and protocols, as well as, continue demonstration of new technologies, such as the Optical Communications Flight Demonstration Project.

Human Space Flight Operations

In FY 2010, NASA consolidated the Flight Crew Operations Directorate projects funding from Exploration Systems Mission Directorate and Space Operations Mission Directorate under the Human Space Flight Operations program. The consolidated Flight Crew Operations Directorate is now Space Flight Crew Operations, which is currently the only project funded under the Human Space Flight Operations program. The Space Flight Crew Operations provides trained crew members for all of NASA human space flight endeavors.

For FY 2010, the Space Flight Crew Operations will support up to six human space flights on the Space Shuttle to the International Space Station, as well as long-duration crew on ISS and crew expertise to Constellation development.

Launch Services

LSP has planned four NASA launches for FY 2010 including: 1) Glory, which will be launched on a Taurus XL; 2) Solar Dynamics Observatory (SDO) launched on an Atlas V; 3) Widefield Infrared Survey Explorer (WISE) launched on a Delta II, and 4) Aquarius mission also launched on a Delta II. LSP will also provide advisory expertise and services to SpaceX's second and third demo flights under the Commercial Orbital Transportation Services (COTS) Project and the Geostationary Operational Environmental Satellite (GOES-P) under the NOAA/GOES Program.

Rocket Propulsion Test

RPT will continue to provide test facility management, and provide maintenance, sustaining engineering, operations, and facility modernization projects necessary to keep the test-related facilities in the appropriate state of operational readiness. RPT has established testing requirements for the Exploration program which will be used to identify excess and "at-risk" test facilities and will support decisions relative to test asset consolidation initiatives.

Crew Health & Safety

CHS will continue to help develop and refine a standardized battery of clinical and physiological tests for all crew members. The Crew Health Surveillance special projects will focus on developing and refining medical standards that are critical to meet the needs of exploration timelines. Similarly, real-time mission evaluation will continue to help define and deliver medical operations hardware for current programs and meet the needs of known architectures.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

SFS programs provide the enabling capabilities required to advance space exploration and expand scientific knowledge of Earth and the universe. Without these capabilities NASA could not perform any of its missions.

SCaN provides the ability to conduct space communications and navigation with both human and robotic spacecraft. Capable and dependable communications are vital for the success of human and robotic space missions.

The LSP project is responsible for enabling access to space for NASA and other select government missions. LSP is responsible for a wide range of activities critical to fulfilling the U.S. Space Exploration Policy and provides safe, reliable, cost-effective, and on-time commercial launch services for NASA and NASA-sponsored payloads using expendable launch vehicles (ELVs).

The RPT capabilities continue to support safe operation of the Space Shuttle, implement the U.S. Space Exploration Policy, and provide test facilities for use by other DOD and commercial programs. Capabilities include rocket propulsion test facilities, associated infrastructure and systems, and the core skilled workforce necessary to operate and maintain these assets for Ares and other future propulsion projects.

CHS provides enhancements to the health care provision environment both in space and on the ground for the Astronaut Corps. CHS contributes to the medical and health certification of astronauts before flight and the provision of care throughout their careers.

Relevance to the NASA Mission and Strategic Goals:

The Space and Flight Support (SFS) Theme supports the U.S. Space Exploration Policy by providing unique operational capabilities for space communications and navigation, launch services, and rocket propulsion tests, as well as managing the health care of the Astronaut Corps. The services provided are critical for enabling the conduct of space exploration, aeronautical research, and biological and physical research and are provided to a wide range of customers, including NASA scientists and engineers, other federal agencies, universities, foreign governments, and industry interests.

The SFS Theme supports the following Goals in the 2006 NASA Strategic Plan:

Goal 3: Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration.

Goal 4: Bring a new Crew Exploration Vehicle into service as soon as possible after Shuttle retirement.

Goal 5: Encourage the pursuit of appropriate partnerships with the emerging commercial space sector.

Goal 6: Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations.

Relevance to education and public benefits:

The benefits of SFS to education and the public includes the return of scientific and educational data from space to Earth; the safe launching of expendable launch vehicles necessary for research; the assurance that rocket systems have been adequately tested; and the testing and implementation of various human health and illness prevention measures. A space program properly supported by this Theme will produce research data that can be used to generate new scientific knowledge through the study of heliophysics, astrophysics, solar system exploration, Earth science, biological and physical research, and more.

Performance Achievement Highlights:

- Deep Space Network, Near Earth Network, and Space Network all exceeded proficiency and availability metrics as all Networks achieved 98% proficiency for delivery of Space Communications services.

- SCaN continued to work with the Space Operations, Exploration Systems, and Science Mission Directorates to ensure that NASA communication and navigation needs were met. As part of this effort, the program worked with the commercial sector to obtain and maintain reliable technologies at competitive prices for several projects: the Communication Navigation and Networking Reconfigurable Testbed (CoNNeCT), a joint government and commercial project investigating reprogrammable (software-defined) radio technology for use during space exploration missions; the Tracking and Data Relay Satellite System (TDRSS) Continuation project, which will sustain the TDRS system with two new satellites designed to serve Science and Exploration System goals; and the Near Earth Network, which provides services for orbiting satellites and the Shuttle.

- SCaN successfully completed demonstration of antenna arraying with two separate TDRS spacecraft. SCaN initiated the Lunar Atmosphere and Dust Environment Explorer (LADEE) optical communications demonstration program and successfully developed strategy with international space agencies for development of a future interoperable space internetworking environment.

-The Launch Services Program (LSP) continues to open the bidding process to a larger number of launch providers, in an effort to help the emerging commercial space sector gain experience to successfully compete for future missions. In March 2008, LSP established the NASA Launch Services (NLS) Contract Follow-on Procurement Development Team (PDT). In April 2008, the PDT released a Request for Information (RFI) to the launch service provider community with a Small and Medium Class mission model. Responses have been received and assessed. These responses, together with input from our current contracted launch service providers and our customers, have been evaluated, and a philosophy for the follow-on contract mechanism to the NLS contract has been proposed. Space Exploration Technologies (SpaceX) was placed onto the NLS contract in April 2008, to include Falcon 1 and Falcon 9 launch services. LSP has also entered into unfunded Space Act Agreements with companies that are actively funding new launch vehicles. The companies will share information with LSP that could aid in future certification efforts in return for LSP's advice and guidance on the development of the launch vehicle.

See Strategic Goals 3, 4, 5, and 6 in the FY 2008 Performance and Accountability Report at http://www.nasa.gov/news/budget/index.html.

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FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	303.9	582.9	496.6	506.9	520.3	524.0	524.0
Space Communications Networks	56.5	363.5	427.2	423.0	440.8	431.1	444.3
Space Communications Support	97.4	65.4	43.4	64.9	56.9	79.5	79.7
TDRS Replenishment	150.0	154.0	26.0	19.0	22.6	13.4	0.0
FY 2009 President's Budget Request	303.9	582.9	475.2	491.3	504.8	508.5	--
Space Communications Networks	90.7	363.5	385.5	409.8	420.2	423.7	--
Space Communications Support	63.9	65.4	63.7	62.5	62.0	71.4	--
TDRS Replenishment	149.3	154.0	26.0	19.0	22.6	13.4	--
Changes from FY 2009 Request	0.0	0.0	21.4	15.5	15.5	15.5	--

Program Overview

Today's spacecraft are increasingly more powerful, complex, and capable of acquiring increasing amounts of mission data. They can also employ artificial intelligence enabling autonomous decisions. However complex and sophisticated these machines have become, two key functions have not changed: the need to communicate with Earth and to navigate in space. A failure of space communications and navigation on the spacecraft or on Earth could result in a complete loss of a mission. Hence, space communications and navigation is a fundamental capability of missions that depends on a high quality of hardware and software present on the spacecraft and the ground.

NASA's space communications and navigation capabilities rely on ground-based and space-based assets that enable near Earth and deep space missions, as well as those of the other U.S. agencies and of our international partners. These national assets are managed as dedicated projects within the Space Communications and Navigation (SCaN) program. The SCaN program manages these assets for the Agency and provides a cost efficient approach to effectively meeting all missions needs throughout all stages of their life.

SCaN is also responsible for all Spectrum Management and Data Standards policy, oversight and management for the Agency. It represents NASA before all domestic and international regulatory or technical bodies dealing with Spectrum and/or Data Standards, thus providing NASA with an integrated approach to promoting and safeguarding its SCaN equities and interests. Additionally, SCaN leads all NASA activities associated with present and future navigation technology and capabilities such as supporting spacecraft tracking and position determination.

These seemingly disparate functions: sustainment of existing assets, technology development, spectrum management, and international standards, are integrated through a robust System Engineering and Integration (SE&I) activity to assure uninterrupted SCaN capabilities and avoiding loss or any impact to science or exploration missions. In addition, SE&I also conducts long-range planning based on projected mission needs and identifies technical performance targets for new technologies such as Disruption Tolerant Networking (DTN), Optical Communications, and Communication Navigation and Networking Reconfigurable Testbed (CoNNeCT).

By planning, developing, operating, and maintaining space and ground networks of tracking and data systems, SCaN supports the Nation's space missions, both crewed and robotic, from low Earth orbit to the fringes of the solar system.

For more information, please see https://www.spacecomm.nasa.gov/spacecomm/.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Space Communications and Navigation

Plans For FY 2010

The SCaN Program will release the Space Network Ground Segment Sustainment (SGSS) request for proposal (RFP) with a target contract award by early 2010. SCaN will also conduct the SGSS Mission Definition Review. SCaN will conduct the Tracking and Data Relay Satellite (TDRS-K/L) Critical Design Review, Mission Operations Review, Ground Test Readiness Review, and the Ground Terminal Pre-Ship Review. SCaN will also conduct the Communication Navigation and Networking Re-Configurable Testbed (CoNNeCT) Flight Readiness Review, as well as, conduct the Disruption Tolerant Networking (DTN) second ISS demonstration flight. Also, SCaN will continue development of an optical terminal and ground-based receiver that will demonstrate the utility of high rate Optical Communications on the LADEE spacecraft in the 2012 timeframe.

Project Descriptions and Explanation of Changes

Space Communications Networks

Deep Space Network (DSN): The DSN consists of three facilities spaced approximately 120 degrees apart on the globe to enable continuous communications to spacecraft as the Earth rotates. The facilities are located in Spain, Australia, and California. DSN stations are NASA-owned assets managed by the DSN Project Office at the Jet Propulsion Laboratory. In addition, SCaN utilizes Construction of Facilities (CoF) funding to provide minor revitalization of the three DSN facilities. In FY 2010, $4.3M is requested to provide essential modification and replacement of the power distribution systems in Australia. The minor revitalization provides continuing support to missions exploring regions beyond Earth orbit, including planetary exploration missions to Mars and beyond. Also, $6.8M of discrete funding is requested in FY 2010 for construction of a new 34-Meter Beam Waveguide Antenna, DSS-35, in Australia. For a list of the CoF projects, see the Cross-Agency Support Appropriation.

Near Earth Network (NEN): The NEN consists of globally distributed tracking stations that are strategically located to maximize the communications service coverage provided to flight missions. The stations are located in Norway and Alaska, with additional antennas located at Wallops Island, VA and Merritt Island, FL. The NEN Project Office at GSFC manages the network, which includes both commercially owned assets and NASA facilities. The NEN provides communications services to a variety of missions in certain orbital and suborbital locations, including Low Earth Orbit (LEO), Geosynchronous Earth Orbit (GEO), lunar, and highly elliptical orbits.

Space Network (SN): The SN consists of the Tracking and Data Relay Satellite System (TDRSS) and a set of supporting ground terminal systems located at White Sands, NM and Guam. The ground terminals transmit signals to and from the TDRSS, which in turn relays those signals to and from flight missions. The SN predominantly supports LEO missions with global coverage, but it can also support launch vehicles and provide communications services to researchers in remote locations on Earth, such as the South Pole.

SN Ground Segment Sustainment (SGSS): SGSS is responsible for replacing outdated equipment and standardizing systems at all SN ground locations, including White Sands and the Guam Remote Ground Terminal (GRGT). After replacement, ground system equipment at every SN ground station will be capable of supporting any spacecraft in the TDRSS fleet. A key objective of SGSS is to establish the capabilities required to support the Ares and Orion Constellation vehicles.

NASA Integrated Services Network (NISN): This network has commercial service backbones providing point-to-point terrestrial signal transport services and routing network services. Management responsibility for this project has moved to the Office of the Chief Information Officer.

Tracking and Data Relay Satellite (TDRS) Replenishment

The TDRS Replenishment Project is responsible for the acquisition of two new Tracking and Data Relay Satellites, TDRS-K and TDRS-L, to replenish the aging fleet of communications spacecraft in the SN. The TDRS K and L Project Office at GSFC is managing the procurement, which includes on-orbit delivery, acceptance of two spacecraft (TDRS-K to be launched in 2012, followed by launch of TDRS-L in 2013), and modification of ground system equipment at the White Sands Complex (WSC) in White Sands, New Mexico.

Space Communications Support

Space Communications Support manages cross-cutting communication functions, which are responsible for defining and protecting the integrity of the overall SCaN architecture, including identifying, assessing, and establishing policy or response to external policies. These functions include Spectrum Management, Systems Planning, and Optical Communications.

Spectrum Management ensures the availability and allocation of radio frequency spectrum for all Agency programs to support the operation of navigation systems, space and ground based radio transmission, and mission sensor operations.

Systems Planning develops a communications and navigation architecture to support Exploration and Science Programs through 2030. This includes Space Data Standards, which pursues the implementation of national and international space data standards with the aim of improved interoperability; Technology, which aims to predict the needs of future communications missions in a manner that will yield initiatives with performance enhancements with reduced costs; and Systems Engineering, which coordinates all SCaN systems engineering activities and manages the requirements that enable NASA to fulfill its space communications and navigation needs for future missions. In addition, SCaN provides subject matter expertise to the NASA Deputy Administrator for the Deputy Secretary-level Positioning, Navigation, and Timing (PNT) Executive Committee that manages the U.S. Global Positioning System (GPS). GPS is a critical infrastructure component for NASA human spaceflight and science, and enables greater autonomous navigation of spacecraft while reducing the operational and cost burdens of traditional two-way ranging and tracking.

Optical Communications will continue the demonstration of the new optical technology that will provide NASA with a high rate communication technique for deep space mission data with an objective of at least a 10-fold increase in the available radio frequency (RF) data rate. This revolutionary technology will provide higher data rates for less spacecraft space, weight, and power burden compared to RF technology. Higher data rates will allow more science spacecraft to share the same Earth-based optical receivers, and enable greater science return over spacecraft life, thus gaining higher mission utilization. The implementation approach will begin with three Near Earth flight demonstrations of optical terminals as co-payloads with Lunar science mission instruments.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Achieve less than 3% of lost operating time on NISN available services.	NASA Integrated Services Network, NISN	None
Achieve at least 98% Network proficiency for delivery of Space Communications services.	Space Network, Deep Space Network, and Near Earth Network	None

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Space Communications and Navigation

Implementation Schedule

Project	Schedule by Fiscal Year: Prior, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22	Phase	Beg	End
Space Communications and Navigation Operations		Tech		
		Form		
		Dev		
		Ops	Oct-05	Oct-20
		Res		
Space Communications and Navigation Non Operations, TDRS Replenishment		Tech		
		Form	Oct-06	Sep-09
		Dev	Oct-09	Sep-12
		Ops		
		Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Space Communications and Navigation

Program Management

The Deputy Associate Administrator for Space Communications and Navigation (SCaN) reports to the Associate Administrator for Space Operations at NASA Headquarters. SCaN projects are managed from NASA Headquarters.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
SN Ground Segment Sustainment	Space Communications and Navigation Program Office - NASA Headquarters	Goddard Space Flight Center	Other Government Agencies
Space Communications Support	Space Communications Program Office - NASA Headquarters	Glenn Research Center, Goddard Space Flight Center, Jet Propulsion Laboratory, Johnson Space Center	N/A
Deep Space Network	Space Communications and Navigation Program Office - NASA Headquarters	Jet Propulsion Laboratory	N/A
TDRS Replenishment	Space Communications and Navigation Program Office - NASA Headquarters	Goddard Space Flight Center, Kennedy Space Center	Non-NASA Partner Agency
Optical Communications	Space Communications and Navigation Program Office - NASA Headquarters	Goddard Space Flight Center, Jet Propulsion Laboratory	N/A
NASA Integrated Services Network	Space Communications and Navigation Program Office - NASA Headquarters	Goddard Space Flight Center, Marshall Space Flight Center	N/A
Near Earth Network	Space Communications and Navigation Program Office - NASA Headquarters	Goddard Space Flight Center	N/A
Network Integration and Engineering	Space Communications and Navigation Program Office - NASA Headquarters	Goddard Space Flight Center, Glenn Research Center, Jet Propulsion Laboratory	N/A
Space Network	Space Communications and Navigation Program Office - NASA Headquarters	Goddard Space Flight Center	Other Government Agencies

Acquisition Strategy

NASA owns a large, established base of space communications assets located nationally, internationally, and in orbit near Earth and Mars. The SCaN Program conducts acquisition planning with the objective of preserving the governments past investments, and altering capability or capacity in response to mission needs and NASA SCaN architecture goals.

NASA conducts major SCaN acquisitions on a competitive basis. To meet mission support objectives and achieve best value for NASA, mission suitability and cost criteria are appropriately weighted and evaluated for competitively awarded acquisitions. When feasible, NASA pursues commercially available space communications services and products in preference to developing NASA-owned systems. NASA may also consider unique technical capabilities and maintenance of core competency in the NASA work force during the "make versus buy" decision process. To further achieve best value for NASA and the U.S. Government, the Agency may place task orders on Government Wide Acquisition Contracts (GWAC).

NASA will require several major procurements to support future Agency SCaN requirements. Flight systems and associated ground terminals will be required at several locations in the Solar System. The type of contract depends upon the maturity of the technology and the associated mission risk. In general, lower risk radio frequency relay spacecraft near the Earth are acquired under "fixed price" terms with delivery on-orbit. Relay satellites at distant locations or acquisitions involving new technology, such as optical space communications, may be acquired under "cost plus award fee" terms.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	National Research Council	01/2006	SOMD Space Communications Independent Evaluation by National Research Council (NRC) was completed in September 2006 with the final report delivered the first quarter of CY 2007. This report validated the need to centralize management of all NASA space communications, formalized in a detailed program plan.	N/A

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Space Communications and Navigation
Project In Formulation:	TDRS Replenishment

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	150.0	154.0	26.0	19.0	22.6	13.4	0.0
FY 2009 President's Budget Request	149.3	154.0	26.0	19.0	22.6	13.4	--
Total Change from 2009 President's Budget Request	0.7	0.0	0.0	0.0	0.0	0.0	--

Project Purpose

The existing fleet of the Tracking and Data Relay Satellite System (TDRSS) supports tracking, data, voice, and video services to the International Space Station (ISS), Space and Earth science missions, as well as other government agency users. The total mission load is predicted to increase, which will require additional satellites to be added to the fleet.

The existing fleet is aging and reliability analysis predicts a shortage of flight assets to support NASA missions and the user community by 2011. As a result, NASA began in FY 2007 the acquisition of two additional spacecraft, TDRS-K and TDRS-L, to be launched in 2012 and 2013 respectively. By adding these two spacecraft to the TDRSS fleet, continuity of service will be insured for NASA and other government agency user missions through approximately 2016.

The TDRS Replenishment Project supports the Agency's goal to establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations. It accomplishes this by implementing the space communications and navigation architecture responsive to Science and Exploration mission requirements and implementing technology initiatives consistent with approved baseline space communications and navigation architecture.

Project Preliminary Parameters

The TDRS system consists of in-orbit telecommunications satellites stationed at geosynchronous altitude and associated ground stations located at White Sands, New Mexico and Guam. This system of satellites and ground stations comprises the Space Network that provides mission services for near -Earth user satellites and orbiting resources, with many near-Earth spacecraft being totally dependent upon it for performance. The TDRSS constellation includes the first-generation satellites (TDRS 1-6), the replacement satellite (TDRS 7), and the second-generation satellites (TDRS 8, 9, and 10).

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Space Communications and Navigation
Project In Formulation:	TDRS Replenishment

Estimated Project Deliverables

The TDRS-K and TDRS-L spacecraft will be fully compatible with and capable of functioning as part of the TDRS System as implemented and operated by the White Sands Complex (WSC) and Guam ground terminals. Requirements will include: design, development, fabrication, integration, test, on-orbit delivery, and launch services. Launch dates for TDRS-K and TDRS-L will be in 2012 and 2013 respectively. The spacecraft are required to have an operational life of 11 years. The basic requirement will also include modification of the WSC Space-to-Ground Link Terminals to provide compatibility with the new spacecraft, while preserving compatibility with the existing TDRS fleet.

Project Element	Provider	Description	FY 2009 PB Request	FY 2010 PB Request
TDRS Replenishment	NASA	Aging hardware replacement	NASA committed $450M through FY 2013	No Change

Estimated Project Schedule

Milestone Name	Formulation Agreement Estimate	FY 2009 PB Request	FY 2010 PB Request
Formulation			
Mission Operations Review	Quarter 2, FY 2010	N/A	N/A
Ground Test Readiness Review	Quarter 3, FY 2010	N/A	N/A
Ground Terminal Pre-Ship Review	Quarter 3, FY 2010	N/A	N/A

Project Management

The Deputy Associate Administrator for Space Communications and Navigation reports to the Associate Administrator for Space Operations at NASA Headquarters.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
TDRS Replenishment	Space Communications and Navigation (SCAN) Office	Headquarters SCaN Program Office	GSFC, KSC, and Non-NASA Agencies

Acquisition Strategy

The Acquisition Strategy for this procurement uses a Firm Fixed Price with Incentive Fee contract.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Space Communications and Navigation
Project In Formulation:	TDRS Replenishment

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
TDRS-K and TDRS-L Obsolescence Risk Management	Aging spacecraft requires replacement hardware by 2013. The mission load is predicted to exceed current capacity and will need additional spacecraft to provide enough capacity.	The project has awarded a Firm Fixed Price with Incentive Fee contract as of December 2007. Spacecraft will launch in 2012 and 2013.

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Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Human Space Flight Operations

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**0.0**	**0.0**	**114.7**	**88.5**	**88.6**	**88.7**	**89.0**
Space Flight Crew Operations	**0.0**	**0.0**	**114.7**	**88.5**	**88.6**	**88.7**	**89.0**
Changes from FY 2009 Request	**0.0**	**0.0**	**114.7**	**88.5**	**88.6**	**88.7**	**--**

Program Overview

As the Space Shuttle program (SSP) comes to closure in FY 2010 with the accompanying completion of the International Space Station (ISS), there are a number of unique human spaceflight capabilities and facilities that have primarily supported the Space Shuttle and ISS assembly which NASA will continue to need in order to support human space flight operations into the future. These capabilities are required for continued support of the International Space Station and future support of the Constellation program.

NASA established the Human Space Flight Operations (HSFO) line item beginning in FY 2010 as a single integrated program that will consolidate these capabilities to support multiple agency programs. As a first step, NASA consolidated the funding for Flight Crew Operations Directorate (FCOD) from Exploration Systems Mission Directorate (ESMD) and Space Operations Mission Directorate (SOMD) under this line item. The consolidated project is now known as Space Flight Crew Operations (SFCO) and is currently the only project funded under the HSFO program. NASA will continue to assess and define projects that support human space flight for inclusion in this program in future budget submissions as these capabilities are identified. The projects that will be included will be those deemed to be discrete multi-program functions that support the Agency's HSFO requirements regardless of the vehicle being supported. This proposed approach will allow these capabilities to be reshaped for the future as the agency's needs change. In all cases, the projects would provide program support, including technical input, via boards and panels; requirements, concept and design support; hardware development and testing support; mission support; and essential training.

Plans For FY 2010

For FY 2010, the SFCO will support up to six human space flights on the Space Shuttle to the ISS and provide support and training for crew members preparing for future flights to the ISS. In addition, SFCO provides technical and safety panel support to the Constellation program, participates on the CEV cockpit design review team, and provides early template astronaut flight readiness training requirements.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Human Space Flight Operations

Project Descriptions and Explanation of Changes

Human Space Flight Operations

In FY 2010, the SFCO project is the only funded project under this program. The SFCO project provides trained crew members for all of NASA human space flight endeavors and to bring experienced crew member expertise to help resolve operations or development issues within the human space flight programs. SFCO is responsible for all JSC aircraft operations including aircrew training.

Program Management

HSFO's program manager reports to the Associate Administrator for the Space Operations Mission Directorate at NASA Headquarters.

Acquisition Strategy

The contracts supporting the Space Flight Crew Operations project are the Aircraft Maintenance and Modification Program (AMMP) provided by the Computer Services Corp. and the Aircraft Simulation Program (ASP) contract with Lockheed Martin.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Launch Services

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**91.8**	**89.6**	**85.9**	**84.1**	**83.9**	**83.9**	**82.8**
Launch Services	**91.8**	**89.6**	**85.9**	**84.1**	**83.9**	**83.9**	**82.8**
FY 2009 President's Budget Request	**91.7**	**99.6**	**84.0**	**83.4**	**83.8**	**83.8**	**--**
Launch Services	**91.7**	**99.6**	**84.0**	**83.4**	**83.8**	**83.8**	**--**
Changes from FY 2009 Request	**0.0**	**-10.0**	**1.8**	**0.7**	**0.1**	**0.2**	**--**

Program Overview

Assuring reliable and cost-effective access to space for missions is critical to achieving the U.S. Space Exploration Policy. NASA has assigned responsibility for understanding the full range of civil space launch needs to the Space Operations Mission Directorate Launch Services Program. The Launch Services Program, which works closely with other government agencies and the launch industry, seeks to ensure that the most safe, reliable, on-time, cost-effective commercial launch opportunities are available on a wide range of launch systems. A key challenge for the program is matching the launch capabilities to the needs of the different civil government customers. These customers seek to: understand Earth processes, including the use of weather satellites; explore the solar system with planetary probes, Mars rovers, and orbiters; understand the universe primarily through the use of space-based telescopes; and enhance life on Earth by understanding the Earth-Sun system using various scientific missions. The program purchases fixed-price launch services from domestic suppliers and provides oversight to ensure that these valuable, one-of-a-kind missions safely leave Earth to explore this planet and the universe beyond. The program works with customers from universities, industry, government agencies, and international partners from the earliest phase of a mission. The funding provides the capability for NASA to maintain critical skills that provide technical management of launch services on the full fleet of existing and new launch systems. For more information, please see http://www.nasa.gov/centers/kennedy/launchingrockets/index.html.

The Launch Services Program budget also supports integration activities for the Alpha Magnetic Spectrometer scientific instrument comprised of a 16-nation international particle physics and astrophysics experiment planned for the ISS that will look for dark matter, anti-matter, and strange matter. This experiment is sponsored by the Department of Energy and funded largely by International Partners.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Launch Services

Plans For FY 2010

There are four planned NASA launches for FY 2010 including Glory which will be launched on a Taurus XL; Solar Dynamics Observatory (SDO) on an Atlas V; and Widefield Infrared Survery Explorer (WISE) and Aquarius missions on a Delta II. The LSP will also provide advisory expertise and services to SpaceX's second and third demonstration flights under the COTS Project and the Geostationary Operational Environmental Satellite (GOES-P) under the NOAA/GOES Program. In addition to the processing, mission analysis, spacecraft integration and launch services of the above missions, LSP will continue the advanced planning and trade studies for launching future missions that will extend scientific knowledge and exploration capabilities, such as a mission to Jupiter, the next-generation Mars rover, and a mission to monitor climate trends and global biological productivity. LSP will also conduct advanced planning to support the evolving launch requirements for Moon and Mars exploration. Although NASA will begin to face challenges with all classes of launch services in 2010, LSP will continue to provide support for the development and certification of emerging Alternative Launch Providers.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Launch Services

Project Descriptions and Explanation of Changes

Launch Services Program

The primary elements of the Launch Services Program (LSP) are described below. LSP provides the acquisition of commercial services using primarily domestic launch vehicles and associated standard services and mission unique options. These services are contracted through LSP at the Kennedy Space Center. LSP provides acquisition and management of all program-related services; program-level financial management including the integration and insight of the launch services tasks across multiple Centers; and management of all program resource requirements. LSP provides the Contracting Officer Technical Representative function for launch service contracts, and support services contracts, ensuring consistency and best practices are followed. LSP assures NASA retains the technical, management, and acquisition skills necessary to meet customer demand by providing the necessary resources required to meet the Agency's various needs.

LSP provides mission integration, technical, and launch management functions. Manifesting and scheduling of payload launches are accomplished through the auspices of the Flight Planning Board. Through this process all space access requirements and priorities are assessed to develop flight planning manifests that best meet the requirements and capabilities of the Agency. LSP acquires launch services to meet the full range of customer requirements, ranging from finding space for small payloads to the launch of dedicated payloads on a range of launch vehicles. LSP also provides technical management of the launch service, including planning, execution, and support for flight project customer requirements. This element of the program provides for planning and implementation of mission-specific integration activities, coordination and approval of mission-unique launch vehicle hardware/software development, and provision of payload-processing accommodations. Additionally, LSP offers management of the launch campaign/countdown including coordination with other government agencies and the commercial sector.

LSP provides engineering services and analysis for launch vehicle certification at levels of detail commensurate with the mission risk tolerance. The program maximizes the mission success of commercially developed expendable launch services by employing a technical oversight approach that includes a combination of specified approvals and targeted insight. This element also provides for the coordination of mission-specific and fleet-wide launch vehicle analyses, hardware changes, and production oversight, assessments, and out-of-family anomaly resolution.

LSP Construction of Facility (COF) projects support repairs and modifications to existing buildings and launch pads on the Eastern and Western Coasts which sustain the processing, operations, and launch of NASA spacecrafts. A list of the total COF projects are included in the Cross Agency Support (CAS) section of this document.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
The Launch Services Program is planning for 18 Missions by 2014 and is providing an advisory role for 5 additional missions.	SMD - 16 Missions, and SOMD - 2 Missions	None

Program Management

The Launch Services Program Manager reports to the Assistant Associate Administrator for Launch Services, Space Operations Mission Directorate at NASA Headquarters.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Launch Services Acquisition and Management	Launch Services Program, Kennedy Space Center	Kennedy Space Center	Air Force, National Reconnaissance Office
Engine Assembly and Test	Launch Services Program, Kennedy Space Center	Stennis Space Center	Air Force, National Reconnaissance Office
Mission Planning and Integration	Launch Services Program, Kennedy Space Center	Kennedy Space Center	Science Mission Directorate, Exploration Systems Mission Directorate, Space Operations Mission Directorate, Missile Defense Agency, NOAA
Vehicle Production Insight	Launch Services Program, Kennedy Space Center	Marshall Space Flight Center	Air Force, National Reconnaissance Office

Acquisition Strategy

Under the NASA Launch Services (NLS) contracts with United Launch Alliance, Orbital Sciences Corporation (OSC), and Space Exploration Technologies, Inc. (SpaceX), the program acquires services associated with launches of Delta, Atlas, Pegasus, Taurus, and Falcon launch vehicles. Services are provided on a Firm-Fixed-Price / Indefinite-Delivery-Indefinite-Quantity (IDIQ) basis, and missions can be ordered under these contracts through June 2010. Missions not presently under contract are competed among existing NLS contractors through use of a Launch Service Task Order mechanism. In addition to the NLS contracts, the Glory mission is the only active one remaining under the Small Expendable Launch Vehicle Services contract with OSC.

The NLS solicitation contains a provision that permits technology infusion or improvements. New offerors may seek an NLS contract during open seasons that occur each year in February and August. The NLS contracts enable ordering of standard and non-standard services, as well as special studies and mission-unique modifications.

Integrated launch services are provided by the Analex Corporation through a hybrid fixed-price/cost contract which contains options to continue performance through September 2011. Payload processing for East Coast missions is provided by Astrotech Space Operations. West Coast payload processing is provided after a competitive selection by either Astrotech or Spaceport Systems International.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Launch Services

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO Assessment	10/2006	This was a Non-Advocate Review (NAR) of LSP to present information to Agency decision-making councils. The IPAO Review Team found that LSP is a highly successful program compliant with Agency direction, policy and directives. The review further illustrated that LSP's 100 percent launch success record, together with sound cost management, and demonstrates exceptional performance.	2009

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Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Rocket Propulsion Test

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**41.9**	**41.8**	**45.8**	**44.6**	**44.5**	**44.5**	**44.5**
Rocket Propulsion Testing	**41.9**	**41.8**	**45.8**	**44.6**	**44.5**	**44.5**	**44.5**
FY 2009 President's Budget Request	**41.9**	**41.8**	**44.3**	**44.7**	**44.6**	**44.6**	**--**
Rocket Propulsion Testing	**41.9**	**41.8**	**44.3**	**44.7**	**44.6**	**44.6**	**--**
Changes from FY 2009 Request	**0.0**	**0.0**	**1.5**	**0.0**	**0.0**	**0.0**	**--**

Program Overview

As the principal implementing authority for NASA's rocket propulsion testing, the Rocket Propulsion Test (RPT) Program reviews, approves, and provides direction on rocket propulsion test assignments, capital asset improvements, test facility modernizations and refurbishments, integration for multi-site test activities, identification and protection of core capabilities, and the advancement and development of test technologies.

RPT employs a collaborative approach to ensure rocket propulsion test activities are conducted in a manner that reduces cost, enhances safety, provides credible schedules, achieves technical objectives, and leverages the lessons learned. RPT reduces propulsion test costs through the safe and efficient utilization of rocket propulsion test facilities in support of NASA programs, commercial partners, and the Department of Defense, while eliminating unwarranted duplication. RPT sustains and improves Agency-wide rocket propulsion test core capabilities (both infrastructure and critical skills) and ensures appropriate levels of capability and competency are maintained.

The program strategy is to fund and maintain a core competency of skilled test and engineering crews and test stand facilities; consolidate and streamline NASA's rocket test infrastructure; establish and maintain world-class test facilities; modernize test facility equipment; provide non-project specific equipment and supplies; and develop effective facility/infrastructure maintenance strategies and performance. RPT provides critical institutional and program capabilities to support NASA's missions.

Further information on the RPT Program can be found at: https://rockettest.ssc.nasa.gov/.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Rocket Propulsion Test

Plans For FY 2010

Test facility management, maintenance, sustaining engineering, operations, and facility modernization projects required to keep the test-related facilities in the appropriate state of operational readiness will continue to be funded. Established testing requirements for the exploration program will be used to identify excess and "at-risk" test facilities and will support decisions relative to test asset consolidation initiatives. RPT's inventory of 32 test locations, ranging from active to mothballed facilities, will continue to be maintained at various states of operational readiness as required. Propulsion test technology development will also be continued.

The RPT Program will also continue to assist in the rocket propulsion testing requirements definition for low Earth orbit and in-space propulsion systems and related technologies.

Project Descriptions and Explanation of Changes

RPT

RPT represents the single point interface for NASA's rocket propulsion test facilities located at: Stennis Space Center (SSC), Marshall Space Flight Center (MSFC), Johnson Space Center-White Sands Test Facility (JSC-WSTF), and Glenn Research Center-Plum Brook Station (GRC-PBS). These facilities have a replacement value of greater than $2 billion. The RPT sustains and improves Agency-wide rocket propulsion test core competencies (both infrastructure and critical skills), ensures appropriate levels of capability and competency are maintained, and eliminates unwarranted duplication. The program strategy is to fund and maintain core competencies of skilled test and engineering crews and test stand facilities; consolidate and streamline NASA's rocket test infrastructure; establish and maintain world-class test facilities; modernize test facility equipment; provide non-project specific equipment and supplies; and develop effective facility/infrastructure maintenance strategies and performance. The RPT budget does not include resources to support the marginal costs of testing (e.g., direct labor, propellants, materials, program-unique facility modifications, etc.) since these activities are funded by programs as a direct cost when they utilize the RPT test stands. When NASA, DoD, and commercial partners use the RPT-supported test stands, they are responsible for program-specific facility modifications in addition to the active testing of the program-specific test article.

RPT Construction of Facility (CoF) supports a project to modify the fluid processing facility at Stennis Space Center. A list of the total CoF projects are identified in the CAS section of this document.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Support continued commercial testing of RS-68 engine.	Pratt Whitney Rocketdyne/Air Force	None
Support continued testing of SSME, Shuttle Reaction Control System, and SRB Technology testing.	Space Shuttle Program	None
Support J-2X, Orion System, and ESMD Propulsion System technology development.	Constellation Program	None

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Rocket Propulsion Test

Program Management

The Rocket Propulsion Testing Program Manager reports to the Assistant Associate Administrator for Launch Services, Space Operations Mission Directorate at NASA Headquarters.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Technical Services and Support	Stennis Space Center	Jacobs-Sverdrup, Mississippi Space Services, Plum Brook Operations Support Group	Rocket Propulsion Test Management Board Members: Stennis Space Center, Marshall Space Flight Center, Johnson Space Center, White Sands Test Facility, Glenn Research Center's Plum Brook Station, Kennedy Space Center (associate member), and Glenn Research Center (associate member). National Rocket Propulsion Test Management Board Department of Defense Members: Air Force Research Lab, Arnold Engineering Development Center, Redstone Technical Test Center, and Naval Air Warfare Center.

Acquisition Strategy

The Test Operations Contract (TOC) will be completing its final option contract period in September 2010. A new contract will be openly competed at that time.

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Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Crew Health & Safety

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**8.7**	**8.6**	**8.6**	**8.5**	**8.5**	**8.5**	**8.5**
Crew Health and Safety	**8.7**	**8.6**	**8.6**	**8.5**	**8.5**	**8.5**	**8.5**
FY 2009 President's Budget Request	**8.7**	**8.6**	**8.6**	**8.5**	**8.5**	**8.5**	**--**
Crew Health and Safety	**8.7**	**8.6**	**8.6**	**8.5**	**8.5**	**8.5**	**--**
Changes from FY 2009 Request	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**--**

Program Overview

The health care of the NASA Astronaut Corps is the responsibility of Space Medical Operations at the Johnson Space Center. A portion of the responsibilities is managed within the Crew Health and Safety (CHS) Program. CHS enables healthy and productive crew during all phases of spaceflight missions and on the ground; implementation of a comprehensive health care program for astronauts; and the prevention and mitigation of negative long-term health consequences of space flight. The program works towards these goals by providing the means to capture and analyze the evidence base essential to identify health risks and apply this information to operational medicine. CHS also develops, assesses, and refines standards for clinical and physiological testing, in-flight health and performance, and environmental monitoring. Requirements for the medical care system are continually assessed and refined, modifications and enhancements identified, and development of capabilities undertaken when needed.

Plans For FY 2010

CHS will continue to help develop and refine a standardized battery of clinical and physiological tests for all crewmembers. Refinement of evidence-based information with the intent of applying this information to operational medicine continues. Crew Health Surveillance special projects will focus on developing and refining medical standards. This is critical to meet the needs of exploration timelines. Similarly, real-time mission evaluation will continue to help define and deliver medical operations hardware for current programs and meet the needs of known architectures. The Longitudinal Study of Astronaut Health will be enhanced with respect to data archiving and mining. This is crucial to being able to provide health information for current and future operational medical response, as well as for countermeasures development. Remote Medical Diagnostic and Informatics will design, implement, and maintain a comprehensive data management infrastructure. Modules for real-time collection of medically relevant mission data will continue to be added to the Mission Medical Information System this year. Additional tools will be implemented as operational needs and priorities are identified. NASA will continue adding all forms of clinical data to the Computerized Medical Information System, which is an electronic medical record used for real-time documentation of clinical care at the point of care. Finally, CHS will continue to develop and maintain environmental standards for all space exploration platforms.

Project Descriptions and Explanation of Changes

Crew Health and Safety

The Crew Health and Safety Program (CHS) medically prepares our astronauts for space flight, protects them from the hazards of space travel, and identifies methods that allow astronauts to improve their performance. CHS systematically identifies and assesses critical health and safety risks through projects such as Clinical Status Evaulation, Crew Health Surveillance, Real-Time Mission Evaluation, Longitudinal Study of Astronaut Health, Remote Medical Diagnostic and Informatics, Computerized Medical Information System, Clinical Care Capability Development Project, and Environmental Monitoring.

There were no changes in scope, schedule, or direct costs for FY 2008 and beyond.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Analysis of Fitness-for-Duty Standards	Clinical Status Evaluation	None
Data Reports	LSAH	None
Database for Medical Requirements Data	Remote Medical Diagnostic & Informatics	None
Medical Hardware Certification Process Revision	Clinical Care Capability Development	None
Electronic Medical Record System	Computerized Medical Information System	None
Environmental Standards	Environmental Monitoring	None

Program Management

The Crew Health and Safety Program Manager reports to the Deputy Associate Administrator for Program Integration within Space Operations at NASA Headquarters.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Clinical Status Evaluation	JSC	JSC/Wyle	N/A
Crew Health Surveillance	JSC	JSC/Wyle	JSC/Wyle
Real-Time Mission Evaluation	JSC	JSC/Wyle	N/A
Longitudinal Study of Astronaut Health	JSC	JSC/Wyle	N/A
Remote Medical Diagnostic & Informatics	JSC	JSC/Wyle	N/A
Computerized Medical Information System	JSC	JSC/Wyle	N/A
Clinical Care Capability Development Project	JSC	JSC/Wyle	N/A
Environmental Monitoring	JSC	JSC/Wyle	N/A

Acquisition Strategy

No major acquisitions planned.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	Institute of Medicine	03/2007	At the request of NASA, the Institute of Medicine established a committee and issued this report. The committee was charged with examining the process by which NASA establishes space flight health standards for human performance. It assured the transparency of the current process, as well as considering its validity and integrity, particularly related to ensuring worker safety and integrating stakeholder input.	TBD
Other	Institute of Medicine	07/2008	This report examines NASA's plans to assemble the available evidence on human health risks of spaceflight and to move forward in identifying and addressing gaps in research. The committee provided recommendations to strengthen the content, composition, and dissemination of the evidence books.	04/2009

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Overview

NASA's Office of Education performs a leading role in inspiring the next generation of explorers through lessons, materials, research opportunities and hands-on activities that draw on NASA's unique missions. The National Research Council (NRC) in 2008, stated that "NASA has a unique and important role to play in motivating and inspiring students to consider STEM careers, and citizens to become more knowledgeable participants in the scientific arena." Accordingly, NASA's awe-inspiring science, technology, engineering, and mathematics (STEM) initiatives lead the Nation's exploration of our Earth and its climate, Moon, Mars, and beyond, as well as engage teachers and learners of all ages in various classrooms venues. The Office of Education works to align the NASA education strategy with national STEM priorities in collaboration with other Federal agencies, and state and local education leaders.

NASA is a leader among Federal Research and Development agencies in promoting STEM education opportunities. NASA partners with academic institutions, professional education associations, industry, and other Government agencies to provide teachers and faculty with the experiences that capitalize on the excitement of NASA's discoveries to spark their students' interest and involvement. NASA invests in teacher professional development, post-secondary STEM degrees, school-based resources, and multiple on-line learning options. NASA resources and opportunities are available to a diverse audience of educators and students, including women, minorities, and persons with disabilities.

In FY 2010, NASA will pursue the following education priorities:
- Stimulate competitive research, through grants to universities, targeted education and support to our Nation's Minority Serving Institutions. In order to prepare students for future employment at NASA, in aerospace industry, or academia, student activities will be directly tied to real-world experiences (i.e., Constellation, Mars Exploration; global climate change; aeronautics).
- Provide opportunities for student flight projects to gain access to space. Through partnerships (NASA Centers, universities and industry), students will gain research experiences and hands-on engineering experience on a variety of real-world flight platforms (high altitude balloons, sounding rockets, aircraft, and space satellites).
- Prepare pre-college students for studies in science and mathematics and increase number of science and engineering graduates. High school students will intern under mentorship of NASA scientists and engineers, and university students will participate in ongoing space and aeronautics research missions. Many will contribute to original research and support designing hardware to fly on future NASA missions. Scholarships will be offered to the Nation's most talented students to support their studies and to help make college affordable.
- Recruit NASA scholarship, internship and fellowship recipients into cooperative-education (co-op) and Federal Career Intern Program (FCIP) positions open at NASA.
- Invest in strengthening curricula at the Nation's two-year community colleges which are critical to ensuring students are prepared for work and to successfully transition to four-year institutions. Additionally, NASA will promote graduating students having skills, knowledge, and hands-on experience to make them competitive when applying for employment with NASA, academia, or aerospace industries.
- Immerse students and educators in current NASA science and technology, using social networks, Internet collaborations, a virtual magnet school, and an online science teacher's certificate. NASA will make extensive use of telepresence technology, from web disseminated information and remote control of science instruments, to learning in virtual worlds.
- Inspire learning through participating in authentic experiences via NASA's Digital Learning Network (DLN). Student design competitions will be tied to NASA's ongoing priorities, allowing teachers to engage students in real-time, cutting edge science and engineering problems. DLN will "beam" NASA scientists, engineers, and astronauts into any classroom in the nation for real-time videoconferences on topics related to NASA science and engineering. An electronic professional development system for pre-service, in-service, and informal educators will go live in 2010.
- Capitalize on the flight experiences of Educator Astronaut, Dorothy Metcalf-Lindenburger, aboard Shuttle Atlantis STS-131, to help Americans excel and embrace science and engineering.

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**146.8**	**169.2**	**126.1**	**123.8**	**123.8**	**123.8**	**125.5**
Education	146.8	169.2	126.1	123.8	123.8	123.8	125.5
FY 2009 President's Budget Request	**146.8**	**115.6**	**126.1**	**123.8**	**123.8**	**123.8**	**--**
Education	146.8	115.6	126.1	123.8	123.8	123.8	--
Total Change from FY 2009 President's Budget Request	**0.0**	**53.6**	**0.0**	**0.0**	**0.0**	**0.0**	**--**

Note: In all budget tables, the FY 2010 President's Budget Request depicts the September 2008 Operating Plan for the 2008 Actuals and the 2009 Omnibus Appropriations Act (P.L. 111-8) and the American Recovery and Reinvestment Act (P.L. 111-5) for the 2009 enacted.

Plans for FY 2010

Education

Education

New Initiatives:

None

Major Changes:

In FY 2010, NASA is reorganizing its Education Mission Directorate into three programs: Higher Education STEM Education, K-12 STEM Education, and Informal STEM Education.

Higher Ed STEM Education will include STEM Opportunities, Minority University Research and Education Program (MUREP), Space Grant, and Experimental Program to Stimulate Competitive Research (EPSCoR). NASA also tracks within this program the funding the Congress provided for the Global Climate Change Education in 2008 and 2009. These projects will build, sustain, and provide a skilled, knowledgeable, diverse, and high performing workforce to meet the current and emerging needs of NASA and the Nation.

K-12 STEM Education includes 3 main areas. STEM Student Opportunities engage and help retain students in STEM disciplines through flight opportunities, hands on research and engineering experiences, and increased knowledge of NASA science & technology content. STEM Teacher Development uses NASA's content and resources to provide pre-service and classroom teachers with learning experiences to build STEM skills and better motivate students to pursue STEM careers. NASA also tracks within this program the funding the Congress provided in 2008 and 2009 for the K-12 Competitive Educational Grant Program.

Informal STEM Education will support requests that come to NASA Centers from scouting groups, community based organizations, and other informal education providers who use NASA content to engage their audiences in STEM experiences. NASA will also support the Nation's museums, science centers and planetariums in developing innovative educational experiences that help the American public understand NASA's exploration mission. NASA also tracks within this program the funding the Congress provided in 2008 and 2009 for science center, museum, and planetarium grants and the NASA Visitor Centers' education activities.

NASA does not request FY 2010 funding for the Global Climate Change Education, the K-12 Competitive Educational Grant Program, Science Museums and Planetarium Grants, or NASA Visitors Centers. NASA will be able to address the intended outcomes of these initiatives as well as NASA's stated education goals through programs for which the Agency is requesting funding.

Major Highlights for FY 2010

In FY 2010, NASA will invest $126M in STEM education. From this investment, NASA's Office of Education proposes to:

- Support more than 3,000 of the Nation's talented undergraduate and graduate students studying in STEM fields with scholarships, internships, and fellowships.

- Recruit students who receive scholarships, internships, and fellowships from NASA into co-op and Federal Career Intern Program (FCIP) positions that are open at NASA Centers.

- Engage the capacity of over 550 of the Nation's colleges and universities through the National Space Grant College and Fellowship Program to engage students in student launch activities, scholarships, research, and courses based upon NASA science and engineering.

- Provide over $24M in grants to universities to support NASA-related research and to enhance their capacity to compete for new Federal research dollars.

- Provide 470,000 K-12 students with hands-on STEM experiences based on NASA's science and engineering disciplines.

- Link students in every state to NASA's missions, including the flight of Educator Astronaut Dorothy Metcalf-Lindenburger, via the Internet, Digital Learning Network, and other interactive technologies.

- Provide stipends, scholarships, internships, and fellowships for 350 underserved and underrepresented individuals beginning their careers as new faculty or entering the K-12 teaching profession.

- Ensure every Minority Serving Institution in the Nation has an awareness of NASA education and the tools necessary to support students applying for NASA support.

- Based upon science and shuttle missions launched in 2010, release three student design competitions, providing middle and high school students an opportunity to participate in activities based upon NASA's work.

- Publish interim results of the 2008 and 2009 NASA K-12 Competitive Grant Program, including: linkages between authentic research and field-based studies for students, new science courses for secondary school or dual credits (high school and college) based on NASA content, and new technology tools that extend the reach and impact of NASA activities to diverse audiences.

- Streamline applications for undergraduate and graduate students seeking internships and fellowships at NASA Centers, thus allowing students to apply to multiple centers and internship programs through one application.

- Connect prospective students to current interns via social networking technologies to allow peer-to-peer mentoring and coaching.

Mission Directorate:	Education
Theme:	Education

Theme Overview

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**146.8**	**169.2**	**126.1**	**123.8**	**123.8**	**123.8**	**125.5**
Higher Ed. STEM Education	92.0	107.7	80.6	80.6	80.6	80.7	80.7
K-12 STEM Education	41.3	47.5	43.3	41.0	41.0	41.0	42.7
Informal STEM Education	13.5	14.0	2.1	2.1	2.1	2.1	2.1
FY 2009 President's Budget Request	**146.8**	**115.6**	**126.1**	**123.8**	**123.8**	**123.8**	**--**
Education	146.8	115.6	126.1	123.8	123.8	123.8	--
Total Change from FY 2009 Request	**0.0**	**53.6**	**0.0**	**0.0**	**0.0**	**0.0**	**--**

Relevance

Relevance to national priorities, relevant fields, and customer needs:

Forty years after Apollo XI landed on the moon, the Nation faces new challenges and competition to our leadership in science, technology, and innovation. NASA's education investments increase the scientific literacy of students and the public, enabling a better understanding of technology advances and building a stronger STEM workforce.

NASA helps to ensure the Nation's future competitiveness by building and improving youth interest in STEM careers, quality of teacher preparation, student achievement in STEM disciplines, practices in enabling STEM learning at all levels, students interest in and out of the classroom, and public understanding and interest in STEM.

NASA is uniquely qualified to achieve these goals because of its inspiring missions, workforce, facilities, research, and innovations. NASA provides one-of-a-kind opportunities for students, teachers, and the public to gain access to authentic spaceflight projects and real-world experiences derived from our exploration and aerospace missions.

Relevance to the NASA Mission and Strategic Goals:

NASA Education works to foster a science, technology, engineering, and math workforce in fields that support NASA's strategic goals; attract students to the disciplines through a progression of education opportunities; and build strategic partnerships between formal and informal education providers. Education investments are an important component to establishing NASA affinity with students and institutions to help ensure workforce availability in needed disciplines to support NASA's mission. To this end, education investments are a significant part of an integrated Agency-wide approach to human capital management, supporting Agency strategic goals.

NASA grounds all education in the NASA science and exploration missions and works cooperatively with the Mission Directorates in planning and implementation. Activities and experiences offered to students provide authentic opportunities to interact with scientists and engineers, perform hands-on operations, and conduct cutting-edge research in areas critical to NASA's exploration plans. Providing these experiences and pipelining participants into NASA, aerospace industry, and academic employment will result in a robust workforce that enables the Nation to compete globally in related science and technology fields.

See FY 2010 Performance Plan, under Management and Performance, for specific annual goals for Education.

Relevance to education and public benefits:

NASA Education implements a continuum of projects that increase the number of students proficient in STEM, who choose to major in STEM disciplines, and pursue careers in STEM fields, an imperative for NASA and the Nation.

NASA is committed to engaging all people in the results of our missions, research, and innovations. NASA sustains relationships with more than 500 colleges and universities, hundreds of K-12 schools/districts, and more than 350 museums and science centers. In conjunction with products and services provided through extended networks, professional partners, and education technologies, these relationships enable NASA to reach tens of thousands of collegians, more than a million K-12 students, and innumerable members of the general public each year. Student and public interest and engagement in NASA missions helps create a more scientifically literate and globally competitive populace.

NASA leverages and helps to grow the infrastructures and capabilities of formal and informal education communities by: providing access to NASA staff, research, technology, information, and facilities; supporting cutting-edge student research that contributes to NASA missions; creating necessary professional development opportunities for STEM educators; and by forming collaborative partnerships that improve STEM teaching and learning in formal and informal education. NASA targets recruitment and retention of underserved and underrepresented students, drawing on a largely untapped source of talent to create a diverse future workforce to better serve the Agency and the Nation.

Performance Achievement Highlights:

NASA's Office of Education Performance Achievement Highlights for FY 2008 are reflected below:

- NASA provided opportunities to help students and educators gain hands-on experiences in a range of science, technology, engineering, and mathematics (STEM) related areas through internships, fellowships, and research. These opportunities provided students with the motivation, inspiration, and experience needed to serve the Nation's current and future workforce needs. NASA provided for more than 3,000 summer internships at Centers; more than 800 study opportunities, including 538 Space Grants, to underserved students, teachers, and faculties; and 139 grants were awarded to 50 underrepresented and underserved institutions. Of the students who participated in undergraduate programs, 44 percent continued to pursue advanced degrees. Of those students who completed a NASA program and were eligible to enter the workforce, 51 percent entered NASA-related careers, including working for NASA, aerospace contractors, universities and other educational institutions.
- NASA attracted and retained students in STEM disciplines through the use of educational opportunities for students, teachers, and faculty. An example is the Lunar Plant Growth Chamber Engineering Design Challenge, which achieved participation of over one million students who designed greenhouse chambers to study plants grown from seeds that flew in space. Students also conducted classroom experiments that may help NASA find new ways to grow and sustain plants in space and on the Moon. Other examples of NASA attracting and retaining students in STEM disciplines were achieved with: (1) engaging over 200 high school interns in NASA STEM activities (underrepresented and underserved students targeted) in NASA's Interdisciplinary National Science Program Incorporating Research & Education (INSPIRE) program which has been implemented across NASA's 10 Centers; (2) using new Digital Learning Network (DLN) technology enabling NASA scientists and engineers to virtually "beam" into classrooms throughout the Nation; and (3) supporting NASA Explorer Schools activities that reached over 105,000 students through instructional and enrichment activities.
- NASA promoted a continuous awareness of its Mission and STEM literacy by partnering with the NASA Museum Alliance, the Space Place Network (in every state), the Smithsonian, NASA Visitor Centers, and the Office of Education on a number of special projects. For example, the NASA Museum Alliance provided programming at various museums. This, in turn, allowed the museums to share coverage of Shuttle flights STS-122, 124 and 126. Additionally, coverage and exhibits on a number of aeronautics and space activities, such as the Mars rovers, the Mars Reconnaissance Orbiter (MRO) spacecraft, and the study of heliophysics were made available to many visitors.
- NASA supported innovative efforts to improve global climate education for educators and students, through the Global Climate Change Education initiative that the Congress funded in both FY 2008 and FY 2009.
- NASA awarded grants to public schools and nonprofit organizations on a competitive basis, through the K-12 Competitive Educational Grant Program that the Congress funded in both FY 2008 and FY 2009 to seek out and support new, innovative, and replicable approaches to improving STEM learning and instruction.
- NASA selected institutions to develop and implement public engagement activities and enhance education programs related to space exploration, aeronautics, space science, Earth science, or microgravity through the Science Museums and Planetarium Grants initiative that the Congress funded in both FY 2008 and FY 2009.
- NASA provided resources at the ten NASA Centers to enhance education activities (e.g. Science on a Sphere) through the NASA Visitor Centers initiative that the Congress funded in both FY 2008 and FY 2009.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
All	Abt Associates, Cambridge, MA	FY 2008	An external independent evaluation of the SEMAA project, (including RCT), is assessing the effectiveness and determining how intended goals are being implemented. Evaluation will consider the overall effort, provide data on how differences in effectiveness are associated with site-site variations, and offer explanations for observed outcomes. Abt is to provide results in FY 2009.	FY 2013
All	Abt Associates, Cambridge, MA	FY 2009	The external evaluation contractor is initiating the planning phase for reviewing selected projects in the Higher Education program.	FY 2010
All	NRC - National Academies	FY 2008	An external independent review and critique of Elementary & Secondary Ed Program, conducted by the NRC, included: 1) effectiveness of program; 2) adequacy of metrics and data collection, effectiveness of individual projects 3) funding priorities in the program; 4) extent and effectiveness of coordination and collaboration between NASA and other federal agencies. Outcome: NRC reinforced the important role of NASA STEM education; several recommendations were provided and are being implemented.	2010-12

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Mission Directorate:	Education
Theme:	Education
Program:	Higher Ed. STEM Education

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	92.0	107.7	80.6	80.6	80.6	80.7	80.7
STEM Opportunities (Higher Education)	9.0	9.5	11.6	11.6	11.6	11.6	11.6
NASA Space Grant	35.7	40.0	28.4	28.4	28.4	28.4	28.4
Experimental Program to Stimulate Competetive Research	12.8	20.0	10.0	10.0	10.0	10.0	10.0
Minority University Research & Education Program	27.5	28.2	30.7	30.7	30.7	30.7	30.7
Global Climate Change Education	7.0	10.0	0.0	0.0	0.0	0.0	0.0
FY 2009 President's Budget Request	92.0	74.7	79.1	79.1	79.2	79.2	--
STEM Opportunities (Higher Education)	9.0	9.5	10.1	10.1	10.1	10.1	--
NASA Space Grant	35.7	28.7	28.4	28.4	28.4	28.4	--
Experimental Program to Stimulate Competitive Research	12.8	8.3	10.0	10.0	10.0	10.0	--
Minority University Research & Education Program	27.5	28.1	30.7	30.7	30.7	30.7	--
Global Climate Change Education	7.0	0.0	0.0	0.0	0.0	0.0	--
Changes from FY 2009 Request	0.0	33.0	1.5	1.5	1.5	1.5	--

Project Descriptions and Explanation of Changes

STEM Opportunities (Higher Education)

STEM Opportunities focuses on strengthening the research capabilities of the Nation's colleges and universities, and providing opportunities that attract and prepare increasing numbers of students for NASA-related careers. The research conducted by these institutions contributes to the research needs of NASA's Mission Directorates and furthers the Nation's scientific and technology innovation agendas. The student projects serve as a major link in the pipeline for addressing NASA's Human Capital Strategies. The projects build, sustain, and effectively deploy the skilled, knowledgeable, diverse, and high-performing workforce needed to meet the current and emerging needs of NASA and the Nation's workforce.

STEM Opportunities will consist of the following projects:

- Undergraduate Student Researchers Project (USRP) attracts undergraduate students from the widest array of backgrounds, who are fully representative of America's racial, economic, ethnic, and cultural diversity. It provides them with hands-on, challenging research experiences that stimulate continued student interest in the fields/disciplines aligned with NASA's research and development mission.

- Graduate Student Researchers Project (GSRP) cultivates research ties to the academic community to help meet the continuing needs of the Nation's aeronautics and space effort. GSRP increases the number of highly trained scientists and engineers in aeronautics and space-related disciplines, and broadens the base of students pursuing advanced degrees in science, mathematics, and engineering. The program awards research fellowships for graduate study leading to masters or doctoral degrees in the fields of science, mathematics, and engineering related to NASA research and development.

- Innovation in STEM Education is a new competitive solicitation, that enables NASA to seek out and support innovative and replicable approaches to improve STEM learning and instruction, and opportunities for student and faculty to participate in NASA related research.

National Space Grant

National Space Grant College and Fellowship Program (Space Grant) is a national network of colleges and universities that works to expand opportunities for students and faculty to understand and participate in NASA's aeronautics and space programs by supporting and enhancing science, and engineering education, research, and public information programs.

Mission Directorate:	Education
Theme:	Education
Program:	Higher Ed. STEM Education

Experimental Program to Stimulate Competitive Research

Experimental Program to Stimulate Competitive Research (EPSCoR) develops academic research enterprises that are long term, self-sustaining, and nationally competitive by supporting states with modest research infrastructure to become more competitive in attracting research funding. Funding is awarded to lead academic institutions in twenty-eight eligible states to foster a science, technology, engineering and mathematics (STEM) relationship with industries for research and development opportunities.

Section 704 (b) of the NASA Authorization Act of 2008 (P.L. 110-422) directs that NASA, as part of its annual budget submission, detail additional steps that can be taken to further integrate the participating EPSCoR States in both existing and new or emerging NASA research programs and Center activities. The following information is provided pursuant to this direction:

NASA actively seeks to integrate the research conducted by EPSCoR jurisdictions and the aerospace and exploration agenda being pursued by the Agency. Mission Directorate representatives work closely with EPSCoR program management so that current and future research and engineering needs are reflected in EPSCoR solicitations. The Mission Directorates serve as the proposal selection committee, further ensuring that the selected work contributes to NASA priorities.

Technical Monitors (TM) at the NASA Field Centers and Headquarters monitor and assess the progress of each award. They provide scientific guidance and technical advice throughout the year, as required, on the overall progress of the proposed effort, and review the annual progress report. Additional involvement may occur, depending upon the nature of the collaboration already established or desired. This includes, but is not limited to: integrating the EPSCoR research into ongoing activities or research efforts and increasing the Principal Investigator and his/her team's awareness of other related or relevant research in NASA.

In FY10, NASA Education is planning a technical assistance workshop with EPSCoR jurisdictions.

Mission Directorate:	Education
Theme:	Education
Program:	Higher Ed. STEM Education

Minority University Research and Education Program

Minority University Research and Education Program (MUREP) engages underserved and underrepresented populations in many ways: 1) multiyear grants awarded to assist minority institutions, faculty, and students in research pertinent to NASA missions; and 2) recruitment and retention efforts to students underrepresented in STEM disciplines, through completion of under/graduate degrees through entry into the scientific and technical workforce. The program is composed of Research Clusters, University Research Centers and Minority Institution Collaborations.

Research Clusters is composed of 5 research activities:
- Motivating Undergraduates in Science and Technology (MUST) provides partial scholarships to underserved undergraduate students to support up to 50% of tuition and fees. Students also participate in a NASA Center internship.
- Curriculum Improvement Partnership Award for the Integration of Research (CIPAIR) is a 3-year undergraduate STEM curriculum improvement effort, using NASA related content, for minority institutions (MI), including Historically Black Colleges and Universities, Hispanic Serving Institutions, Tribal Colleges and Universities, and others.
- NASA Science and Technology Institute for Minority Institutions (NSTI-MI) provides research opportunities for faculty and students from MIs that contribute to NASA's astrobiology, biotechnology, IT, and nanotechnology research agenda. Faculty and students collaborate with scientists at NASA, industry, academia and nonprofit organizations to research technologies enabling future exploration.
- Jenkins Pre-doctoral Fellowship Project (JPFP) provides support for underrepresented students (women, minorities, and persons with disabilities) in STEM disciplines who seek advanced degrees and opportunities in NASA-related disciplines, thereby increasing the number of skilled workers. The JPFP provides its participants with access to NASA mentors, NASA research opportunities, and the ability to network and collaborate with the aerospace professionals.
- NASA Administrator's Fellowship Project (NAFP) provides an opportunity for NASA employees to spend a year at MI institutions to help them build research competitiveness. Faculty and administrators spend a year at a NASA Center doing research and gaining experience in the federal system.

University Research Centers provide a broad-based, competitive NASA-related research capability among the Nation's MIs to foster new aerospace science and technology concepts; expand the Nation's base for aerospace R&D; develop mechanisms for increased participation by faculty and students of MI in mainstream research; and increase the number of underserved students obtaining advanced degrees in STEM disciplines.

Minority Institutions Collaborations is a project made up of two activities:
- Tribal College & University (TCU) Project responds to Executive Order 13270, TCU, directing Federal agencies to provide support to Tribal College faculty and students. NASA partners with TCUs to: increase student and faculty involvement in space exploration and cutting-edge technology, improve competitiveness for Federal grants and resources, and provide high-quality educational opportunities to Native American students and faculty.
- MUREP Small Projects support a variety of opportunities for students, teachers, faculty and researchers from underrepresented and underserved communities in NASA-related STEM fields.

Mission Directorate:	Education
Theme:	Education
Program:	Higher Ed. STEM Education

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Provide undergraduates and graduate students opportunities to engage in research and engineering supporting NASA missions.	Higher Education STEM Education Program/ STEM Opportunities	None
Promote a nationwide network of state-based consortia to engage students and faculty in NASA research and other opportunities; enhance capabilities of eligible states and institutions to compete for NASA-sponsored research and technology opportunities	Higher Education STEM Education Program/ Space Grant, EPSCoR	None
Target underserved and under-represented students with opportunities to engage in research and engineering supporting NASA missions. Enhance capabilities of minority serving institutions to compete for NASA-sponsored work.	Higher Education STEM Education Program/ MUREP (Research Clusters, URC, MI Collaborations)	None

Mission Directorate:	Education
Theme:	Education
Program:	Higher Ed. STEM Education

Program Management

The Assistant Administrator for Education is responsible to the NASA Administrator for NASA's education portfolio, reports to the Chief of Strategic Communication, serves as NASA Education Officer, and manages all education responsibilities.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Undergraduate Student Research Program (USRP); [Higher Education STEM Education Program]	Johnson Space Center (JSC)	All NASA Centers	None
Graduate Student Research Program (GSRP); [Higher Education STEM Education Program]	Jet Propulsion Lab (JPL)	All NASA Centers	None
Innovation in STEM Education [Higher Education STEM Education Program]	NASA Headquarters Office of Education	All NASA Centers	None
National Space Grant College and Fellowship Project (Space Grant); [Higher Education STEM Education]	NASA Headquarters Office of Education	All NASA Centers	Fifty-two (52) state (including Puerto Rico and District of Columbia) consortia provide required cost sharing. In FY 2008 it is anticipated that the average ratio of cost sharing to award will be $0.82 to $1.00; as reported in FY 2007.
Experimental Project to Stimulate Competitive Research (EPSCoR); [Higher Education STEM Education]	Kennedy Space Center (KSC)	All NASA Centers	Twenty-seven EPSCoR eligible states provided required cost sharing funds. In FY 2008 it is anticipated that the average ratio of cost sharing to award for EPSCoR research awards will be $0.65 to $1.00 and EPSCoR RID awards will average to $1.05 to $1.00 cost sharing, as reported in FY 2007.
Minority University Research and Education Program (MUREP) Research Clusters; [Higher Ed STEM Ed]	Ames Res Center (ARC), Glenn Res Center (GRC), Jet Prop Lab (JPL), Marshal Space Flight Center(MSFC)	All NASA Centers	None
MUREP: University Research Centers (URC); [Higher Education STEM Education Program]	Dryden Research Flight Center (DRFC)	AL NASA Centers	None
MUREP: Minority Institutions Collaborations; [Higher Education STEM Education]	NASA Headquarters Office of Education	All NASA Centers	None

Acquisition Strategy

NASA solicits new and innovative education products, tools, and services from qualified external organizations. This occurs in response to changes in STEM education trends, identified gaps or opportunities in the education portfolio of investments, a response to demonstrated customer need or demand, or when the Administration or Congress identifies new priorities.

NASA encourages participation of new or less experienced organizations and awards education grants and contracts through full and open competition. NASA includes feedback from staff, subject matter experts, and public in developing solicitations, including the requirements, expected outcomes, schedules, proposal instructions, and evaluation approaches. NASA solicits comments on perceived programmatic risk issues associated with performance of the work. Procurement offices at NASA review all solicitations.

NASA awards all major grants and cooperative agreements based on reviews by external panels of peers for educational merit; NASA and external scientists and engineers for content, merit, feasibility, and alignment to education goals; and Mission Directorates for alignment with NASA's research and development interests. Indications of a clear competitive process are an integral part of reviews. NASA makes awards only after qualified assessments of merit. While competition may sometimes be restricted by legislation to designated participants, such as defined EPSCoR states, grant awards and selection of participating institutions are still determined competitively. When designated participants are identified, all proposals are reviewed for merit, and each award must be justified and deemed worthy of funding.

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Mission Directorate:	Education
Theme:	Education
Program:	K-12 STEM Education

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	41.3	47.5	43.3	41.0	41.0	41.0	42.7
STEM Student Opportunities (K-12)	9.6	10.5	14.5	14.5	14.5	14.5	14.5
STEM Teacher Development (K-12)	20.1	21.0	28.9	26.5	26.5	26.5	28.2
K-12 Competitive Educational Grant Program	11.6	16.0	0.0	0.0	0.0	0.0	0.0
FY 2009 President's Budget Request	41.3	38.9	44.8	42.5	42.5	42.5	--
STEM Student Opportunities (K-12)	6.6	8.6	10.9	10.9	10.9	10.9	--
STEM Teacher Development (K-12)	23.1	30.4	33.9	31.6	31.6	31.6	--
K-12 Competitive Educational Grant Program	11.6	0.0	0.0	0.0	0.0	0.0	--
Changes from FY 2009 Request	0.0	8.6	-1.5	-1.5	-1.5	-1.5	--

Project Descriptions and Explanation of Changes

STEM Student Opportunities (K-12)

STEM Student Opportunities focus on engaging and retaining students in STEM education programs to encourage pursuit of NASA's future engineering, scientific, and technical missions through flight opportunities, hands on research and engineering experiences, and increased knowledge of NASA science & technology content.

The following are projects included in the STEM Student Opportunities portfolio.

- Education Flight Projects provide hands-on experiences to inspire and motivate students to pursue studies and careers in STEM through participation in NASA research applications. Activities include ISS Earth Knowledge Acquired by Middle School Students (EarthKAM), Amateur Radio on the International Space Station (ARISS), ISS In-flight Education Downlinks, and On-orbit Education Activities.

- Interdisciplinary National Science Project Incorporating Research and Education Experience (INSPIRE) is designed to maximize student participation and involvement in NASA and STEM, and enhance the STEM pipeline from high school (grades 9-12) into the undergraduate level.

- Science Engineering Mathematics and Aerospace Academy (SEMAA) reaches K-12 minority and underserved students that are traditionally underrepresented in careers involving STEM. Students meet during school, after school or on Saturday mornings and during the summer to engage in NASA-based hands-on, interactive learning sessions that are specifically designed for each grade level.

- Learning Technologies Project (LTP) develops and refines leading-edge or cutting-edge technologies that are in use within NASA missions and/or projects to enhance the teaching and learning of scientific concepts. Technologies funded under LTP are developed, evaluated, and leveraged with strategic partners to extend reach into educational and commercial applications.

Mission Directorate:	Education
Theme:	Education
Program:	K-12 STEM Education

STEM Teacher Development (K-12)

STEM Teacher Development uses NASA's unique content and resources to provide pre-service and classroom teachers with learning experiences that build critical instructional STEM skills and enable teachers to better motivate students to achieve academic excellence and pursue STEM careers.

The following are projects included in the STEM Teacher Development portfolio.

- Aerospace Education Services Project (AESP) serves the K-12 education community by providing classroom demonstrations, faculty workshops, parent training, in-service and pre-service training for teachers, and appropriate classroom resources.

- NASA Explorer Schools (NES) will take a new direction in FY10. The 2007 National Academies review of the project, input from 2008 external focus groups, and findings and recommendations of the 2009 Benchmarking Study provide the basis for the new secondary education model that will be implemented. The NES project will be open to all interested secondary schools and will heavily utilize current technologies in the delivery of opportunities and experiences to meet the needs of today's learning and learners.

- Endeavor Science Teacher Certificate Program (ESTCP), a new competitive project in 2009 with goal of awarding over 200 Fellowships to in-service and alternative-route teachers over the next 5 years. The project provides workshops to educators of future science teachers at colleges of education. They receive assistance in delivering NASA content in methods and practicum courses for the pre-service teachers. The majority of the Endeavor fellows serve underrepresented student populations. ESTCP assists teachers' professional growth by helping them to earn and maintain state certification.

- NASA Educational Technologies Services (NETS) is responsible for maintaining educational content on NASA Portal, managing operations of Office of Education web site and other e-based dissemination/publishing networks. Additional web support is provided to the education video file (education programming) on the NASA TV Public Services channel and NASA TV Education Services channel.

- Learning Environments and Research Network (LEARN) encompasses 3 major activities: NASA-sponsored Classroom of the Future, Digital Learning Network (DLN), and electronic professional development infrastructure. The intent of LEARN is to conduct empirical educational research that is the basis for development and testing of off-the-shelf and new educational technologies, enabling NASA to better meet the needs of its educational audiences. LEARN will incorporate research findings on cognition, effective application of technology to educational settings, integration of NASA content, and delivery through videoconferencing, Internet multimedia, handheld devices, and dissemination infrastructures available to the Agency.

- e-Education Small Projects develop infrastructure and deploy research-based technology applications, products, and services to enhance the educational process for formal and informal education. The project emphasis is implementation of educational product development, review, and meta-tagging processes and final distribution through approved media, electronic, and/or site-based channels. Another aspect of e-Education Small Projects is the Central Operations for Resources for Educators (CORE). CORE is a national distribution center for NASA's audiovisual educational materials.

Mission Directorate:	Education
Theme:	Education
Program:	K-12 STEM Education

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Provide experiences, tools, & opportunities to educators & students, to engage in missions & learning experiences, & ability to teach/learn in STEM disciplines, & increased use of leveraged multimedia-rich products & technology infrastructures.	K-12 STEM Education/STEM Student Opportunities, STEM Teacher Development	None

Mission Directorate:	Education
Theme:	Education
Program:	K-12 STEM Education

Program Management

The Assistant Administrator for Education is responsible to the NASA Administrator for NASA's education portfolio, reports to the Chief of Strategic Communication, serves as NASA Education Officer, and manages all education responsibilities.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Flight Projects (STEM Student Opportunities); [K-12 STEM Education]	Johnson Space Center (JSC)	All NASA Centers	None
Interdisciplinary Nat Sci Prog Inc Res & Ed Exper (INSPIRE) (STEM Student Opportunity); [K12 STEM Ed]	Kennedy Space Center (KSC)	All NASA Centers	None
Science, Engin. Math & Aerospace Acad.(SEMAA) (STEM Student Opportunity); [K -12 STEM Education Prog]	Glenn Research Center (GRC)	All NASA Centers	Fourteen implementation sites are required to develop local partnerships for cost and resource sharing
NASA Learning Technologies Project (LTP) (STEM Student Opportunity); [K-12 STEM Education Program]	Goddard Space Flight Center (GSFC)	All NASA Centers	Project Whitecard, Information in Place and Virtual Heroes (competitively selected) will provide in-kind labor and product development costs for an educational game.
Aerospace Education Services Program (AESP) (STEM Teacher Development); [K-12 STEM Education Prog]	Langley Research Center (LaRC)	All NASA Centers	None
NASA Explorer Schools (NES) (STEM Teacher Development); [K-12 STEM Education Program]	Glenn Research Center (GRC)	All NASA Centers	None
Endeavour Teacher Science Certificate Project (STEM Teacher Development); [K-12 STEM Education Prog]	Goddard Space Flight Center (GSFC)	All NASA Centers	None
NASA Education Technology Services (NETS) (STEM Teacher Development); [K-12 STEM Education Program]	Marshall Space Flight Center (MSFC)	All NASA Centers	None
Learning Environment and Research Network (LEARN) (STEM Teacher Development); [K-12 STEM Education]	Langley Research Center (LaRC)	All NASA Centers	None
eEducation Small Projects (STEM Teacher Development); [K-12 STEM Education Program]	Marshall Space Flight Center (MSFC)	All NASA Centers	None

Mission Directorate:	Education
Theme:	Education
Program:	K-12 STEM Education

Acquisition Strategy

NASA solicits new and innovative education products, tools, and services from qualified external organizations. This occurs in response to changes in STEM education trends, identified gaps or opportunities in the education portfolio of investments, a response to demonstrated customer need or demand, or when the Administration or Congress identifies new priorities.

NASA encourages participation of new or less experienced organizations and awards education grants and contracts through full and open competition. NASA includes feedback from staff, subject matter experts, and public in developing solicitations, including the requirements, expected outcomes, schedules, proposal instructions, and evaluation approaches. NASA solicits comments on perceived programmatic risk issues associated with performance of the work. Procurement offices at NASA review all solicitations.

NASA awards all major grants and cooperative agreements based on reviews by external panels of peers for educational merit; NASA and external scientists and engineers for content, merit, feasibility, and alignment to education goals; and Mission Directorates for alignment with NASA's research and development interests. Indications of a clear competitive process are an integral part of reviews. NASA makes awards only after qualified assessments of merit. While competition may sometimes be restricted by legislation to designated participants, such as defined EPSCoR states, grant awards and selection of participating institutions are still determined competitively. When designated participants are identified, all proposals are reviewed for merit, and each award must be justified and deemed worthy of funding.

Mission Directorate:	Education
Theme:	Education
Program:	Informal STEM Education

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	13.5	14.0	2.1	2.1	2.1	2.1	2.1
Science Museums and Planetarium Grants	7.8	7.0	0.0	0.0	0.0	0.0	0.0
NASA Visitor Centers	5.8	7.0	0.0	0.0	0.0	0.0	0.0
NASA Informal Education Opportunities	0.0	0.0	2.1	2.1	2.1	2.1	2.1
FY 2009 President's Budget Request	13.5	2.0	2.1	2.1	2.1	2.1	--
Science Museums and Planetarium Grants	7.8	0.0	0.0	0.0	0.0	0.0	--
NASA Visitor Centers	5.8	2.0	2.1	2.1	2.1	2.1	--
Changes from FY 2009 Request	0.0	12.0	0.0	0.0	0.0	0.0	--

Project Descriptions and Explanation of Changes

NASA Informal Education Opportunities (NIEO)

NASA Informal Education Opportunities (NIEO) includes a competitive grants component for the Nation's museums, science centers and planetariums to enhance NASA STEM education activities, including exhibits, events and materials. NIEO also supports each NASA Center, allowing the Agency to retain NASA-unique informal education experts and activities that occur at the NASA Centers and their visitor centers. Funded activities address one or more of the NASA Education outcomes and align with NASA Education principles, and state or national standards. Starting in 2010, the NASA Explorer Institutes (NEI) pilot will end and be replaced by the NIEO.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
Provide educators and students with tools, experiences and opportunities to engage in NASA missions and learning experiences, improving their knowledge of, and ability to teach/learn in STEM disciplines.	Informal STEM Education Program/ NASA Informal Education Opportunities (NIEO)	None

Mission Directorate:	Education
Theme:	Education
Program:	Informal STEM Education

Program Management

The Assistant Administrator for Education is responsible to the NASA Administrator for NASA's education portfolio, reports to the Chief of Strategic Communication, serves as NASA Education Officer, and manages all education responsibilities.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
NASA Informal Education Opportunities (NIEO); [Informal STEM Education Program]	NASA Headquarters Office of Education	All NASA Centers	None

Acquisition Strategy

NASA solicits new and innovative education products, tools, and services from qualified external organizations. This occurs in response to changes in STEM education trends, identified gaps or opportunities in the education portfolio of investments, a response to demonstrated customer need or demand, or when the Administration or Congress identifies new priorities.

NASA encourages participation of new or less experienced organizations and awards education grants and contracts through full and open competition. NASA includes feedback from staff, subject matter experts, and public in developing solicitations, including the requirements, expected outcomes, schedules, proposal instructions, and evaluation approaches. NASA solicits comments on perceived programmatic risk issues associated with performance of the work. Procurement offices at NASA review all solicitations.

NASA awards all major grants and cooperative agreements based on reviews by external panels of peers for educational merit; NASA and external scientists and engineers for content, merit, feasibility, and alignment to education goals; and Mission Directorates for alignment with NASA's research and development interests. Indications of a clear competitive process are an integral part of reviews. NASA makes awards only after qualified assessments of merit. While competition may sometimes be restricted by legislation to designated participants, such as defined EPSCoR states, grant awards and selection of participating institutions are still determined competitively. When designated participants are identified, all proposals are reviewed for merit, and each award must be justified and deemed worthy of funding.

Overview

NASA's Cross-Agency Support (CAS) provides critical mission support activities that are necessary to ensure the efficient and effective operation and administration of the Agency but cannot be directly aligned to a specific program or project requirement. These functions align and sustain institutional and program capabilities for the purpose of supporting NASA's mission portfolio by leveraging resources to meet mission needs, establishing Agency-wide capabilities, and providing institutional checks and balances. NASA's CAS includes three themes: Center Management and Operations; Agency Management and Operations; and Institutional Investments. CAS institutional and program capabilities ensure core services are ready and available Agency-wide for performing our Mission roles and responsibilities. CAS institutional capabilities ensure agency operations are effective and efficient and activities are conducted in accordance with all statutory, regulatory, and fiduciary responsibilities. CAS program capabilities ensure vital skills and assets are ready and available to meet technical milestones for programs and projects; ensure missions and research are technically and scientifically sound; and ensure that Agency practices adhere to standards and processes that ensure safety and reliability through proper management of risk.

Center Management and Operations directly supports Agency programs and projects that are hosted and executed at NASA Centers. This theme provides for the care of institutional assets, for establishing and maintaining the staff and their competencies, and for the facilities required by current and future programs and projects at nine field Centers. Center Institutional Capabilities provides resources, oversees the assignment of workforce and facilities, and manages Center operations. Center Program Capabilities sustains the technical facilities, workforce expertise and skills, and equipment, tools, and other resources required to facilitate program and project execution.

NASA's Agency Management and Operations activities provide policy and oversight to assure compliance with external and internal requirements; assure safety and mission success; sustain Agency-wide critical capabilities; and support technology development. These activities provide effective and efficient management of human capital, acquisitions, financial performance, information technology, and performance improvement. Agency Management and Operations provides for near and long-term alignment of its human capital policy and a corporate approach to managing its unique or highly-specialized facilities. It maintains a core complement of civil service professionals to resolve its financial, acquisition, and business challenges.

NASA's Institutional Investments ensures that facilities and field installations are ready to meet the Agency's Mission requirements in a safe, secure and environmentally sound manner. The Agency identifies facility and environmental requirements for its missions and establishes investment activities to ensure readiness. Institutional Construction of Facilities provides for the construction, repair, rehabilitation, and modification of the Agency's basic infrastructure and institutional facilities. To ensure that the Agency's facilities can efficiently and effectively support its mission into the future, NASA has undergone a comprehensive review of its facilities and is developing plans to reduce and renew these critical assets. NASA's Environmental Compliance and Restoration Program provides the personnel, services, and activities necessary to complete the cleanup of hazardous materials and wastes that have been released to the surface or groundwater at NASA installations. These activities are mandated under a variety of federal and state environmental laws and regulations, as well as legally enforceable orders and agreements.

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**3,251.4**	**3,356.4**	**3,400.6**	**3,468.4**	**3,525.7**	**3,561.4**	**3,621.4**
Center Management and Operations	2,011.7	2,024.0	2,084.0	2,119.2	2,142.5	2,166.1	2,189.9
Agency Management and Operations	834.1	921.2	961.2	956.9	964.5	972.3	981.5
Institutional Investments	325.5	343.7	355.4	392.3	418.7	423.0	450.0
Congressionally Directed Items	80.0	67.5	0.0	0.0	0.0	0.0	0.0
FY 2009 President's Budget Request	**3,242.9**	**3,299.9**	**3,323.9**	**3,363.7**	**3,436.1**	**3,511.3**	**--**
Center Management and Operations	2,013.0	2,045.6	2,046.7	2,088.0	2,155.3	2,211.6	--
Agency Management and Operations	830.2	945.6	945.5	939.8	950.5	961.3	--
Institutional Investments	319.7	308.7	331.7	335.9	330.4	338.3	--
Congressionally Directed Items	80.0	0.0	0.0	0.0	0.0	0.0	--
Total Change from FY 2009 President's Budget Request	**8.5**	**56.5**	**76.7**	**104.7**	**89.6**	**50.1**	**--**

Note: In all budget tables, the FY 2010 President's Budget Request depicts the September 2008 Operating Plan for the 2008 Actuals and the 2009 Omnibus Appropriations Act (P.L. 111-8) and the American Recovery and Reinvestment Act (P.L. 111-5) for the 2009 enacted.

Plans for FY 2010

Cross-Agency Support

Center Management and Operations

New Initiatives:

None

Major Changes:

None

Major Highlights for FY 2010

Center Management and Operations provides for continuing operations of nine field Centers in support of NASA's mission portfolio. It ensures that Centers can provide the basic support required to meet internal and external requirements; effectively manage its human capital, information technology, and facility assets; responsibly execute its financial management and acquisition responsibilities; ensure independent technical oversight of NASA's programs and projects in support of safety and mission success; and provide a safe, secure, and environmentally sustainable workplace. Additionally it provides increased funding to partially offset rising utility costs and the added repair requirements of NASA's aging technical and institutional facilities. Without such increase, many facility maintenance activities would be deferred, increasing the risk of costly emergency repairs in future years.

Agency Management and Operations

New Initiatives:

In FY 2010, NASA is initiating the Innovative Technology project to establish a process to identify, competitively select, and fund new technologies with high potential to increase capbilities of future programs.

Major Changes:

None

Major Highlights for FY 2010

The Agency Management and Operations programs will continue to deliver policies, controls, and oversight across a range of functional and administrative management service areas including procurement, finance, human capital, real property and infrastructure, security, diversity, equal opportunity, and small business.

The Safety and Mission Success program will continue to administer and refine policies, procedural requirements, and technical standards. Safety and Mission Success program activities are a key compenent of the forums that provide advice to the Administrator, Mission Directorates, Program Managers and Center Directors who are ultimately accountable for the safety and mission success of all NASA programs, projects, and operations. The plans for FY 2010 provide for an effective NASA Engineering and Safety Center, NASA Safety Center, and Independent Verification and Validation Facility as established and recognized components of a well-rounded and complete remedial response to lessons learned from NASA's greatest tragedies. The plans include the required support for independent research, audit, and assessment of NASA activities that have risk for loss or failure.

NASA will complete deployment of several initiatives to improve security, efficiency and integration of information and systems. The NASA CIO will consolidate several IT contracts and implement centralized management of the IT infrastructure, which is expected to yield efficiencies and improved security of networks, end-user devices, and data center services. The Security Operations Center (SOC) will be fully implemented and enable improved incident detection and response via centralized monitoring and intrusion detection across all Centers. The NASA Communications Improvement (NCI) project will reconfigure border routers, gateways and circuits to better control and secure the network perimeter, enabling implementation of Trusted Internet Connections. The Center Zoned Architecture Project (CZAP) will establish network security zones to enable secure collaboration across NASA Centers and programs, while still allowing necessary connectivity with external partners and universities for research. Finally, the use of Smart Cards for logical access to many NASA systems will complete testing and undergo initial implementation.

Innovative Partnerships Program's portfolio of technology investments and partnerships will continue to address the technology needs of NASA's Mission Directorates, and IPP will continue to transfer NASA-derived technology for broad public benefit. Specifically IPP plans to achieve 105 instances of technology infusion into NASA programs in FY 2010.

Strategic Capabilities Assets Program (SCAP) will continue to provide strategic management and funding for critical facilities. The current portfolios consist of thermal vacuum chambers which provide for the thermal testing of spacecraft, flight simulators which provide for simulation of air and space vehicle flight characteristics, and arc jet for critical testing of re-entry materials.

Institutional Investments

New Initiatives:

None

Major Changes:

None

Major Highlights for FY 2010

Institutional Investments will improve mission assurance by making repairs to critical facilities supporting NASA programs. This will improve system reliability and reduce risk to mission success. Approximately 20 projects in the program will improve infrastructure reliability, having a direct impact on mission assurance.

NASA will continue to invest in a sustainable future through the construction of buildings and major renovations that incorporate sustainable features such as reduced energy and water usage, improved indoor environment, and reduced environmental impact.

NASA will mitigate identified risks to personnel and property with cleanup of hazardous materials and wastes, repairs to protection systems, security upgrades, and improvements for hurricane hardening. Several projects in the program will result in a safer environment for NASA workers and reduced damage to NASA property from weather events, fires, etc.

NASA will continue to reduce its infrastructure through the Construction of Facilities demolition program. NASA continues to identify obsolete, abandoned, and un-needed infrastructure and will use the demolition program to eliminate facilities that are costly to maintain and pose safety or environmental risks as they deteriorate.

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Mission Directorate:	Cross-Agency Support
Theme:	Center Management and Operations

Theme Overview

NASA's Center Management and Operations (CMO) budget request funds the ongoing management, operations, and maintenance of nine NASA field Centers, including four major component facilities, in ten separate states across the Country. It provides Center Institutional and Program Capabilities to satisfy program requirements and schedules. The Center Management and Operations budget request enables execution of NASA's mission at the Centers by providing the resources required to effectively oversee the assignment of workforce and facilities and manage Center operations to facilitate program and project execution while ensuring that statutory, regulatory, and fiduciary compliance requirements are met.

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**2,011.7**	**2,024.0**	**2,084.0**	**2,119.2**	**2,142.5**	**2,166.1**	**2,189.9**
Center Management and Operations	2,011.7	2,024.0	2,084.0	2,119.2	2,142.5	2,166.1	2,189.9
FY 2009 President's Budget Request	**2,013.0**	**2,045.6**	**2,046.7**	**2,088.0**	**2,155.3**	**2,211.6**	**--**
Center Management and Operations	2,013.0	2,045.6	2,046.7	2,088.0	2,155.3	2,211.6	--
Total Change from FY 2009 Request	**-1.3**	**-21.6**	**37.3**	**31.2**	**-12.8**	**-45.5**	**--**

Plans for FY 2010

Center Management and Operations

Activities funded within the FY 2010 CMO budget request include a wide variety of essential operations:

Security, environmental management, and safety services to ensure that Centers meet basic workplace standards for the public and for the NASA workforce;

Facility maintenance and operations, including utility funding, to support the Agency's infrastructure, including support to more than 5,500 facilities with a Current Replacement Value of over $23B;

Information Technology services to provide video, voice, network, data center, and desktop computer support at the Centers;

Program Capability support required to ensure that the Agency's Science, Engineering, and Technical Authority staff have the resources, services, and laboratory support required to achieve the Agency's technical mission;

Training, logistics, occupational health, and human resources services required to support the Agency's 16,600 Center civil servants;

Senior management, legal, Equal Employment Opportunity, and public affairs support at the Centers;

Procurement and Financial services supporting contract and financial management; and

Labor for the civil servants and on-site contractors that provide the above essential services at the Centers.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

Center program capability support to NASA's mission contributes to the development of advances in U.S. leadership in human space exploration,aeronautics, space and earth sciences, advancement of technical partnerships in the commercial space sector, and development of innovative technologies that benefit society.

Relevance to the NASA Mission and Strategic Goals:

NASA's Center Management and Operations contributes to the Agency's Strategic Goals by providing critical institutional and program capabilities to support NASA's missions. It provides critical mission support activities that are necessary to ensure the efficient and effective operation and administration of the Agency's field centers but cannot be directly aligned to a specific program or project requirement. These functions align and sustain institutional and program capabilities for the purpose of executing NASA's mission portfolio.

Relevance to education and public benefits:

Strategic communications activities at the Centers keep stakeholders and the public informed in a way that helps them understand our policies, programs, and plans. It also fulfills the mandate of the National Aeronautics and Space Act of 1958 "[to] provide for the widest practicable and appropriate dissemination of information concerning its activities and results thereof."

Performance Achievement Highlights:

Over the past year NASA Centers continued to provide high quality support for the execution of Programs and Projects. NASA faced the challenge of providing adequate levels of institutional support to the current programs while absorbing increasing labor and utility costs and new requirements from external initiatives and mandates.

To partially offset these increasing costs, NASA has implemented energy savings initiatives, consolidated activities, and reduced or deferred some Center Management and Operations activities, particularly in the area of facility maintenance.

To support energy savings, NASA updated its facilities maintenance and operations practices to strengthen the commitment to and use of sustainable procedures and methods within existing facilities as outlined by the U. S. Green Building Council LEED re-commissioning guidelines. NASA implemented plans to provide electrical service metering and monitoring for facilities, installing metering, as appropriate, in most facilities. This enables a reduction in electrical power use by monitoring real-time usage to identify and resolve inefficient practices. NASA initiated water conservation technical assessments in FY 2008 and will complete assessments in FY 2009, to enable NASA to achieve its goal of reducing water usage 15% by FY 2015.

Consolidation efforts included the migration of financial management's Accounts Payable and Accounts Receivable to the NASA Shared Services Center and initial implementation of an Information Technology (IT) infrastructure consolidation and renewal process. The IT activities improve the Agency's IT Security posture and control IT operation cost growth, now and into the future. The consolidation efforts maximize organizational effectiveness to achieve NASA's mission.

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Mission Directorate:	Cross-Agency Support
Theme:	Center Management and Operations
Program:	Center Management and Operations

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	2,011.7	2,024.0	2,084.0	2,119.2	2,142.5	2,166.1	2,189.9
Center Institutional Capabilities	1,555.6	1,579.0	1,608.6	1,626.1	1,631.7	1,637.2	1,644.5
Center Programmatic Capabilities	456.1	445.0	475.4	493.1	510.8	528.9	545.4
FY 2009 President's Budget Request	2,013.0	2,045.6	2,046.7	2,088.0	2,155.3	2,211.6	--
Center Institutional Capabilities	1,553.6	1,591.6	1,597.3	1,614.3	1,662.6	1,700.5	--
Center Programmatic Capabilities	459.4	454.0	449.4	473.8	492.6	511.1	--
Changes from FY 2009 Request	-1.3	-21.6	37.3	31.2	-12.8	-45.5	--

Project Descriptions and Explanation of Changes

Center Institutional Capability

NASA's Center Institutional Capability encompasses a diverse set of activities including financial and human capital management; acquisition services; facility maintenance; utilities; information technology; and safety and security. This capability manages and sustains the Center staff, facilities and operations required for program and project execution and provides for the ongoing operations of nine Center campuses to maintain a safe, healthy, and environmentally friendly workplace.

Most of NASA's facilities are more than 40 years old and are becoming increasingly expensive to operate and maintain. As a result, deferred maintenance of these facilities increased 6% in FY 2008. In addition, facility energy unit costs have increased 8% annually since FY 2000 due to rising energy costs, outpacing Agency efforts to reduce utility usage. The FY 2010 Center Management request includes additional funding to partially offset these increasing costs. In order to better adapt to these ongoing rising costs, NASA is pursuing a long-term facility strategy with the ultimate goal of reducing the size of NASA's infrastructure, improving building efficiency, and reducing operational facility costs across the Agency.

Center Program Capability

NASA's Center Program Capability supports the scientific and engineering staff across the Agency tasked with providing engineering assessment and safety oversight pertaining to the technical readiness and execution of NASA programs and projects. It also sustains NASA's analysis, design, research, test services, and fabrication capabilities; enabling efficient execution of the programs and projects hosted at the Centers. A key component of NASA's overall system of checks and balances is provided within Technical Capabilities through formally delegated Technical Authorities. The Technical Authorities at NASA's nine Centers number 900 civil servants who provide independent oversight and review of programs and projects in support of safety and mission success. This is to assure that NASA's activities are safely implemented in accordance with accepted standards of professional practice and applicable NASA requirements.

The FY 10 request reflects an increase above the FY 09 level due to a transfer of technical capability support at Ames Research Center from program budgets to CMO. This zero-sum transfer of content and budget aligns Ames CMO technical capability content with that of the rest of the Agency to improve consistency and clarity.

Center Management and Operations Technical Authority

Budget Authority ($ millions)	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Safety & Mission Assurance Technical Authority Total	**50.0**	**51.1**	**51.7**	**53.4**	**55.3**	**56.6**
Ames Research Center	0.8	1.5	1.5	1.6	1.7	1.8
Dryden Flight Research Center	4.7	4.7	4.8	5.0	5.2	5.4
Glenn Research Center	2.1	2.1	2.2	2.3	2.4	2.5
Goddard Space Flight Center	13.7	13.0	13.3	13.6	14.0	13.9
Johnson Space Center	6.4	6.7	6.5	6.7	7.0	7.2
Kennedy Space Center	10.0	10.4	10.3	10.6	11.0	11.3
Langley Research Center	3.0	3.1	3.2	3.3	3.4	3.6
Marshall Space Flight Center	8.1	8.2	8.5	8.8	9.2	9.4
Stennis Space Center	1.3	1.3	1.4	1.4	1.5	1.5
Engineering Technical Authority Total	**118.2**	**125.2**	**129.6**	**134.6**	**139.4**	**143.7**
Ames Research Center	2.6	3.3	3.5	3.6	3.8	4.0
Dryden Flight Research Center	5.9	6.1	6.3	6.5	6.8	7.0
Glenn Research Center	13.2	13.7	14.3	14.9	15.6	16.0
Goddard Space Flight Center	11.1	11.8	12.6	13.4	14.3	15.2
Johnson Space Center	19.8	21.5	21.7	22.4	22.5	22.5
Kennedy Space Center	11.9	12.3	12.7	13.1	13.6	14.0
Langley Research Center	15.7	16.3	17.0	17.6	18.4	19.1
Marshall Space Flight Center	35.2	37.1	38.4	39.7	41.2	42.3
Stennis Space Center	3.0	3.1	3.2	3.3	3.4	3.5

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Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations

Theme Overview

Agency Management and Operations provides for the management and oversight of Agency missions, programs, functions and performance of NASA-wide activities.

Agency Management and Operations activities at NASA Headquarters ensure that 1) core services are ready and available Agency-wide for performing our Mission roles and responsibilities, 2) the Agency operations are effective and efficient, and 3) our activities are conducted in accordance with all statutory, regulatory, and fiduciary responsibilities.

NASA Headquarters develops policy and guidance for the Centers and provides strategic planning and leadership on the issues concerning availability, readiness, and sustainability. They also establish programs and initiatives to maximize individual and organizational capabilities.

NASA Headquarters establishes Agency-wide requirements and capabilities that improve collaboration, efficiency, and effectiveness. Agency management leverages resources and capabilities to meet mission needs, eliminate excess Agency capacity, and scale assets accordingly.

Agency Management and Operations includes the Headquarters management of all essential corporate functions such as human capital, finance, information, infrastructure, procurement, chief counsel, security, occupational health and safety, equal opportunity and diversity, small business programs, external relations, and strategic communications.

This theme is divided into the following five programs: Agency Management, Safety and Mission Success, Agency Information Technology Services, Innovative Partnerships Program, and Strategic Capabilities Assets Program.

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**834.1**	**921.2**	**961.2**	**956.9**	**964.5**	**972.3**	**981.5**
Agency Management	353.8	390.0	412.7	417.4	422.0	426.6	431.3
Safety and Mission Success	171.5	179.1	183.9	186.1	188.6	190.9	193.0
Agency IT Services (AITS)	134.9	163.9	150.4	138.3	138.0	138.3	139.7
Innovative Partnerships Program	146.8	160.2	184.8	184.9	185.7	186.3	187.0
Strategic Capabilities Assets Program	27.2	28.0	29.4	30.2	30.2	30.2	30.5
FY 2009 President's Budget Request	**830.2**	**945.6**	**945.5**	**939.8**	**950.5**	**961.3**	**--**
Agency Management	361.5	414.6	422.5	430.6	438.8	447.3	--
Safety and Mission Success	161.6	163.4	165.4	167.3	169.3	171.3	--
Agency IT Services (AITS)	133.1	163.9	145.9	133.1	133.5	133.9	--
Innovative Partnerships Program	146.8	175.7	181.9	178.0	178.1	178.1	--
Strategic Capabilities Assets Program	27.2	28.0	29.8	30.7	30.7	30.7	--
Total Change from FY 2009 Request	**4.0**	**-24.4**	**15.7**	**17.1**	**14.0**	**11.0**	**--**

Plans for FY 2010

Agency Management

The Agency Management program will continue to deliver policies, controls, and oversight across a range of functional and administrative management service areas including procurement, finance, human capital, real property and infrastructure, security, diversity, equal opportunity, and small business.

Safety and Mission Success

The Safety and Mission Success program will continue to administer and refine the pertinent policies, procedural requirements, and technical standards. The program will participate in forums that provide advice to the Administrator, Mission Directorates, Program Managers and Center Directors who are ultimately accountable for the safety and mission success of all NASA programs, projects, and operations. The plans for FY 2010 provide for an effective NASA Engineering and Safety Center, NASA Safety Center, and Independent Verification and Validation Facility as established and recognized components of a well-rounded and complete remedial response to lessons learned from NASA's greatest tragedies. These organizations form a basis for a more disciplined execution of safety, reliability, quality and system engineering needed for the successful pursuit of NASA's missions.

Agency IT Services (AITS)

NASA will continue operations for essential Agency IT services such as the Agency business applications, the NASA Scientific and Technical Information (STI) program, NASA Public Web portal, NASA Enterprise Architecture, and E-Government in FY 2010. The NASA Information Resources Management Strategic Plan focuses on four goals in this budget year associated with the Agency IT Services program. The four goals are: 1) improve the management of information and information technology, 2) improve the security of NASA information and information technology, 3) improve IT efficiency and collaboration capabilities, and 4) improve IT service delivery and visibility.

Innovative Partnerships Program

Innovative Partnerships Program's (IPP) portfolio of technology investments and partnerships will continue to address the technology needs of NASA's Mission Directorates, and IPP will continue to transfer NASA-derived technology for broad public benefit. Specifically IPP plans to achieve 105 instances of technology infusion into NASA programs in FY 2010. Sources of technology for infusion come from many elements of the IPP portfolio including Small Business Innovative Research (SBIR), Small Business Technology Transfer Research (STTR), Seed Fund, Centennial Challenges, and other partnerships. IPP also plans to advance technologies that have potential for use by NASA, as measured by improvements in their technology readiness level. In FY 2010, IPP plans to achieve 200 Technology Readiness Levels (TRL) step advancements through its technology portfolio.

Strategic Capabilities Assets Program

Strategic Capabilities Assets Program (SCAP) will continue to provide management oversight and critical funding for our current portfolio of assets. These portfolios include thermal vacuum chambers which provide capability for thermally testing spacecraft, flight simulators which test air and space vehicles flight characteristics, and arc jet which provides capability for critical testing of re-entry materials.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

Through the Innovative Partnerships Program (IPP), NASA provides technology transfer out of NASA for commercial and other benefits to the Nation, facilitating protection of the government's rights in NASA's inventions, as mandated by legislation. NASA's Small Business Innovative Research (SBIR) and Small Business Technology Transfer (STTR) programs provide the high-technology small business sector with an opportunity to develop technology for NASA. Technology partnerships and Centennial Challenges tap into sources of innovation outside NASA and leverage NASA's resources with private or other external resources to develop new technologies for NASA mission use. Seed Fund contributes to the development of technology through leveraged development with industry and other partners, and to support NASA programs and priorities. IPP serves NASA's mission interests, both in the near and long terms, through developing a broad range of technologies and advancing their technology readiness and provides opportunities to a broad spectrum of U.S. industrial and non-profit entities for direct involvement in addressing NASA's technology needs in exploration and other missions.

Relevance to the NASA Mission and Strategic Goals:

NASA's Agency Management and Operations (AMO) contributes to the Agency's Strategic Goals by providing critical institutional and program capabilities to support NASA's missions. AMO provides ongoing management support, technology alternatives to NASA programs and projects, and IT operations to benefit all Mission Directorates. The management of the Agency's unique test facilities and technical capability, including independent engineering and safety oversight provided in AMO are critical to NASA's success.

Relevance to education and public benefits:

Strategic communications at NASA Headquarters keep stakeholders and the public informed in a way that helps them understand our policies, programs, and plans. It also fulfills the mandate of the National Aeronautics and Space Act of 1958 to provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations

Performance Achievement Highlights:

AMO supported on-going management and operations activities across the Agency and was responsible for operational efficiency gains in many mission support areas during this past year. With the initiation of the IT infrastructure consolidation, the Agency's IT security posture was improved and IT operational cost was brought under control. Network consolidation and security operations center initiatives successfully completed their Critical Design Review.

NASA established a fully integrated state-of-the-art photo and ID/access control system in compliance with Homeland Security Presidential Directive (HSPD-12) requirements and deadlines. Currently, NASA has issued 95% of HSPD-12 compliant credentials/badges to NASA's eligible workforce and is on target to achieve 100% by the end of the 2nd quarter FY2009. Noted counterintelligence accomplishments included conducting 17 full field investigations and producing Agency and Center-specific CI/CT threat assessments for all 9 centers and JPL.

The Agency established a solid baseline for the successful implementation of an Agency Safety Center in Cleveland, Ohio. Accomplishments include the 1) development of a technical qualification program for Agency Safety and mission assurance technical excellence, 2) trending of root causes and communication of lessons learned from Agency mishap investigations, and 3) continuation and improvement of the Agency safety and mission assurance review and audit program.

The NASA Engineering and Safety Center made progress resolving NASA's most critical mission success issues including the Shuttle Engine Cut-off Sensor reliability, Shuttle Wing Leading Edge reinforced carbon spallation, ISS rotary joint bearing life, and Orion seat landing loads attenuation, power system optimization, and acceleration options. The Agency developed a strategy for Agency-wide support of Product Data Management/Product Lifecycle Management standards and implementation.

The Agency negotiated fifty-five Space Act Agreements with domestic and foreign government entities, processed 3,000 Agency-wide export control related actions including 230 export license reviews, and 500 foreign national visit reviews. NASA implemented the Continuous Monitoring Program which provided an overall framework of management controls that NASA uses to assess and evaluate internal controls, compliance with Generally Accepted Accounting Principles, and evidence that balances and activity reported in its financial statements are accurate and complete. After establishing the FY08 Small Business Improvement Plan oriented toward increasing the number of competitively awarded small business prime contracts, the Agency increased small business prime contract awards by $291M. The Agency also enhanced acquisition planning and implementation by increasing the success of NASA programs, projects, and institution in meeting their commitments.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
All	IPAO (Independ Program Assmt)	2009	Review Implementation of Strategic Capabilities Assets Program providing a credible, objective assessment of program performance and management. Review is completed and has been closed.	none

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Agency Management

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	353.8	390.0	412.7	417.4	422.0	426.6	431.3
Agency Management	353.8	390.0	412.7	417.4	422.0	426.6	431.3
FY 2009 President's Budget Request	361.5	414.6	422.5	430.6	438.8	447.3	--
Agency Management	361.5	414.6	422.5	430.6	438.8	447.3	--
Changes from FY 2009 Request	-7.6	-24.6	-9.8	-13.2	-16.8	-20.7	--

Program Overview

Agency Management provides governance and functional and administrative management oversight for the Agency. Through Agency Management, policies, controls, and oversight are delivered across a range of functional and administrative management service areas. This program function primarily supports on-going operations. Agency Management support reflects the activities required for being in business in the federal sector and provides the capability to respond to legislated or other mandated services that the Agency must provide.

Agency Management activities are performed at NASA Headquarters with critical support provided by multiple NASA field centers including the NASA Management Office (NMO) at the Jet Propulsion Laboratory and the NASA Shared Services Center (NSSC) at Stennis Space Center. The Agency Management program supports over thirty-five discrete operations and mission support projects with over 210 separate activity line items.

Agency Management governance and oversight activities include the NASA Administrator and staff, finance, security, general counsel, public affairs, external relations, legislative affairs, training, human capital, procurement, real property and infrastructure, budget management, systems support, internal controls, diversity, equal opportunity, program analysis and evaluation, and small business programs.

The Agency Management program provides for the operational activities of Headquarters as an installation. These activities include building lease costs, facility operations costs such as physical security, maintenance, logistics, information technology hardware and software costs, and automated business systems implementation and operations costs including e-Government initiatives.

Agency Management provides for all the Headquarters civil service labor and related personnel costs including the civil service labor for all the Mission Directorates. The program also covers the travel and business costs for over twenty mission support and staff offices of the Headquarters workforce.

The program is responsible for conducting independent technical assessments of Agency programs and delivers strategic planning services. Through Agency Management efforts, NASA program and mission performance are assessed and evaluated.

Plans For FY 2010

Agency Management will deliver policies, controls, and oversight across a range of functional and administrative management service areas, and provide independent technical assessments and strategic planning service, and direct the activities in procurement, finance, human capital, real property and infrastructure, security and program protection, diversity, equal opportunity, and small business.

Project Descriptions and Explanation of Changes

Agency Management

The Agency Management budget includes Headquarters personnel salaries, benefits, travel, training, and operational costs such as rents, IT support, payroll information services, and facility services. Civil Service labor components include employee salaries and benefits and associated employee costs, such as, employee awards, promotions, lump sum retirement payments, worker's compensation, permanent change of station, recruit and retention allowances, transit subsidy program, student loan repayments and employee training. The FY 2010 labor budget supports 1,200 FTE. This reflects the HQ downsizing of 40 FTEs from the 1,240 funded level in FY 2009.

HQ Operations elements include the lease costs for the rent of the HQ office building, and Inspector General leased space in New Jersey and California. Other significant operations activities include: IT and Communications infrastructure hardware and software acquisitions and maintenance, contracted IT support services, printing, graphics; facility operations support including physical security, custodial and maintenance services, equipment, expendable supplies, mail services, motor pool operations, logistics services, emergency preparedness, employee occupational health/fitness and medical services; human resources staffing, employee payroll and benefits processing, retirement services, grants awards, and employee training; costs of support provided by the Goddard Space Flight Center for accounting and procurement operations; costs of operations support, configuration maintenance, automated business and administrative systems; contract close-out services and payments to the Office of Naval Research for grants management ; equal opportunity alternate dispute resolution services, EEO complaint investigations and special emphasis diversity recognition program; and human resources.

Agency Management also provides the functions of finance, security, and program analysis. The Chief Financial Officer (CFO) is responsible for the financial leadership of NASA and its primary duty is to uphold strong financial management and accountability while providing timely, accurate, and reliable financial information and enhancing internal control. The Security and Program Protection (OSPP) office serves as the focal point for policy formulation, oversight, coordination and management of the Agency security, counter-intelligence (CI), counter-terrorism (CT), emergency preparedness planning, and continuity of operations functions. Program Analysis and Evaluation (PA&E) is an independent assessment organization that provides objective, transparent, and multidisciplinary analysis to support strategic decision making.

HEADQUARTERS BUDGET BY OFFICE

Agency Management Budget by Office ($ in millions)	FY 2008 Funding	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Total Agency Management (1)	**353.8**	**390.0**	**412.7**	**417.4**	**422.0**	**426.6**	**431.3**
	(1)						
Mission Directorates	**57.4**	**58.9**	**63.3**	**66.1**	**69.9**	**74.2**	**78.5**
Science	23.3	24.5	26.4	27.6	29.1	30.9	32.7
Aeronautics Research	5.7	5.5	5.9	6.2	6.5	6.9	7.3
Exploration Systems	13.2	14.1	15.1	15.8	16.7	17.7	18.7
Space Operations	15.2	14.8	15.9	16.6	17.5	18.6	19.7
Mission Support and Staff Offices	**189.9**	**201.5**	**215.1**	**219.9**	**227.8**	**233.5**	**242.6**
Office of the Administrator	3.4	3.3	3.5	3.6	3.8	4.0	4.2
Safety and Mission Assurance	6.5	6.5	7.0	7.3	7.7	8.2	8.7
Program Analysis and Evaluation	25.4	28.1	30.2	30.8	31.6	32.5	33.4
Chief Engineer	3.4	4.2	4.5	4.7	5.0	5.3	5.6
Program and Institutional Integration	10.2	10.2	11.1	11.2	11.4	11.8	12.2
Chief Financial Officer	22.2	23.9	25.1	25.8	26.9	28.0	29.1
Chief Health and Medical Officer	1.3	1.2	1.3	1.4	1.5	1.5	1.6
Chief Information Officer	4.4	5.5	6.0	6.2	6.6	7.0	7.4
External Relations	11.0	12.0	12.6	13.0	13.5	13.3	13.8
General Counsel	8.0	9.2	9.8	10.2	10.6	11.0	11.5
Innovative Partnership Program	1.7	1.8	1.9	2.0	2.1	2.3	2.4
Institutions and Management							
Institutions and Management	1.2	0.8	0.6	0.6	0.6	0.7	0.7
Diversity and Equal Opportunity	3.7	5.8	4.5	4.5	4.7	4.9	5.1
Human Capital Management	25.2	28.8	33.2	34.3	35.7	36.0	36.9
Infrastructure	15.5	16.3	16.8	17.2	17.8	17.9	18.6
Internal Controls and Management Systems	2.1	2.5	2.5	2.6	2.7	2.8	2.9
Procurement	6.8	7.0	7.9	7.8	8.3	8.3	8.8
Small Business Programs	1.5	1.8	2.2	2.3	2.3	1.8	1.9
Security and Program Protection	17.1	13.2	15.2	14.8	15.1	15.6	16.1
Strategic Communications							
Strategic Communications	2.5	2.4	2.5	2.5	2.6	2.8	2.9
Education	2.8	2.9	3.1	3.3	3.4	3.7	3.9
Legislative and Intergovernmental Affairs	3.8	4.2	4.5	4.7	4.9	5.1	5.4
Public Affairs	10.1	9.9	9.0	9.0	9.0	9.1	9.5
Operations	**106.6**	**129.6**	**134.3**	**131.4**	**124.3**	**119.0**	**110.2**
Office of Headquarters Operations	99.0	122.3	126.1	123.0	115.7	110.1	101.5
Budget Management and Systems Support	7.6	7.3	8.2	8.4	8.6	8.8	8.7

Footnote:
(1) An additional $39.3M of prior year funds were obligated in FY 2008, for a total executed budget of $393.2M.

HEADQUARTERS TRAVEL BUDGET BY OFFICE

Headquarters Travel Budget ($ in millions)	FY 2008 Actuals	FY 2009 Enacted	FY 2010
Total Headquarters Travel Budget	**9.4**	**9.4**	**9.1**
Mission Directorates	**4.6**	**4.9**	**4.8**
Science	1.4	1.3	1.2
Aeronautics Research	0.5	0.4	0.4
Exploration Systems	1.2	1.5	1.5
Space Operations	1.5	1.7	1.7
Mission Support and Staff Offices	**4.6**	**4.4**	**4.2**
Office of the Administrator	0.3	0.4	0.4
Safety and Mission Assurance	0.3	0.3	0.3
Program Analysis and Evaluation	0.3	0.2	0.2
Chief Engineer	0.2	0.2	0.2
Program and Institutional Integration	0.2	0.2	0.2
Chief Financial Officer	**0.3**	0.4	0.4
Chief Health and Medical Officer	0.1	0.1	0.1
Chief Information Officer	0.2	0.1	0.1
External Relations	0.8	0.7	0.7
General Counsel	0.1	0.1	0.1
Innovative Partnership Program	0.1	0.1	0.1
Institutions and Management			
Institutions and Management	0.0	0.0	0.0
Diversity and Equal Opportunity	0.1	0.1	0.1
Human Capital Management	0.1	0.1	0.1
Infrastructure	0.5	0.4	0.4
Internal Controls and Management Systems	0.0	0.1	0.0
Procurement	0.2	0.2	0.2
Small Business Programs	0.1	0.1	0.1
Security and Program Protection	0.2	0.2	0.1
Strategic Communications //			
Strategic Communications	0.1	0.1	0.1
Education	0.1	0.2	0.2
Legislative and Intergovernmental Affairs	0.1	0.1	0.1
Public Affairs	0.2	0.1	0.1
Operations	**0.2**	**0.1**	**0.1**
Office of Headquarters Operations	0.0	0.1	0.1
Budget Management and Systems Support	0.2	0.0	0.0

HEADQUARTERS FTE ASSIGNMENTS BY OFFICE

Headquarters	FY 2008 Total FTE	FY 2008 SES	FY 2008 Non-Career	FY 2008 Contract WYE	FY 2009 Total FTE	FY 2009 SES	FY 2009 Non-Career	FY 2009 Contract WYE	FY 2010 Total FTE	FY 2010 SES	FY 2010 Non-Career	FY 2010 Contract WYE
Total Agency Management	**1,193**	**134**	**17**	**636**	**1,200**	**142**	**17**	**629**	**1,200**	**142**	**17**	**628**
Mission Directorates	**354**	**40**	**0**	**164**	**353**	**43**	**0**	**153**	**353**	**43**	**0**	**153**
Science	145	16		62	144	17		62	144	17		62
Aeronautics Research	34	6		11	33	8		10	33	8		10
Exploration Systems	81	8		46	83	8		45	83	8		45
Space Operations	94	9		45	93	10		36	93	10		36
Mission Support and Staff Offices	**740**	**92**	**17**	**181**	**737**	**96**	**17**	**189**	**737**	**96**	**17**	**188**
Office of the Administrator	22	5	4	0	19	5	4	**0**	**19**	**5**	**4**	**0**
Safety and Mission Assurance	39	6		0	37	6		0	37	6	0	0
Program Analysis and Evaluation	61	7		0	64	8		0	64	8	0	0
Chief Engineer	21	8		8	24	8		8	24	8	0	8
Program and Institutional Integration	36	3		0	36	3		0	36	3	0	0
Chief Financial Officer	91	7	2	53	98	9	2	53	98	9	2	53
Chief Health and Medical Officer	9	1		1	8	1		1	8	1	0	0
Chief Information Officer	26	5		15	32	6		18	32	6	0	18
External Relations	51	8		6	51	7		6	51	7	0	6
General Counsel	47	6	1	0	44	5	1	0	44	5	1	0
Innovative Partnership Program	11	1		0	11	1		0	11	1	0	0
Institutions and Management												
Institutions and Management	4	1		0	3	1		0	3	1	0	0
Diversity and Equal Opportunity	18	2		0	19	3		0	19	3	0	0
Human Capital Management	39	5		11	38	5		11	38	5	0	11
Infrastructure	63	6		0	61	7		0	61	7	0	0
Internal Controls and Management Systems	11	1		1	11	1		1	11	1	0	1
Procurement	39	4		0	35	4		0	35	4	0	0
Small Business Programs	5	1		3	5	1		3	5	1	0	3
Security and Program Protection	46	2		58	46	2		58	46	2	0	58
Strategic Communications												
Strategic Communications	13	2	3	0	10	2	3	0	10	2	3	0
Education	17	3		3	17	3		3	17	3	0	3
Legislative and Intergovernmental Affairs	30	3	4	0	28	4	4	0	28	4	4	0
Public Affairs	42	4	3	22	40	4	3	27	40	4	3	27
Operations	**99**	**3**	**0**	**291**	**110**	**4**	**0**	**287**	**110**	**4**	**0**	**287**
Office of Headquarters Operations	**81**	**2**		276	92	3		272	92	3		272
Budget Management and Systems Support	18	1		15	18	1		15	18	1		15

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Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Safety and Mission Success

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	171.5	179.1	183.9	186.1	188.6	190.9	193.0
Safety and Mission Assurance	43.9	42.9	48.3	48.8	49.3	49.7	50.4
Chief Engineer	94.8	87.0	102.2	103.6	105.3	106.8	107.0
Chief Health and Medical Officer	2.3	4.1	3.7	3.7	3.7	3.8	3.8
Independent Verification and Validation	30.5	45.0	29.7	30.0	30.3	30.6	31.9
FY 2009 President's Budget Request	161.6	163.4	165.4	167.3	169.3	171.3	--
Safety and Mission Assurance	42.2	42.9	43.4	43.8	44.2	44.6	--
Chief Engineer	87.7	87.0	88.2	89.4	90.6	91.9	--
Chief Health and Medical Officer	2.8	4.1	4.1	4.2	4.2	4.2	--
Independent Verification and Validation	29.0	29.3	29.7	30.0	30.3	30.6	--
Changes from FY 2009 Request	9.9	15.7	18.5	18.8	19.3	19.6	--

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Safety and Mission Success

Program Overview

The Safety and Mission Success (SMS) program includes the NASA Headquarters programs for technical excellence, assurance and technical authority. SMS includes the corporate work managed by the offices of the Chief, Safety and Mission Assurance (including the NASA Safety Center and the Independent Verification and Validation Facility), the Chief Engineer (including the NASA Engineering and Safety Center), and the Chief Health and Medical Officer. The elements of SMS reflect the recommendations of many studies, boards and panels including the direct recommendations from two major accident investigations resulting in the loss of 14 astronauts (Challenger, 1986 and Columbia, 2003). The features of these programs directly support NASA's core values and serve to improve the likelihood for safety and mission success for NASA's programs, projects, and operations while protecting the health and safety of NASA's workforce. Aerospace technology advancement, because it is leading the edge of known capability, will always present a risk of catastrophe. SMS is the only resource that has as its exclusive mission the objective to extend the intervals between success and the ever-present possibility of failure.

SMS is responsible for developing policy and procedural requirements. The program provides advice to the Administrator, Mission Directorates, Program Managers and Center Directors who, due to their line management responsibilities, are ultimately accountable for the safety and mission success of all NASA programs, projects and operations and the safety and health of the associated workforce. In addition, SMS resources provide the foundation for NASA's system of "checks and balances" enabling the effective application of the strategic management framework and the technical authorities defined in NASA's Strategic Management and Governance Handbook. SMS funding maintains and trains a competent technical workforce within the disciplines of system engineering (including system safety, reliability, and quality) and space medicine.

Resources provided by SMS are essential for judging the implications on safety and mission success, as well as the health and medical aspects of new requirements and departures from existing requirements. With this funding, an array of professionals judge the criticality of the associated risk and evaluate the risk acceptability through an established process of independent review and assessment. The information and advice from these experts is critical for developing key decision information for the proper execution of the delegated technical authority applied at program and project decision forums.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Safety and Mission Success

Plans For FY 2010

For FY 2010, the individual plans for each element of the SMS align with and directly support the objectives of the Agency's four Mission Directorates by helping to improve the likelihood of safety and mission success for all NASA programs, projects, and operations. SMS managers will continue to administer and refine the pertinent policies, procedural requirements, and technical standards. The managers will participate in forums that provide advice to the Administrator, Mission Directorates, Program Managers and Center Directors who are ultimately accountable for the safety and mission success of all NASA programs, projects, and operations.

The plans for FY 2010 provide for an effective NASA Engineering and Safety Center, NASA Safety Center, and Independent Verification and Validation Facility as adjuncts and necessary to fulfilling the organization's assigned missions. This support assures that NASA civil service employees have, and continue to apply, the appropriate knowledge, skills, abilities, and tools for sound and well-informed decision-making on matters critical to safety and mission success. The plans will include prioritized development, maintenance, and conduct of training and education necessary for assuring the existence of a competent technical workforce. The plans include the required support for independent research, audit, and assessment of NASA activities that have risk for loss or failure.

These organizations charter independent reviews under SMS resources that judge the safety and likelihood of success of NASA activities and the health of those individuals exposed to risks that are not commonplace. The ability to author effective requirements, evaluate precisely the departures from conformance with existing requirements, and determine the criticality of the risk and evaluate and advise on its acceptability are totally reliant on the proper investment in SMS. This established process of independent review supports informed decision-making through the execution of delegated technical authority applied to program and project decisions. Without a robust application of these resources, the Agency strategy to challenge the validity of complex engineering and operational plans and proposals is flawed and subject to incuring unneccessary risks.

Due to the tremendous energies possessed by space debris, the collision between a piece of debris only a half-inch in diameter and an operational spacecraft has the potential for catastrophic consequences. The intentional destruction of the Chinese Fengyun-1C weather satellite in January of 2007 and the accidental collision of American and Russian spacecraft in February 2009 have increased the cataloged debris population by nearly 40 percent, in comparison with all the debris remaining from the first 50 years of the Space Age. For FY 2010, NASA, in connection with the U.S. Space Surveillance Network, will increase its effort in scientific studies to characterize the near-Earth space debris environment, to assess its potential hazards to current and future space operations, and to identify and to implement means of mitigating its growth. Enhancements to this space situational awareness data program during FY 2010, especially close approach predictions, offer the greatest near-term and lowest cost improvement to space safety.

Project Descriptions and Explanation of Changes

Safety and Mission Assurance

The SMS supports the Office of Safety and Mission Assurance (OSMA) by providing resources for independent evaluations of their approaches to improving mission success. OSMA is responsible for establishing and maintaining an acceptable level of technical excellence and competence in safety, reliability, maintainability and quality engineering within the Agency. OSMA assures that the risk presented by either a lack of safety requirement or from lack of compliance with a safety requirement is analyzed, assessed, communicated and used for proper decision-making and risk acceptance by the appropriate organizational leader.

Fundamental to these two responsibilities is the definition and execution of a robust and well understood methodology and process for the application of the disciplines of safety, reliability and quality (S, R and Q) in defining the level of risk. In addition, the organization conducts a schedule of review and assessments that focus on the life cycle decision milestones for crucial NASA programs and projects and S, R, and Q processes. Embodied in this program is a structured development of methodology and investigation into system attributes that improve the probability of mission success.

The NASA Safety Center (NSC) in Cleveland, OH assists OSMA in achieving its objectives in consolidating SMS efforts agency-wide in four key areas: safety and mission assurance (SMA) technical excellence, knowledge management, audits and assessments, and mishap investigation support. Since being established in FY 2007, the NSC has: (1) established a Technical Excellence initiative to improve and formalize training and qualification requirements for five SMA engineering disciplines (system safety; reliability and maintainability; quality; software assurance; and operational and aviation safety); (2) undertaken streamlined processes to increase and sustain domain knowledge within the SMA community through the facilitation, storage and retrieval of important documents and lessons learned; by providing data analysis and trending of mishap-related data; by rapidly disseminating mishap-related Agency Safety Alerts; and improving the Agency Incident Reporting Information System, a comprehensive, Agency-wide tool used for reporting mishaps and close calls; (3) continued to evaluate and streamline the conduct of facilities, programmatic and supplier audits; and (4) assembled and deployed a trained team of mishap investigators to support mishap investigations boards. The end result of these activities is to promote the highest level of safety and reliability for NASA's programs and projects. This increase in request is to make the NASA Safety Center in Cleveland, OH fully operational.

Chief Engineer

The SMS supports the Office of Chief Engineer (OCE) by providing the resources for independent and senior engineering expertise to enhance mission success. The OCE promulgates policy and requirements for program and project management, for the engineering excellence of the Agency, system engineering methodology, and for the Agency's system of engineering standards. The Office of Chief Engineer manages the NASA Engineering and Safety Center (NESC), which is responsible for rapid, cross-Agency response to mission-critical engineering issues and for improving the state of practice in critical engineering areas. OCE also sponsors the Academy of Program/Project and Engineering Leadership (APPEL) to develop Program and Project Management and Systems Engineering skills.

APPEL delivers the necessary program/project management and engineering competence learning through the application of learning strategies, methods, models and tools. APPEL provides professional development products and services for individual practitioners and program and project teams. This includes: a formal training curriculum designed to address four career levels from recent college graduate to executive; direct support to project teams in the field through workshops, coaching, and technical experts; and conferences, forums and publications.

The NESC, established in 2003 in response to the Columbia accident, responds rapidly to cross-Agency mission-critical engineering issues and for improving the state of the practice in critical engineering areas. The NESC performs value-added independent testing and analyses and technical assessments of NASA's projects and technical activities to enhance safety and mission success. The NESC works proactively to help NASA avoid problem recurrence and to prevent future problems. SMS funding provides for the core NESC organization of senior engineering experts from across the Agency, including the NASA Technical Fellows and their Technical Discipline Teams composed of experts from NASA, industry, and academia.

Chief Health and Medical Officer

The Office of the Chief Health and Medical Officer (OCHMO) promulgates Agency health and medical policy, standards, and requirements, assuring the medical technical excellence of the Agency, assuring the physical and mental well being of the NASA workforce, and assuring the safe and ethical conduct of NASA-sponsored human and animal research. OCHMO exercises oversight of NASA medical and health related activities through audit processes, and monitors the implementation of health and medical related requirements in all developmental human spaceflight programs through designated discipline experts at NASA Centers. OCHMO also provides oversight of medical and health related activities in operational human spaceflight through Center-based discipline experts and clinical boards. On-going medical and health discipline professionalism and licensure is supported through annual certified Continuing Medical Education (CME) activities, and flight surgeon education and clinical currency is provided through OCHMO-sponsored, university based physician training programs. NASA's biomedical research programs in support of human spaceflight are guided by OCHMO-developed health and medical standards. Center-based review boards under OCHMO sponsorship provide direct supervision of NASA-sponsored human and animal research safety and ethics, completing a comprehensive system of oversight to maintain robust health and medical support of NASA personnel at all levels.

Independent Verification and Validation

The NASA Independent Verification and Validation (IV&V) Project, as a part of the Agency's overall Software Assurance and Risk Mitigation strategy, provides systems engineering activities that improve software safety, reliability, and quality of NASA programs and projects through effective applications of systems and software IV&V methods, practices, techniques, and tools. The NASA IV&V Facility applies software engineering best practices to evaluate the correctness and quality of critical and complex software systems throughout the project's System Development Life Cycle.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Agency IT Services (AITS)

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**134.9**	**163.9**	**150.4**	**138.3**	**138.0**	**138.3**	**139.7**
IT Management	17.3	17.3	31.9	25.8	25.1	24.0	23.0
Applications	68.3	67.2	70.2	66.1	66.7	67.1	68.8
Infrastructure	49.3	79.4	48.3	46.4	46.2	47.2	47.9
FY 2009 President's Budget Request	**133.1**	**163.9**	**145.9**	**133.1**	**133.5**	**133.9**	**--**
IT Management	33.2	24.2	24.9	23.5	22.3	22.3	--
Applications	68.0	61.4	65.0	61.7	62.0	62.2	--
Infrastructure	31.9	78.4	56.0	48.0	49.1	49.5	--
Changes from FY 2009 Request	**1.7**	**0.0**	**4.5**	**5.2**	**4.5**	**4.4**	**--**

Program Overview

NASA's Agency IT Services (AITS) program provides business and management applications, common IT infrastructure, IT security, and IT management services necessary for Agency operations in accordance with OMB guidance, federal laws and regulations, and industry best practices. The three following projects constitute the AITS program; 1) Applications, 2) IT Infrastructure (which includes IT security), and 3) IT Management.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Agency IT Services (AITS)

Plans For FY 2010

The AITS program provides sustaining operations for essential Agency IT services, such as, Agency business applications, the NASA Scientific and Technical Information (STI) program, NASA Public Web portal, NASA Enterprise Architecture, and E-Government.

The NASA Information Resources Management Strategic Plan focuses on the following four goals.

1) Improve the management of information and information technology
2) Improve the security of NASA information and information technology
3) Improve IT efficiency and collaboration capabilities
4) Improve IT service delivery and visibility

To meet the four goals, significant events planned for FY 2010 are:
1) Improving security operations and incident response by maturing the central NASA Security Operations Center, which provides the capability for improved incident detection, response, management, and mitigation.
2) Deploying smart cards and an integrated identity, account, active directory, and smart card management system for logical access to NASA IT systems. All systems/applications will be required to integrate into the NASA logical access system, with all systems with High security categorization implemented in FY10.
3) Improving integration and security of NASA networks by deploying an Agency level zoned architecture that will enable better definition of the network perimeter and NASA intranet and locate information systems and assets in appropriate zones based on the information sensitivity and access requirements.
4) Improving management and security of NASA networks by deploying an Agency network services contract for consolidated management and provisioning of local area and wide area network services. This will provide NASA with end to end network management and visibility to improve incident detection and response and improve the ability to securely collaborate across multiple Centers. Expected efficiencies will be applied towards upgrading aging network infrastructure. All Centers will migrate to the enterprise contract.
5) Increasing standardization and security of end-user devices (desktops, laptops, etc) by competing an Agency contract for properly configured and managed end-user devices that integrate with the planned Agency network and application environment. This will enable the Agency to apply patches and secure configurations more quickly, and provide for the greatest economy of scale in service provisioning.
6) Simplifying and integrating the NASA applications portfolio by utilizing a portfolio management approach to identify opportunities for consolidation. AITS budget will be applied to conduct business cases and to fund consolidation initiatives. An initiative to consolidate product lifecycle management and product data management applications and infrastructure, leading to a more integrated and standardized IT architecture to support engineering processes with an initial focus on supporting the Constellation Program.
7) Improving security and efficiency of data center services through the implementation of an Agency outsourced data center capability. This will avoid the cost of upgrading the current NASA Data Center facility, and will improve continuity of operations, and reduce electrical costs.
8) Making NASA's information easier to discover and access by making NASA's public facing content available through the NASA.GOV portal, increasing use of meta-data and tagging, and continuing to integrate improvements in commercial search technologies.

Project Descriptions and Explanation of Changes

IT Management

The IT Management Project provides Agency level services for managing IT and meeting internal and external requirements relative to Agency CIO responsibilities. Included in this project are fees paid to E-Gov managing partners for the various E-Gov activities and Federal CIO Council Committees in which NASA participates. This project also constitutes the budget for the NASA Office of the CIO to meet OMB guidance, Executive Orders, laws and regulations relative to E-Government, Paperwork Reduction and Information Collection, the Federal Information Security Management Act, Records Management, Mail Management, Forms Management, Privacy, Capital Planning and Investment Control, and IT Budget Formulation under Circular A-11.

Applications

The Applications Project provides steady state operations of NASA's business and management systems developed under the Integrated Enterprise Management Program, such as, the Core Financial System (SAP), Integrated Asset Management System, the Human Capital Information Environment, and Aircraft Management Module. It also supports the implementation of E-Gov initiatives, such as, E-Travel, Grants.gov and E-Training. For FY10, relatively minor development is planned to address gaps in business and management systems capabilities. This project also provides Scientific and Technical Information (STI) services for the Agency.

Infrastructure

The IT Infrastructure Project provides common core infrastructure services across the Agency, such as, the NASA Public Web portal, enterprise licensing, Personal Identification Verification (PIV) card systems required for logical access control, and configuration control capabilities for networks, end-user services, and data centers. This Project also provides IT security capabilities at the Agency level, such as the Security Operations Center (SOC), third party penetration testing, vulnerability scanning, and patch management. For FY10, an increase in funding will be applied to several initiatives to improve IT security and harden Agency IT infrastructure and applications, such as, SOC operations, E-authentication for Web services, Cyber Threat identification, Trusted Internet Connection deployment, implementation of a zoned network architecture, and Desktop Smartcard Integration.

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FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	146.8	160.2	184.8	184.9	185.7	186.3	187.0
Technology Infusion	6.7	9.1	13.5	13.1	13.5	13.7	14.0
Small Business Innovative Research	86.9	113.4	124.1	124.1	124.1	124.1	124.1
Small Business Technology Transfer Research	13.2	13.6	14.1	14.1	14.1	14.1	14.1
Innovation Incubator	0.0	0.0	2.5	2.5	2.5	2.5	2.5
Future Centennial Challenges	0.0	0.0	4.0	4.0	4.0	4.0	4.0
Partnership Development	39.9	24.1	23.8	20.2	19.9	19.7	21.3
Innovative Technology	0.0	0.0	2.8	6.8	7.5	8.1	7.0
FY 2009 President's Budget Request	146.8	175.7	181.9	178.0	178.1	178.1	--
Technology Infusion	8.5	13.1	11.8	11.0	11.2	11.4	--
Small Business Innovative Research	103.7	117.9	124.1	124.1	124.1	124.1	--
Small Business Technology Transfer Research	12.5	14.1	14.1	14.1	14.1	14.1	--
Innovation Incubator	0.0	2.5	2.5	2.5	2.5	2.5	--
Future Centennial Challenges	0.0	4.0	4.0	4.0	4.0	4.0	--
Partnership Development	22.0	24.1	25.4	22.3	22.2	22.0	--
Changes from FY 2009 Request	0.0	-15.5	2.9	6.9	7.6	8.2	--

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Innovative Partnerships Program

Program Overview

NASA's Innovative Partnerships Program (IPP) is focused on adding value to NASA and the Nation through partnerships. Advancing technology through partnerships has always been important to NASA, not only to address NASA's needs, but also to apply NASA-derived technology to a range of applications that provide broad benefit to the public. NASA seeks partnerships that match technology needs with technology capabilities, moving technology both into (technology infusion) and out of (technology transfer) the Agency. IPP is administered at NASA Headquarters and has program offices at each of the agency's nine field centers and JPL.

The Innovative Partnerships Program consists of three elements: Technology Infusion, Innovation Incubator, and Partnership Development.   Together, these program elements serve to increase the range of technology solutions for NASA, enable cost avoidance, and accelerate technology maturation. Dual-use partnerships and licensing create socio-economic benefits through technology transfer or spinoffs.

Technology Infusion includes the Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) programs and the Program Seed Fund. The SBIR/STTR programs exist to stimulate technological innovation in the private sector; to strengthen the role of small businesses in meeting federal R&D needs; to increase the commercial application of these research results; and to encourage participation by disadvantaged persons and women-owned small businesses. The IPP Seed Fund enhances NASA's ability to meet mission technology goals by providing seed funding to resolve partnership barriers and to initiate cost-shared, joint-technology development partnerships.

Innovation Incubator includes Centennial Challenges, Facilitated Access to the Space Environment for Technology Development and Training (FAST), Innovation Ambassadors, Innovation Scouts, and new efforts to facilitate purchase of services from the emerging commercial space sector.

Partnership Development includes Intellectual Property Management, Technology Transfer, and new innovative partnerships. For Intellectual Property Management, IPP facilitates the protection of NASA's rights in its inventions, thereby enabling NASA's ability to license its technologies for public benefit. IPP is NASA's agent for technology transfer, commercializing space flight technologies and seeking Earth-bound applications for NASA-derived technologies. IPP works with industry, universities, and other agencies to put NASA technologies to use in areas such as health, medicine, transportation, public safety, consumer goods, environmental and agricultural resources, computer technology, and industrial productivity. IPP continuously seeks new partnerships with a broad range of partners to both address NASA's technology needs and facilitate transfer of NASA-derived technology for public benefit.

For additional information see http://ipp.nasa.gov

Plans For FY 2010

IPP's portfolio of technology investments and partnerships will continue to address the technology needs of NASA's Mission Directorates, and IPP will continue to transfer NASA-derived technology for broad public benefit. Specifically IPP plans to achieve 105 instances of technology infusion in FY10. Sources of technology for infusion come from elements of the IPP portfolio including SBIR/STTR, Seed Fund, Centennial Challenges, FAST, and other partnerships. IPP also plans to advance technologies that have potential for use by NASA, as measured by improvements in their Technology Readiness Level (TRL). In FY10, IPP plans to achieve 200 TRL step advancements through its technology portfolio.

Through the Agency's Technology Transfer partnerships in FY10, IPP intends to continue successful movement of NASA intellectual property to put it to work in the economy, by achieving (over the prior five years) 38 licenses generated for every 100 patented technologies in NASA's intellectual property inventory. In FY10, IPP also intends to document 40-50 notable new technology transfer successes in the annual Spinoff publication. As an important step in identifying NASA technology for transfer, IPP intends to facilitate the documentation of 1,800 New Technology Reports. IPP also seeks commercialization success of SBIR/STTR technologies by commercializing 30% of SBIR/STTR phase II awards over the prior five years.

In Technology Infusion, IPP will continue to implement NASA's SBIR and STTR programs with the primary objective of providing the high-technology small business sector with an opportunity to develop technology for NASA, but also seeking commercialization of those technologies for broader application. In FY10, NASA's SBIR/STTR programs will continue to provide high-priority technology needs for NASA with specific technology needs developed in close coordination with NASA's Mission Directorates and other NASA-wide efforts to determine priorities for future technology requirements. Specific plans for SBIR/STTR will reflect pending reauthorization for these government-wide programs. IPP will also seek approximately 15-20 new leveraged technology development partnerships through the IPP Seed Fund that also help address high-priority technology needs of the agency.

In Innovation Incubator, Centennial Challenges will continue to address key technology needs with new sources of innovation including small businesses outside the traditional aerospace community. IPP will continue the ongoing prize competitions, in which prizes have not yet been won and formulate new prizes in the most relevant technology areas. IPP will continue to encourage the pursuit of appropriate partnerships with the emerging commercial space sector through FAST and other activities. IPP anticipates conducting the third round of reduced-gravity testing on parabolic aircraft flights in FY10 and to begin planning for technology testing activities on suborbital flights if the expected commercial services have begun operations.

Partnership Development will continue to seek opportunities for partnership with businesses, academia and other government agencies to address NASA's needs and also transfer NASA technology for use in other important applications. This includes operation of IPP offices at all 9 NASA centers and JPL, which provide essential IPP functions including new technology reporting, software release, outreach to generate partnership opportunities, licensing of technologies, and negotiation of partnerships.

Project Descriptions and Explanation of Changes

Technology Infusion

SBIR/STTR Program Support provides direct support in the administration of NASA's SBIR and STTR programs. Support includes managing the "electronic handbook," NASA's system for processing proposals, and managing the SBIR and STTR award budgets.

The FY 2010 NASA SBIR solicitation will be implemented with newly defined topic areas divided into sub-topics developed by each of the 4 NASA Mission Directorates. Subtopics include current and future Agency program needs and priorities. IPP expects to receive approximately 2000 proposals. For each solicitation, Phase I proposals are given 2 independent evaluations by the NASA field centers for scientific and technical merit, key staff qualifications, soundness of the work plan, and plans for commercial application. The FY2010 program support budget must also support evaluation of FY2009 Phase II proposals which represent about 12% of the Phase I proposals.

SBIR/STTR Program Support funds the outreach efforts needed to increase participation in SBIR/STTR by the small business community. The percentage of new firms participating in NASA's SBIR/STTR programs each year has been in the 30-50% range, yielding new applicants each year. New participants have submitted between 20-35% of the total number of proposals in any given year.

The Investment Seed Fund is an annual process that provides seed funding to resolve partnership barriers and initiate cost-shared joint development partnerships that leverage funding, resources, and expertise from non-NASA partners, NASA programs and projects, and NASA Centers. The Seed Fund supports the future technology needs of NASA's four Mission Directorates. Proposals selected must demonstrate scientific/technical merit and feasibility, relevance and value to NASA Mission Directorates, capability and strength of partnership team (composed of representatives from industry, programs, and IPP), and leveraging of resources as demonstrated by a realistic budget and schedule needed to complete the Seed Fund activity. Proposed projects are 1 year in duration and include 1 or more non-NASA partners willing to provide cost-sharing equal to or greater than the IPP funding provided. To date, IPP has initiated over 80 collaborative Seed Fund projects, leveraging IPP resources nearly 4:1 with $19M in IPP funding yielding a total of $73M in project funding. Projects have resulted in partnerships in 35 states between NASA and 81 businesses (large and small), 20 universities, 4 FFRDCs, and 6 other government agencies.

The objective of these technology development partnerships is to achieve infusion of technological innovations into NASA's programs and projects. Successfully maturing technologies to reduce the risk of infusion is a key factor in success.

Small Business Innovative Research

IPP implements NASA's SBIR and STTR programs with the primary objective of providing the high technology small business sector with an opportunity to develop technology for NASA. In FY 2008, IPP selected 396 Small Business Innovation Research projects, with nearly $100 million awarded to 205 firms across 31 states.

The Small Business Innovation Research Program was established by Congress in 1982 to increase research and development opportunities for small businesses, to increase employment, and to improve U.S. competitiveness. The program's specific objectives are to stimulate U.S. technological innovation, employ small businesses to meet federal research and development needs, increase private-sector commercialization of innovations derived from federal research and development, and encourage and facilitate participation by socially disadvantaged businesses. NASA, as a mission driven agency, seeks small, high-technology companies to participate in government-sponsored research and development efforts in technology areas critical to NASA's missions. IPP will implement the SBIR program consistent with pending reauthorization. Current authorization provides for SBIR funding at 2.5 percent of NASA's extramural research and development expenditures.

The SBIR program is for small businesses with 500 or fewer employees. NASA encourages these organizations to learn more about its program needs and promotes SBIR to the small business community as a significant source of seed funding for the development of innovations.

The SBIR Phase I contracts have a term of six months with a maximum funding of $100,000, and Phase II contracts have a term of 24 months with a maximum funding of $600,000 (up to $750,000 with Phase IIE and matching $150,000 from a Mission Directorate). Historically, the ratio of the number of Phase I proposals to awards for SBIR is 8:1. About 40 percent of the completed Phase I projects receive funding for Phase II development.

NASA is now tracking the maturity of technologies funded by SBIR/STTR through use of Technology Readiness Levels (TRLs). This is important for understanding when technologies will be ready for infusion into NASA's programs and projects and their readiness for commercial use. Tracking TRLs will also provide insight into the progress that technologies are making, and over time, the performance of different firms for successful maturing technologies.

Technologies funded by SBIR/STTR have made invaluable contributions to NASA programs and projects and have also been commercial successes that are bringing important benefits to society. The agency is actively working to increase the number of NASA-funded SBIR/STTR technologies with applicability and adequate maturity for use in NASA's missions and projects. SBIR/STTR technologies are making important contributions to some of NASA's high-profile programs including the Space Shuttle, ISS, Mars rovers, and the Phoenix lander.

Small Business Technology Transfer Research

IPP implements NASA's STTR program with the primary objective of facilitating the transfer of technology developed by a research institution through the entrepreneurship of a small business, resulting in technology to meet NASA's needs. The Small Business Technology Transfer Research (STTR) Program awards contracts to small business concerns for cooperative research and development with a non-profit research institution, such as a university. The small business and its partnering institution are required to sign an intellectual property agreement. In FY 2008, IPP selected 35 Small Business Technology Transfer (STTR) projects, with $8 million awarded to 24 small businesses partnered with 22 universities and research institutions across 14 states.

Modeled after the SBIR Program, STTR is a separately funded activity. STTR is smaller than SBIR, with funding set at three-tenths of a percent of the extramural research and development budget, approximately one-eighth of the amount for SBIR. The small company must take the research and intellectual property of the research institution and convert it into a useful product. While the proposal is still submitted by small business concerns, at least 30 percent of the funding and work must originate with the research institution and a minimum of 40 percent must come from the small business concerns.

Phase I STTR projects receive up to $100,000 in funds for a one-year effort. The maximum contract value for STTR Phase II is $600,000 (up to $750,000 with Phase IIE and matching $150,000 from a Mission Directorate). Historically, the ratio of the number of Phase I proposals to awards for STTR is 5:1. About 40 percent of the completed Phase I projects receive funding for Phase II development. The STTR Program Solicitation research areas correspond to the central underlying technological competencies of each participating NASA Center with the goal of ensuring that small business innovations are part of NASA's success. The Jet Propulsion Laboratory (JPL) participates in the management of the STTR Program.

Innovation Incubator

Innovation Incubator includes Centennial Challenges (budgeted separately), Facilitated Access to the Space Environment for Technology Development and Training (FAST), Innovation Ambassadors, Innovation Scouts, and new efforts to facilitate purchase of services from the emerging commercial space sector. FAST has the dual objectives of demonstrating the purchase of commercial services from the emerging commercial space sector and advancing technology maturity through use of those services. Innovation Transfusion will create connections between innovative external organizations and NASA for increased Agency benefit from external creativity.

The FAST program provides opportunities for emerging technologies to be tested in the space environment thereby increasing infusion of new technologies into NASA and industry. Currently, the program focuses on testing technologies on parabolic aircraft flights that can simulate microgravity and the reduced gravity environments of the Moon or Mars. The FAST program promotes the growth of emerging commercial space services by employing a private reduced gravity flight service for these test flights.

In 2008, an initial set of FAST reduced gravity flights were accomplished. During these flights, five SBIR companies demonstrated a range of new technologies and increased the readiness of these technologies for future application. The FAST program leveraged previous NASA investments in SBIR technology developments by providing a testing opportunity that increased the Technology Readiness Level (TRL) of the technologies. This approach provides a continuum for technology insertion via the SBIR and STTR programs.

In 2009, IPP plans to select at least 20 FAST participants, not limited to SBIR companies, and anticipates larger numbers in future years. IPP also expects to expand this program to offer enhanced testing capabilities on suborbital and orbital flights when those services become commercially available. A measure of FAST program success will be the extent to which it can infuse new technologies into NASA programs while encouraging the development of commercial space services by enlarging the customer base for this emerging industry.

The Innovation Transfusion program will increase the exchange of ideas between NASA employees and the most innovative segments of the private sector and government. There are two elements of the program: Innovation Ambassadors (NASA employees spend up to 1 year at a private company/organization known for innovation in order to share expertise and learn about innovative products, processes and business models) and Innovation Scouts (small groups of NASA employees visit innovative external organizations for 1- or 2-day workshops to exchange ideas and learn about products, processes, and business models that will help NASA become more effective). Both elements will focus on exchanges with organizations outside the traditional aerospace field to seek fresh ideas and create new partnerships.

Future Centennial Challenges

Centennial Challenges program seeks innovative solutions to technical problems related to NASA's programs in space operations, science, exploration and aeronautics. NASA's current seven prize challenges have been successful in encouraging broad participation by innovators across our nation and across generations. Many of these technical challenges also have direct relevance to national and global needs such as energy and transportation.

Prize programs encourage diverse participation and multiple solution paths. A measure of diversity is seen in the geographic distribution of participants (from Hawaii to Maine) that reaches far beyond the locales of the NASA Centers and major aerospace industries. The participating teams have included individual inventors, small startup companies, and university students and professors. An example of multiple solution paths was seen in the Regolith Excavation Challenge. NASA can typically afford one or two working prototypes but at this Challenge event, sixteen different working prototypes were demonstrated for the NASA technologists. All of these prototypes were developed at no cost to the government.

The return on investment with prizes is high as NASA expends no funds unless the accomplishment is demonstrated. NASA provides only the prize money and the administration of the competitions is done at no cost to NASA by non-profit allied organizations. For the Lunar Lander Challenge, twelve private teams spent nearly 70,000 hours and the equivalent of $12 million trying to win $2 million in prize money. Prizes also focus public attention on NASA programs and generate interest in science and engineering. During the recent Lunar Lander Challenge, a live webcast had over 45,000 viewers and over 100,000 subsequent downloads. Prizes also create new businesses and new partners for NASA. The winner of the 2007 Astronaut Glove Challenge started a new business to manufacture pressure suit gloves. Armadillo Aerospace began a partnership with NASA related to the reusable rocket engine that they developed for the Lunar Lander Challenge, and they also sell the engine commercially.

In selecting topics for prize competitions, NASA will consult widely within and outside of the Federal Government. Topics for future challenges that are under consideration include revolutionary energy storage systems, solar and other renewable energy technologies, laser communications, demonstrating near-Earth object survey and deflection strategies, innovative approaches to improving the safety and efficiency of aviation systems, closed-loop life support and other resource recycling techniques, and low-cost access to space. The goal in future challenges is to address common NASA and national technology needs, balance the challenges across the fields of science, exploration, space operations, and aeronautics, and broaden the geographical distribution of competitor teams and host venues.

Partnership Development

IPP is NASA's agent for facilitating the transfer of NASA-derived technology for commercial application and other national benefit. The National Aeronautics and Space Act of 1958 and subsequent legislation direct NASA to have a formal technology transfer program, and take an active role in transferring technology to the private sector and state and local governments for the purposes of commercial and other application of the technology for the national benefit. IPP does this for NASA through Partnership Development, with offices at each of NASA's ten field centers.

The Partnership Development Program element, formerly Technology Transfer Partnerships, includes Intellectual Property Management, Technology Transfer, and new innovative partnerships. Space exploration provides the scientific and technological progress to meet challenging mission requirements. Many commercial technologies are the direct result of NASA-supported funding for internal research and development projects performed at NASA's Centers, and NASA-supported external research performed by the small business community. Through Partnership Development, IPP seeks partnerships for transfer of new or improved technology and innovations to NASA missions, and facilitates transfer out of NASA technology for commercial or other benefits to the Nation. Partnership Development encourages participation by all firms, from small to Fortune 500 companies, including companies from the non-aerospace ("non-traditional") sectors that otherwise might not recognize the opportunity to partner with NASA. Partnerships often involve state and other federal agencies, academic institutions, and other non-profit entities.

Partnership Development includes managing NASA's intellectual property. IPP seeks out potential licensees and negotiates license agreements to transfer NASA technology. In FY 2008, IPP documented 1,100 New Technology Reports on NASA-funded technology that could lead to patenting and transfer. 110 patent applications were filed and 112 patents were awarded in FY 2008. In addition, during FY 2008 IPP executed 30 license agreements and 800 software use agreements transferring NASA technology for broad use and public benefit. IPP has also begun to auction licenses for NASA technologies through an auctioning intermediary at no cost to NASA - previously unprecedented in government. Thus, NASA cultivates partnerships with private industry, academia, and other government agencies to bring its science back down to Earth.

Each year, IPP documents recent successes in its "Spinoff" publication with over 1,600 successes having been documented. The most recent issue, "Spinoff 2008" highlights 50 new examples of how NASA innovation can be transferred to the commercial marketplace.

IPP has strengthened the involvement of the Mission Directorates and Mission Support Offices in all of its program elements to better serve Agency-wide and public needs.

Innovative Technology

The National Research Council review of the Exploration Technology Development Program as well as NASA's internal assessments have noted that NASA does not currently have a robust way to solicit or identify low maturity ideas which are potentially high reward but risky because of their immaturity. Investments in these basic research areas provide the innovation that enables new and more capable missions in the future.

NASA is establishing an Innovative Technology Project that is intended to identify and competitively select, low maturity research projects, and to establish a process to successively eliminate low potential ideas and mature those with high potential. This project will be managed jointly by the Innovative Partnership Program and the Office of the Chief Engineer. The project will issue regular internal and external calls for proposals for small amounts, nominally $50K for 3-6 months study, with successive, phased follow-up awards possible for amounts of $250K-$2M for 6 months to 2 years of research. All selections will be subject to peer review endorsement for the initial and any successive awards. The core funding for this project, $2.8M in FY 2010 within the IPP program, may be augmented by up to $20M in funds from the Mission Directorate's program technology projects, to manage investments in specific disciplines of interest to the Agency's programs.

Program Commitments

Commitment/Output FY 2010	Program/Project	Changes from FY 2009 PB Request
105 technologies infused into NASA programs/projects from total Innovative Partnerships Program portfolio.	All IPP projects.	New metric
0.23 ratio of SBIR/STTR technologies successfully infused into NASA programs relative to the number of Phase II awards issued over the prior five years.	Small Business Innovative Research (SBIR)/ Small Business Technology Transfer (STTR)	New metric
200 technology readiness level (TRL) advancements achieved from the Innovative Partnerships Program portfolio.	All IPP projects.	New metric
35 SBIR/STTR Phase III contracts initiated or expanded.	SBIR/STTR	New metric
0.60 ratio of licenses generated from the Intellectual Property (IP) portfolio of patents from the last five years relative to the	Partnership Development.	New metric
40 notable technology transfer successes documented annually in NASA's Spinoff publication	All IPP projects.	New metric
1800 New Technology Reports (NTRs) produced each year, representing the new technologies available for potential transfer.	All IPP projects.	New metric
0.34 ratio of SBIR/STTR technologies used in commercial products or services, relative to the number of Phase II awards issue over the prior five years.	SBIR/STTR	New metric

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Innovative Partnerships Program

Program Management

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Small Business Innovative Research (SBIR)	NASA HQ IPP	All	NASA Programs/Projects for Phase IIE
Small Business Technology Transfer Research (STTR)	NASA HQ IPP	All	NASA Programs/Projects for Phase IIE
Partnership Development	NASA HQ IPP	All	All NASA Centers, external partners in industry, academia, other agencies
SBIR-STTR Program Support	NASA HQ IPP	All	N/A
Future Centennial Challenges	NASA HQ IPP	NASA HQ	5 allied organizations and their sponsors, competition partners.
Faciliatated Access to the Space Environment for Technology Development and Training (FAST)	NASA HQ IPP	All	NASA Program/Projects and non-NASA organizations
Investment Seed Fund	NASA HQ IPP	All	NASA Mission Directorates and non-NASA organizations
Innovation Transfusion	NASA HQ IPP	All	External organization hosts

Acquisition Strategy

NASA's SBIR/STTR programs represent major annual acquisitions, with a combined solicitation typically in July and selections announced in November. Other IPP activities are primarily partnerships not acquisitions.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	OMB	09/2008	Program Assessment Rating Tool (PART) Outcome: Program rated "Moderately Effective" due to lack of demonstrated results with new program metrics.	3 Years
Performance	National Research Council	09/2008	Review of SBIR/STTR Program: Review is currently in Phase II of a 2-phase study; each study phase to be completed within a 3-year period, currently in the 2nd year of study phase. Phase I results are available. Phase II planned to be completed in FY 2008.	TBD

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Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Strategic Capabilities Assets Program

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	27.2	28.0	29.4	30.2	30.2	30.2	30.5
Simulators	10.9	11.5	11.7	12.1	12.1	12.1	11.9
Thermal Vacuum Chambers	7.7	7.2	8.3	8.4	8.4	8.4	8.7
Arc Jets	8.6	9.3	9.4	9.7	9.7	9.7	9.9
FY 2009 President's Budget Request	27.2	28.0	29.8	30.7	30.7	30.7	--
Simulators	10.9	11.5	11.9	12.3	12.3	12.3	--
Thermal Vacuum Chambers	7.7	7.2	8.2	8.4	8.4	8.4	--
Arc Jets	8.6	9.3	9.7	10.0	10.0	10.0	--
Changes from FY 2009 Request	0.0	0.0	-0.4	-0.5	-0.5	-0.5	--

Program Overview

NASA's Strategic Capabilities Assets Program (SCAP) ensures that identified operational core assets and capabilities are available to support NASA's current and future missions. The SCAP establishes an alliance between all centers with like assets; makes decisions on disposition of capabilities no longer required; identifies re-investment/re-capitalization requirements within and among classes of assets; and implements changes. SCAP reviews the assets' capabilities each year to ensure the requirements continue to be valid.

SCAP ensures that essential test facilities are in a state of "ready to test". It maintains the skilled operational workforce and performs essential preventative maintenance to keep core facilities available to meet program requirements. The core capabilities supported within SCAP are Thermal Vacuum Chambers, Simulators, and Arc Jet facilities.

For additional information on SCAP, please see: http://oim.hq.nasa.gov/oia/scap/index.html.

Plans For FY 2010

SCAP will sustain the strategic technical capabilities needed by NASA for successful missions. SCAP will institute consistency in reimbursable pricing policies, perform quarterly program performance reviews continually reassess the strategy and provide a forum for cooperation between all centers within asset classes.

SCAP will ensure maximum benefit across government by broadening its alliances outside of the Agency for capabilities, such as, thermal vacuum chambers. By initiating new organizations, such as, the Space Environments Simulation Facilities Alliance (SESFA) between NASA, DOD, and other entities. This year an arc jet alliance will be established to allow coordination between DOD and NASA in this test area. SCAP will examine and scrutinize new proposals for additional capabilities that are submitted as part of the FY 2011 budget process.

SCAP is committed to continue developing and implementing disposition plans for assets which are no longer required by the Agency.

Project Descriptions and Explanation of Changes

Simulators

SCAP sustains operations of simulators which are critical components of the success of NASA's Aeronautics Research in the areas of fundamental aeronautics and aviation safety. This capability includes an array of research and development manned flight simulator assets at ARC and LaRC which are in the operations phase. Principal assets include the Vertical Motion Simulator, a large motion system, and its supporting cabs, laboratories, and equipment at ARC which provides scientists and engineers with tools to explore, define, and resolve issues in both vehicle design and missions operations. The Cockpit Motion Facility and its supporting suite of simulators (the Differential Maneuvering Simulator and the Visual Motion Simulator) and other central support facilities at LaRC are designed to support aeronautics and spaceflight vehicle research studies in which motion cues are critical to the realism of the experiments being conducted.

Thermal Vacuum Chambers

SCAP sustains thermal-vacuum, vacuum, and acoustic chambers at NASA facilities (Glenn Research Center, Goddard Space Flight Center, Jet Propulsion Laboratory, Johnson Space Center, Kennedy Space Center, Marshall Space Flight Center, and Plum Brook Station) that simulate conditions in the launch and space environments. These assets are large enough to accommodate a spacecraft with adequate space surrounding the structure for safe, easy access while inside the chamber. Chambers with minimum outline dimensions of 10 ft. by 10 ft. will generally meet this provision. These chambers have the capability of producing pressures of 1 X 10-2 torr or lower and thermal shrouds capable of liquid nitrogen temperatures or lower. Acoustic chambers are capable of generating approximately 150 dB at frequencies in the range of 25 to 1000 Hertz. These chambers perform significant risk mitigation for most of NASA payloads launched into space as well as many in other government agencies such as NOAA, and DOD. Almost all spacecraft launched into space must first be tested in one of NASA's thermal vacuum chambers.

Arc Jets

The NASA SCAP sustains arc-jet complexes located at Ames Research Center and the Johnson Space Center. An arc jet provides simulated high temperature, high velocity environments that support the design, development, test and evaluation (DDT&E) activities in thermal protection materials, vehicle structures, aerothermodynamics, and hypersonics. A gas (typically air) is heated and accelerated to supersonic/hypersonic speeds by a continuous electrical arc. This high-temperature gas passes over a test sample, producing an approximation of the surface temperature and pressure environments experienced by a vehicle on atmospheric entry. Arc jet testing has been critical in the safe return of Space Shuttles from orbit with tile damage. In addition, arc jet testing performed essential validation of materials for the Mars entry missions such as Mars Science Laboratory. NASA maintains two of the four arcjets in the United States providing a critical national capability.

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Mission Directorate:	Cross-Agency Support
Theme:	Institutional Investments

Theme Overview

Institutional Investments provides for design and execution of non-programmatic discrete and minor revitalization construction of facilities projects, facility demolition projects, and environmental compliance and restoration activities.

The Institutional Construction of Facilities (CoF) program funds all institutional CoF projects. These projects are managed via NASA's Capital Facility Investment Program which also includes programmatic facility investments funded by Mission Directorates. The construction planning process starts several years in advance, with design being funded two budget years prior to construction start. The CoF program is developed through a process involving both internal and external stakeholders. All of the Centers' requirements are reviewed and prioritized annually to ensure that only the highest ranking priorities are funded.

The purpose of NASA's Environmental Compliance and Restoration (ECR) program is to clean up chemicals released to the environment from past activities. Cleanups are prioritized to ensure that the highest priority liabilities are addressed first in order to protect human health and the environment and preserve natural resources for future missions.

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	325.5	343.7	355.4	392.3	418.7	423.0	450.0
Institutional Construction of Facilities	249.0	268.9	284.2	326.0	367.4	371.6	397.4
Environmental Compliance and Restoration	76.5	74.8	71.2	66.3	51.3	51.4	52.6
FY 2009 President's Budget Request	319.7	308.7	331.7	335.9	330.4	338.3	--
Institutional Construction of Facilities	243.2	233.9	260.5	269.6	279.1	286.9	--
Environmental Compliance and Restoration	76.5	74.8	71.2	66.3	51.3	51.4	--
Total Change from FY 2009 Request	**5.8**	**35.0**	**23.7**	**56.4**	**88.3**	**84.7**	**--**

Plans for FY 2010

Institutional Construction of Facilities

The Construction of Facilities Program will make capital repairs to NASA's critical infrastructure and make improvements that will improve safety and security, protect NASA's infrastructure, and improve NASA's operating efficiency by reducing utility usage. The program will continue to right size the infrastructure by demolishing infrastructure that is no longer needed.

Projects with initial cost estimates between $1.0 million and $10.0 million are included in the program as Minor Revitalization and Construction projects, and projects with initial cost estimates of $10.0 million or greater are budgeted as discrete projects. Projects with initial cost estimates of $1.0 million or less are accomplished by routine day-to-day facility maintenance and repair activities provided for in program and Center operating budgets. NASA is requesting five-year fund availability to enable effective and efficient management of institutional and programmatic construction projects.

NASA will invest in projects that protect the agency's critical assets, improve mission assurance, and reduce mission risk. Investment in projects such as utility tunnel upgrades at JSC and launch facility protection at Wallops Island will protect NASA's critical assets in the case of natural disasters. Fire protection system repairs and upgrades such as the fire main system repairs at Stennis Space Center's largest test stands will improve worker safety and provide safer testing and operations.

NASA's repair by replacement program will provide sustainable and energy efficient infrastructure by replacing old, inefficient, deteriorated buildings with new efficient high performance buildings. In some cases, NASA will be able to refurbish existing facilities into sustainable buildings that will meet NASA's future technology needs by retaining only the structure and replacing the systems necessary for mission operations. When this approach is viable, the projects will save capital investment over wholesale replacement but still yield a good return on investment through reduced operating costs.

By investing in demolition, NASA will be able to reduce un-needed infrastructure and avoid future expenses for maintaining this infrastructure. The FY 2010 program will demolish some of the first facilities that the agency has identified as un-necessary once the Space Shuttle is retired. This will allow the agency to shift some investment in Shuttle facilities to support new programs shortly after the Shuttle's last flight.

More than 80% of NASA's infrastructure is beyond its design life. As NASA's facilities age beyond their useful life, the facilities become unreliable and put NASA's programs and operations at risk. To mitigate the increasing risk to NASA's missions from infrastructure failure, NASA must maintain its investment in infrastructure repair and refurbishment.

Environmental Compliance and Restoration

For FY 2010 Environmental Compliance and Restoration (ECR) major cleanup activities with the highest priority requirements are:

1) Decontamination and demolition of NASA's Plum Brook Reactor Facility
2) Address ground water and drinking water issues at the Jet Propulsion Laboratory
3) Continue cleanup of ground water contamination at White Sands Test Facility
4) Accelerate cleanup of contamination at Santa Susana Field Laboratory

Mission Directorate:	Cross-Agency Support
Theme:	Institutional Investments

Relevance

Relevance to national priorities, relevant fields, and customer needs:

Institutional Investments funding ensures that NASA's facilities and field installations meet the Agency's infrastructure needs in a safe, secure, and environmentally sound manner. Activities implement sustainable design practices and support compliance with state and national environmental laws and initiatives outlined under the Energy Policy Act of 2005.

Relevance to the NASA Mission and Strategic Goals:

Institutional Investments contributes to the Agency's Strategic Goals by providing critical institutional and program capabilities to support NASA's missions. NASA's Construction of Facilities supports NASA's mission by making capital repairs to the infrastructure necessary for testing space flight hardware, processing spacecraft payloads, launching aircraft and spacecraft and monitoring NASA flight tests and missions. Investment in NASA's ground infrastructure ensures successful space exploration and research. Proper investment in NASA's infrastructure is vital to reducing the risk to NASA's programs and missions resulting from unreliable facilities. Further, the program protects NASA's investments toward its strategic goals by protecting the people and equipment necessary for the execution of the exploration and research mission.

Relevance to education and public benefits:

The Environmental Compliance and Restoration program ensures that the public is not exposed to hazards and that impacted natural resources are restored for future use.

Performance Achievement Highlights:

NASA continued essential infrastructure repair and revitalization activities, completing $122 million of institutional construction of facility projects and awarding 57 institutional construction projects and 46 program construction funded projects.

Additionally NASA continued reducing its infrastructure by disposing of 107 un-needed facilities. Assertive recycling strategies and sustainable demolition practices facilitated demolishing a large inactive Wind Tunnel.

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Mission Directorate:	Cross-Agency Support
Theme:	Institutional Investments
Program:	Institutional Construction of Facilities

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**249.0**	**268.9**	**284.2**	**326.0**	**367.4**	**371.6**	**397.4**
Institutional Construction Of Facilities	**249.0**	**268.9**	**284.2**	**326.0**	**367.4**	**371.6**	**397.4**
FY 2009 President's Budget Request	**243.2**	**233.9**	**260.5**	**269.6**	**279.1**	**286.9**	**--**
Institutional Construction Of Facilities	**243.2**	**233.9**	**260.5**	**269.6**	**279.1**	**286.9**	**--**
Changes from FY 2009 Request	**5.8**	**35.0**	**23.7**	**56.4**	**88.3**	**84.7**	**--**

Program Overview

The Construction of Facilities (CoF) program ensures that the facilities critical to achieving NASA's space and aeronautics programs are the right size and type, and that they are safe, secure, environmentally sound, and operated efficiently and effectively. NASA manages over 5500 facilities with a current replacement value in excess of $23 billion. The CoF Program provides on-going capital improvements to protect the Nation's investment in these facilities. It also ensures that NASA installations conform to requirements and initiatives for the protection of the environment and human health. NASA facilities are essential to the Agency and facility revitalization is needed to maintain infrastructure that is safe and capable of supporting NASA's missions. The facilities being revitalized or constructed in this program are expected to remain active in the long term and are consistent with current and anticipated Agency roles and missions. Projects with initial cost estimates between $1.0 million and $10.0 million are included as Minor Revitalization and Construction projects, and projects with initial cost estimates of $10.0 million or greater are budgeted as discrete projects. Projects with initial cost estimates of $1.0 million or less are accomplished by routine day-to-day facility maintenance and repair activities provided for in program and Center operating budgets. Activation and outfitting costs are not included in CoF funding but are described when they exceed industry standards due to unique NASA requirements.

Institutional CoF projects are required for components of NASA's basic infrastructure and institutional facilities. Funding for Institutional CoF projects is included within the Agency's Institutional Investment account. Funding for construction projects required for specific programs is included in the appropriate budget line item within each Mission Directorate and summarized herein as programmatic projects. Descriptions and cost estimates of FY 2010 institutional and programmatic projects are provided to show a complete picture of NASA's budget requirement for facilities revitalization and construction.

Mission Directorate:	Cross-Agency Support
Theme:	Institutional Investments
Program:	Institutional Construction of Facilities

Plans For FY 2010

The institutional facility projects requested for FY 2010 continue the vital rehabilitation, modification, and repair of facilities to renew and help preserve and enhance the capabilities and usefulness of existing facilities and ensure the safe, economical, and efficient use of NASA's physical plants. The projects repair and modernize deteriorating and obsolete building and utility systems that have reached or exceeded their normal design life, are no longer operating effectively or efficiently, and cannot be economically maintained. These projects include mechanical, structural, cooling, steam, electrical distribution, sewer, and storm drainage systems. Some projects replace substandard facilities in cases where it is more economical to demolish and rebuild than it is to restore. Funds requested for construction planning, design and management cover labor, travel, advance planning and design requirements for future projects; preparation of facility project design drawings and bid specifications; master planning; facilities studies; engineering reports and studies; and critical functional leadership activities directed at increasing the rate of return of constrained Agency resources while keeping the facility infrastructure safe, reliable, and available.

Institutional facilities projects support NASA's mission and strategic goals by revitalizing the infrastructure to ensure reliable ground systems critical for NASA's flight, space flight, and research missions. Projects will reduce un-needed infrastructure through demolition and disposal and reduce the Agency's liability resulting from facilities that the Agency no longer needs. The Agency will reduce energy usage and energy dependence by constructing high performance, sustainable facilities and replacing old failing systems with new energy efficient systems. Projects within the Institutional Construction of Facilities program will improve mission safety and success, protect the NASA workforce and mission equipment, and improve employee health by improving indoor air quality.

NASA will initiate several recapitalization projects in 2010. These projects will mitigate the Agency's highest facility risks and bring facilities back to their design life and parameters by revitalizing major systems and eliminating their associated maintenance backlog, or replacing facilities when it is not economically viable to revitalize. The projects that comprise this request are of the highest priority based on relative urgency and expected return on investment.

Summary of Resources Included in Budget Request

In Millions of Dollars	FY 2008 Actuals	FY 2009 Enacted	FY 2010
Total Construction of Facilities	**366.1**	**402.2**	**412.0**
Science	43.9	21.6	12.6
Exploration	64.0	97.0	88.4
Space Operations	9.2	14.7	26.8
Cross-Agency Support	249.0	268.9	284.2

PROJECT DESCRIPTIONS AND EXPLANATIONS OF CHANGES

SUMMARY OF FY 2010 NON-PROGRAMMATIC COF PROJECTS

SUMMARY OF FY 2010 NON-PROGRAMMATIC CoF PROJECTS

In Millions of Dollars	FY 2008 Actuals	FY 2009 Enacted	FY 2010
Institutional CoF Projects	249.0	268.9	284.2
Repair Hangar, Fire Protection and Electrical, B4820 (DFRC)	---	---	10.0
Repair Primary Electrical Distribution System (DFRC)	---	---	12.0
Construct Centralized Office Building (GRC)	---	---	25.3
Construct Shipping and Receiving Facility (GSFC)	---	---	12.8
Revitalize Administrative Support Building 12 (JSC)	---	---	22.0
Renovation of Operations & Checkout Building (KSC)	7.0	6.5	18.0
Revitalize High and Medium Voltage Electrical Distribution Systems (KSC)	---	---	18.1
Replace Asbestos Siding and Provide Energy Upgrades to Building 4707 (MSFC)	---	7.4	5.0
Construct Collaboration Support Facility, Building N232 (ARC)	---	29.0	---
Upgrade Electrical Supply Reliability, NASA Advanced Supercomputing Facility (ARC)	---	11.5	---
Construct Replacement Propellants North Maintenance Facility (KSC)	---	5.0	---
Revitalize Electrical Maintenance Facility (KSC)	---	5.9	---
Repair and Construct Consolidated Information Technology Center, Phase 2 (DFRC)	---	10.8	---
Upgrade Auxiliary Chiller Plant (JSC)	---	7.5	---
Repair Hurricane Damage, American Recovery and Reinvestment Act (JSC)	---	50.0	---
Construct Flight Project Center (JPL)	3.9	---	---
Construct New Office Facility (JSC)	11.9	---	---
Construct Replacement Administrative Office Bldg (LaRC)	28.8	---	---
Construct Replacement Engineering Building (MSFC)	34.0	---	---
Replace Asbestos Siding and Provide Energy/Safety Upgrades, Bldg 4705 (MSFC)	8.9	---	---
Minor Revitalization of Facilities at Various Locations (less than $10M per project)	105.6	80.9	94.6
Demolition of Facilities	14.4	15.0	20.0
Construction Planning, Design and Management	34.5	39.4	46.4

NON-PROGRAMMATIC DISCRETE PROJECTS

Project Title: Repair Hangar, Fire Protection and Electrical, B4820
Location: Dryden Flight Research Center, Kern County, CA
FY 2010 Estimate: $10.0M

The building 4820 aircraft hangar currently has a high bay deluge fire protection system. This project replaces components of the existing system necessary to provide a fire protection system compliant with current policy for hangars with fueled aircraft. The project also replaces the electrical power distribution system, including the installation of explosion proof duplex outlets with dedicated circuit breakers for each outlet. About half of the duplex outlets will be supplied through an uninterruptible power supply (UPS) which is required to protect test systems. Power control cabinets will be replaced. The existing power control cabinets were manufactured in the 1960s, are obsolete, and have significant safety concerns. Personnel emergency egress from room 121, a control room, office space in rooms 121 and 122, and storage areas in rooms 221 and 222, will be brought into life safety code compliance. This includes the construction of a safe egress corridor from the first floor rooms to the outside of the building. A second floor office area with conference room and restroom will also be constructed, and will address the Americans with Disabilities Act requirements for rooms 221 and 222 which are currently non-compliant.

Project Title: Repair Primary Electrical Distribution System
Location: Dryden Flight Research Center, Kern County, California
FY 2010 Estimate: $12.0M

This project will replace Dryden's main electrical distribution Substation 16 by constructing a new electrical substation with two sources of power, and integrating it with the existing emergency generators. A new building for the switchgear assemblies will also be provided. These switchgear assemblies will provide a source for power distribution throughout the center. Substation 16 is failing and difficult to repair. If this substation fails, DFRC will no longer be able to support any missions. The repair of this system is essentially a constant effort due to the age of the equipment and the extreme desert weather/environment. Critical components of this substation have already failed including one of two main incoming power circuit breakers for which no replacement parts are available. Some equipment in this substation is more than 35 years old and beyond its design life. There is no way to predict future equipment failures.

Project Title: Construct Centralized Office Building
Location: Glenn Research Center, Cleveland, Ohio
FY 2010 Estimate: $25.3M

This project will construct an 80,000 to 90,000 square foot office building designed to consolidate 300 of Glenn Research Center's program, project management, and engineering personnel onto the main Lewis Field campus. This will allow for the deconstruction* of 205,000 square feet of deteriorated North Campus Office Buildings Numbers 500 and 501. The new building will be three or four stories with a partial basement, contain ten conference rooms, and include an auditorium sized to seat 400 persons. Included in the project scope will be site work, underground utilities, and surface parking for 200 to 250 vehicles. The building will be energy and water efficient, use materials with significant recycled and recyclable content, and provide an exceptional indoor environment that will achieve a LEED (Leadership in Energy and Environmental Design) Silver rating and employ sustainable design principles to comply with energy and water efficiency standards for Federal buildings. In order to clear the main campus site needed for the new office building and surface parking requirements, the deconstruction* of the 10,000 square foot Storage Building No. 84, and the 8,000 square foot Warehouse Building No. 137 is also required. These old structures are no longer weather-tight and have significant mold and moisture problems. A new 18,200 square foot warehouse will be constructed in the GRC Lewis Field West Area to replace these old facilities. The new building will be one story above grade with high bay framing, have 12,000 square feet of high capacity storage space, include office space for approximately

16 persons, and include approximately 20 new parking spaces. Site work and underground utilities for the new warehouse are also included.

*Note: Deconstruction work is being funded through our normal demolition account and is not part of this project.

Project Title: Construct Shipping and Receiving Facility
Location: Goddard Space Flight Center, Greenbelt, Maryland
FY 2010 Estimate: $12.8M

The project will construct an approximately 25,000 gross square foot building located in a relatively isolated area of the eastern perimeter of GSFC. The building will house the shipping and receiving functions for GSFC including mail room and duplication, packing and crating, a small amount of office space, temporary storage space, and bathrooms and other institutional support space. Associated work includes loading docks, new and upgraded roadways, parking, traffic control, security station and fencing, site lighting, new and upgraded utilities, erosion and sediment control, storm water management, forest conservation, and landscaping. Capacity for warehouse expansion and ultimate site build out is included to limited extents. This project is within the scope of the GSFC's master plan. The Building 16 Complex was built in 1964 to house GSFC's Logistics functions. When built the facility was on the perimeter of the Center's west campus adjacent to a public roadway. That is no longer the case. The facility now lies approximately in the middle of a unified east/west Center and deliveries must be inspected at perimeter Center security gates which are inadequate for proper receipt and inspection of bulk deliveries. These functions need to be relocated to the perimeter of the Center for security purposes. Complete and proper inspections need to occur before shipments reach to highly populated areas and critical facilities on the Center. The Complex has been added to over the years to provide additional office spaces which now house over 200 Program Project Management personnel. These two disparate functions housed together in the same Complex make this building a single point of failure for missions in the event of an attack through the mail/delivery system.

Project Title: Revitalize Administrative Support Building 12
Location: Johnson Space Center, Houston, Texas
FY 2010 Estimate: $22.0M

This project will provide for total refurbishment of Administrative Support Building 12 which houses Finance, Education, Human Resources, Information Systems and Business Management personnel. It contains a film vault, the Center language lab, software design labs and Center computer training rooms. The refurbishment will be LEED Silver and strive to attain Gold certification. The project will remove asbestos sprayed on the underside of the decking, contained in floor tile, pipe insulation, and sheet rock. Indoor air quality will be improved by replacing HVAC systems. Accessibility issues for the disabled will be addressed. Obsolete fire protection equipment will be replaced, and a sprinkler system will be installed. All electrical switchgear and Motor Control Center equipment will be replaced. Building architectural issues, such as the floor plan, lighting, open stairwell (fire issue) will be replaced or upgraded. Building 12 is a two-story, 63,511 square feet facility that houses over 220 people who will be relocated during construction. It is the oldest building on site, and was constructed in 1963 as a main frame computer building. The function of the building has changed significantly, resulting in inadequate and oversized HVAC systems with marginal fresh air to meet indoor air quality standards. The facility has experienced high failure rates of equipment and critical components are obsolete. Repair work orders in 2006 numbered 208. For 2007, the trend has increased to 298 repair work orders. Mechanical and electrical equipment rooms are combined and equipment cannot be replaced without cutting the equipment into pieces.

Project Title: Renovation of Operations and Checkout Building
Location: Kennedy Space Center, Merritt Island, Florida
FY 2010 Estimate: $18.0M

This project revitalizes the Operations and Checkout Building for indoor air quality, energy efficiency and life safety compliance in various locations. The revitalization will consist of installing a sprinkler system, energy-efficient office lighting, complete updating of the Heating, Ventilation, and Air Conditioning (HVAC) systems and demolishing the existing HVAC ductwork that contributes to poor indoor air quality and asbestos abatement. Other facility systems include HVAC controls, lighting and fire protection. This phase will include the demolition and renovation of the remaining portion of the North Wing, including the three walkways between the north and the south wings. It also includes selected facility systems that support the institutional laboratories in the south wing, such as the air handling units, the motor control centers, and the lightning

protection system. In addition, this project will upgrade employees' office areas in the north wing, including power, communications and data systems. A critical need exists at the Kennedy Space Center to revitalize substandard facilities affecting the health, safety and welfare of personnel. The deteriorated substandard facilities are contributing to costly maintenance requirements, highly inefficient energy consumption and unhealthy working environments. The facility has not been updated to current Florida Building Codes, Florida Fire Prevention Codes, or National Fire Protection Association Life Safety Standards. This project will relieve personnel of the health dangers associated with poor Indoor Air Quality and Building Related Illnesses. An increase in space utilization will be realized. This is the fifth and final phase of this project.

Project Title: Revitalize High and Medium Voltage Electrical Distribution Systems
Location: Kennedy Space Center, Merritt Island, Florida
FY 2010 Estimate: $18.1M

This project will replace deteriorated, degraded and defective high-voltage (HV) and medium-voltage (MV) electrical equipment including but not limited to feeder cables, switchgears, duct banks, transformers, unit substations, protective relays, and corrosion control on electrical equipment enclosures and supporting structures. Selected portions of the power system duct banks will be replaced where deterioration precludes re-use for new cabling. Much of the existing medium voltage cable installed between 1960 and 1980 is deteriorated, obsolete, and failing. Corrosion is a major contributor to deterioration of electrical equipment at KSC resulting from the proximity to the coast and salt-water laden environment. The majority of KSC MV cables are installed in underground duct banks that are submerged in water due to the high water table. Moisture migration through sheath and insulation is a factor for accelerated deterioration of these types of cables. The new cables being installed are EPR and have a better performance in wet environments.

Project Title: Replace Asbestos Siding and Provide Energy Upgrades to Building 4707, Phase 2
Location: Marshall Space Flight Center, Huntsville, Alabama
FY 2010 Estimate: $5.0M

This project provides upgrades to mechanical and electrical distribution systems that no longer meet the current and future operational needs of this facility. Air handling units will be replaced, centralized and/or supplemented. The mechanical and electrical systems will be added to the Utility Control System network for automated control for improved energy conservation. This project will contribute toward meeting MSFC's requirement to operate at or below the established 2010 energy efficiency goals and will also reduce deferred maintenance, enhance indoor air quality, and optimize operational and maintenance practices. Building 4707 offers unique capabilities not otherwise available on or off-site. It is defined as a "Significant" mission support facility in MSFC's Master Plan and will continue to be a showcase of unique technological capabilities. This one-of-a-kind facility houses the highest state-of - the-art equipment that supports both national collaborative strategies and joint programs for manufacturing research and development including the National Center for Advanced Manufacturing (NCAM) that are applicable to a broad spectrum of programs and projects. Mechanical systems are fragmented, subject to breakdown, and operating, maintenance and repair costs are increasing. The facility does not provide an adequate environment for its current functions and without these upgrades will not be able to support the Mission and Programs. This is the second of two phases with the total estimated cost of $12.4M.

INSTITUTIONAL MINOR REVITALIZATION AND CONSTRUCTION OF FACILITIES (PROJECTS LESS THAN $10.M EACH)

This request includes facility revitalization and construction needs with initial cost estimate greater than $1.0 million but less than $10.0 million per project. Projects with initial cost estimates of $1.0 million or less are normally accomplished by routine day-to-day facility maintenance and repair activities provided for in direct program and Center operating budgets. Proposed FY 2010 Institutional minor revitalization and construction projects total $94.6 million for components of the basic infrastructure and institutional facilities, funded in Institutional Investments, and $55.8 million for Program funded projects. These resources provide for revitalization and construction of facilities at NASA field installations and government-owned industrial plants supporting NASA activities. Revitalization and modernization projects provide for the repair, modernization, and/or upgrade of facilities and collateral equipment. Repair projects restore facilities and components to a condition substantially equivalent to the originally intended and designed capability. Repair and modernization work includes the substantially equivalent replacement of utility systems and collateral equipment necessitated by incipient or actual breakdown. It also includes major preventive measures that are normally accomplished on a cyclic schedule and those quickly needed out-of-cycle based on adverse condition information revealed during predictive testing and inspection efforts. Modernization and upgrade projects include both restoration of current functional capability and enhancement of the condition of a facility so that it can more effectively accomplish its designated purpose or increase its functional capability or so that it can meet new building, fire, and accessibility codes.

The minor revitalization and construction projects that comprise this request are of the highest priority, based on relative urgency and expected return on investment. The titles of the projects are designed to identify the primary intent of each project and may not always capture the entire scope or description of each project. Also, during the year, some rearrangement of priorities may be necessary which may cause a change in some of the items to be accomplished.

INSTITUTIONAL MINOR REVITALIZATION PROJECTS: $94.6 MILLION

A. Ames Research Center (ARC), $18.8 million for the following:

1. Emergency/Fire Water Storage and Valves
2. Restore Electrical Distribution System, Phase 8
3. Replace Feedwater Tank and De-aerator
4. Upgrade Perimeter Fence Line
5. Automatic Fire Suppression Systems, Various Buildings
6. Replace Unitary Plan Wind Tunnel 7200V Transformer Secondary Cables

B. Glenn Research Center (GRC), $10.2 million for the following:

1. Repair Raw Water System, Plum Brook Station
2. Security Requirements for GRC Lewis Field Main Gate Area, Phase 3
3. Repair Boiler, Electric Power Laboratory, Building No. 301
4. Repair High Voltage System, Plum Brook Station, Phase 2

C. Goddard Space Flight Center (GSFC), $25.1 million for the following:

1. Repair Central Power Plant Equipment, Building 24, Greenbelt
2. Revitalize X-141 Switching Station, Wallops
3. Replace Roofs, Various Buildings, Greenbelt & Wallops
4. Upgrade Fire Alarm System, Various Buildings, Greenbelt
5. Launch Facility Protection, Wallops Island
6. Replace Building 25 Geothermal Heat Pump

D. Johnson Space Center (JSC), $15.8 million for the following:

1. Upgrade Sanitary Sewer System, WSTF
2. Upgrade Site Electrical Distribution System
3. Replace Potable Water Piping Distribution System
4. Rehabilitate Emergency Electrical Systems, Various Areas and 300 Area Substation, WSTF

E. Kennedy Space Center (KSC), $4.5 million for the following:

1. Repair Center Wide Fire Monitoring, Detection and Alarm System, Phase 1
2. Revitalize/Upgrade Water & Waste Water Systems, Various Locations, Phase 2

F. Langley Research Center (LaRC), $9.3 million for the following:

1. Replace Unit Substations, Various Facilities
2. Repair Underground Utility Tunnels #1 & #2 and Steam Distribution Systems and Components inside the Tunnels

G. Marshall Space Flight Center (MSFC), $4.5 million for the following:

1. Repair Electrical Distribution System, Site Wide, Phase 2

H. Stennis Space Center, $6.4 million for the following:

1. Refurbish Test Stand Fire Main System, Phase 1
2. Repair High and Low Voltage Electrical System Sitewide

DEMOLITION OF FACILITIES

Cognizant Office: Office of Infrastructure
FY 2010 Estimate: $20.0M
The amount requested is required to fund major demolition projects Agency-wide. NASA owns over 2,500 buildings, and over 2,300 other structures, totaling more than 40 million square feet with a current replacement value of over $24 billion. About 420 of these facilities are "mothballed" or "abandoned." Closed facilities are a drain on NASA resources and should be demolished because they can deteriorate into eyesores and possible safety hazards. Demolition projects have accounted for a significant deferred maintenance reduction and have an estimated payback period of seven years.

CONSTRUCTION PLANNING, DESIGN AND MANAGEMENT

Cognizant Office: Office of Infrastructure
FY 2010 Estimate: $46.4M

These funds are required to provide for: advance planning and design activities; special engineering studies; facility engineering research; preliminary engineering efforts required to initiate design-build projects; preparation of final designs, construction plans, specifications, and associated cost estimates; Center labor and travel required to support Institutional CoF Program management; and participation in facilities-related professional engineering associations and organizations. These resources provide for project planning and design activities associated with non-programmatic construction projects. Project planning and design activities for construction projects required to conduct specific programs or projects are included in the appropriate budget line item. Other activities funded include: master planning; value engineering studies; design and construction management studies; facility operation and maintenance studies; facilities utilization analyses; engineering support for facilities management systems; and capital leveraging research activities.

SUMMARY OF FY 2010 PROGRAM DIRECT BY MISSION DIRECTORATE

SUMMARY OF FY 2010 PROGRAM DIRECT PROJECTS BY MISSION DIRECTORATE

In Millions of Dollars	FY 2008 Actuals	FY 2009 Enacted	FY 2010*
PROGRAMMATIC COF PROJECTS	117.1	133.3	127.8
SCIENCE	43.9	21.6	12.6
Construct Laser Fabrication and Test Facility (GSFC)	---	5.4	---
Improve Launch Pad Infrastructure, WFF (GSFC)	---	14.0	---
Construct Exploration Sciences Building (GSFC)	20.0	---	---
Construct Flight Projects Center (JPL)	14.2	---	---
Minor Revitalization of Facilities at Various Locations funded by Earth Science Research	---	---	11.4
Minor Revitalization of Facilities at Various Locations funded by Heliophysics Research	---	1.5	1.2
Minor Revitalization of Facilities at Various Locations funded by Cosmic Origins	2.9	.6	---
Minor Revitalization of Facilities at Various Locations funded by Planetary Science Research	1.1	.1	---
Minor Revitalization of Facilities at Various Locations funded by Deep Space Network	5.7	---	---
EXPLORATION SYSTEMS	64.0	97.0	88.4
Modify Launch Complex 39B for ARES 1 Vehicles (KSC)	---	21.7	6.8
Modify Vehicle Assembly Building (KSC)	---	2.5	35.8
Modify Multi-Payload Processing Facility for Orion (KSC)	---	---	1.0
Modify Building 103 to Support Upper Stage Manufacturing, MAF (MSFC)	---	11.0	2.5
Construct A-3 Propulsion Test Facility (SSC)	---	---	16.8
Modify Space Power Facility for Orion Integrated Environmental Testing, Plum Brook Station (GRC)	4.0	---	2.3
Modify Multi-Payload Processing Facility for Crew Exploration Vehicle (KSC)	---	7.7	---
Construct Vertical Assembly & Welding High Bay in Building 103, MAF (MSFC)	---	42.3	---
Modify A-1 Propulsion Test Facility (SSC)	---	0.9	---
Construct Center for Human Space Flight Performance and Research (JSC)	5.0	---	---
Construct Crew Exploration Vehicle Avionics and Integration Lab (JSC)	23.0	---	---
Revitalize Operations and Checkout Building for Orion Crew Vehicle (KSC)	18.2	---	---
Minor Revitalization of Facilities at Various Locations funded by Constellation Systems	13.8	10.9	21.2
Minor Revitalization of Facilities at Various Locations funded by Exploration Technology Development Program	---	---	2.0
SPACE OPERATIONS	9.2	14.7	26.8
Construct 34-Meter Beam Waveguide Antenna, DSS-35, Canberra, Australia (JPL)	---	---	6.8
Construct Center for Human Space Flight Performance and Research (JSC)	4.0	---	---
Minor Revitalization of Facilities at Various Locations funded by Space Station	1.9	---	---
Minor Revitalization of Facilities at Various Locations funded by Deep Space Network	---	12.2	4.3
Minor Revitalization of Facilities at Various Locations funded by Space and Flight Support	3.3	2.5	15.7

* The human spaceflight review may result in changes to the budget for Exploration activities.

PROGRAMMATIC DISCRETE PROJECTS

Exploration

Project Title: Modify Launch Complex 39B for ARES I Vehicles
Location: Kennedy Space Center, Merritt Island, Florida
Mission Directorate: Exploration Systems
FY 2010 Estimate: $6.8 M

This project modifies and upgrades Launch Complex 39B to support launch of the Orion crew exploration vehicle on the ARES I crew launch vehicle. Launch Complex 39B is currently configured to support launch of the Space Shuttle. The differences in vehicle architecture between ARES I and Shuttle are significant enough to necessitate considerable changes to the existing launch complex. Implementation of these changes is critical to enable safe and affordable operation of the ARES I crew launch vehicle. This is the second increment of a multi-year funded project. The $38.4 million first phase of this project is already underway and is funded using fiscal year 2006 and 2007 resources. Two additional phases are planned in FY11 and FY12 for a total project cost estimate of $96.9 million.

Project Title: Modify Vehicle Assembly Building
Location: Kennedy Space Center, Merritt Island, Florida
Mission Directorate: Exploration Systems
FY 2010 Estimate: $35.8 M

This project modifies the Vehicle Assembly Building to accommodate assembly of the ARES I crew launch vehicles. This is the second increment of a multi-year funded project. The first increment of this project was funded with $2.5 million in fiscal year 2009. The original description provided to Congress for the first increment reflected our plans at the time to modify the existing work platforms, lifting devices, lighting, and other building infrastructure systems. Trade studies performed as part of our preliminary engineering work determined it would be more cost effective to replace the existing platforms rather than modify them. Additional facility modifications are required and critical to enable the safe and affordable operation of the ARES-I crew launch vehicle. Two additional phases are planned in FY11 and FY12 for a total project cost estimate of $64 million.

Project Title: Modify Multi-Payload Processing Facility (MPPF) for Orion
Location: Kennedy Space Center, Merritt Island, Florida
Mission Directorate: Exploration Systems
FY 2010 Estimate: $1.0 M

This project modifies and upgrades the Multi-Payload Processing Facility to enable off-line Orion spacecraft processing for hazardous fueling operations, as well as non-hazardous cargo loading and system testing. The capability to conduct hazardous operations of the Orion spacecraft off-line will provide a safer environment for personnel conducting the hazardous operations, a four day critical path reduction for launch processing, and a rollback and de-servicing capability for contingency operations. These capabilities are critical requirements to enable safe and affordable deployment of the Orion Crew Exploration Vehicle, and cannot be economically accommodated in any other facility. The first phase of this project is $1 million, and the second phase is projected to be $9.5 million for a total project cost estimate of $10.5 million.

Project Title: Modify Building 103 to Support Upper Stage Manufacturing
Location: Michoud Assembly Facility, New Orleans, Louisiana
Mission Directorate: Exploration Systems
FY 2010 Estimate: $2.5 M

This project provides for modifications to Building 103 at MAF for horizontal welding, reaction control system assembly, avionics integration, test and assembly, machining, and common bulkhead assembly and cleaning. This is the second increment of a multi-year funded project. The first increment of this project is funded with $11 million of FY 2009 resources. The project will modify various locations in Building 103 to accommodate robotic weld tools, humidity and temperature controlled environments, heavy machinery, ovens, and cleaning tanks. Modifications will include the installation of mass foundations, various mechanical systems such as shop air, pneumatics, hydraulics, and electrical systems such as power, lighting and grounding. An additional phase is planned in FY11 for a total project cost estimate of $19 million.

Project Title: Construct A-3 Propulsion Test Facility
Location: Stennis Space Center, Mississippi
Mission Directorate: Exploration Systems
FY 2010 Estimate: $16.8 M

This project consists of construction of a new propulsion test facility in Stennis Space Center A-complex including Test Stand, Test Control Center, Operations Support Building, and auxiliary buildings. The new test facility will enable long duration altitude testing of the J-2X engine. The facility will have the capability to simulate high altitude testing, sea-level testing, and engine gimbaling. Infrastructure systems included are test stand structure, access roadways and parking, propellant storage and delivery systems, gas storage and delivery systems, propellant barge docks, engine handling and staging, altitude simulation systems, electrical power systems, and other supporting sub-systems to make the facility operational. This is the third increment of a multi-year funded project. The first and second phases of this project are already underway, and are funded using fiscal year 2006 and 2007 resources totaling $71.7 million. An additional phase is planned in FY11 for a total project cost estimate of $94 million. The project cost estimate has grown by $22 million from the 2009 President's Budget due to increased program requirements, as well as an increase in labor and material costs.

Project Title: Modify Space Power Facility for Orion Integrated Environmental Testing
Location: Glenn Research Center, Plum Brook Station, Sandusky, Ohio
Mission Directorate: Exploration Systems
FY 2010 Estimate: $2.3M

This project provides for modifications to the Space Power Facility at Plum Brook Station to enable thermal vacuum, electromagnetic, acoustic and vibration testing of the Orion and Altair spacecrafts. New construction within the existing facility creates a radiant acoustic test chamber and a mechanical vibration test position. Changes related to technical and testing requirements maturation for the Orion crew module have increased the complexity and cost of this project, since first presented. The first and second phases of this project are already underway, and are funded using fiscal year 2007 and 2008 resources totaling $55.0 million. Two additional phases are planned in FY11 and FY12 for a total project cost estimate of $103 million. The state of Ohio is funding $5 million for construction services.

Space Operations

Project Title: Construct 34-Meter Beam Waveguide Antenna, DSS-35
Location: Canberra, Australia
Mission Directorate: Space Operations
FY 2010 Estimate: $6.8 M

This project includes fabrication and installation of the antenna structure, panels, gearboxes, bearings, electric drives, encoders, beam waveguide mirrors, subreflector and subreflector positioner. It also includes the design and construction of the foundation and pedestal, as well as facilities in and around the Canberra Complex, antenna structure and pedestal, such as paved

access road, trenches, drainage, flood control devices, water main and distribution system, antenna apron, security fence, HVAC, electrical power distribution, fire detection and suppression system, and surveillance system assembly. A Beam Waveguide antenna is needed to add resilience in the southern hemisphere for the Deep Space Network. This antenna is needed to support additional mission loading from projects currently under development and scheduled for launch during or after 2015. This is the first of three increments with a total estimated construction cost of $25.7 million with the last phase planned for FY 2012.

PROGRAMMATIC MINOR REVITALIZATION PROJECTS: $55.8 MILLION

SCIENCE

A. Ames Research Center (ARC), $4.9 million for the following:

1. Renovate Electrical Systems, Building N233 (Earth Science Research)

B. Goddard Space Flight Center (GSFC), $1.2 million for the following:

1. Modification and Rehabilitation of Vehicle Assembly Building, White Sands Missile Range (WSMR), Phase 2 (Heliophysics Research)

C. Jet Propulsion Laboratory (JPL), $6.5 million for the following:

1. Restore Data Center, B320, Phase 1 (Earth Science Research)

EXPLORATION *

A. Ames Research Center (ARC), $2.0 million for the following:

1. Replace Steam Vacuum System, Arcjet Facility (Exploration Technology Development Program)

B. Kennedy Space Center (KSC), $5.0 million for the following:

1. Install Pier Scour Protection (Constellation)

C. Marshall Space Flight Center (MSFC), $16.2 million for the following:

1. Modify Building 110 for Upper Stage LO2 Proof Test, MAF (Constellation)
2. Modify Cell N Building 131 for Thermal Protection System, MAF (Constellation)
3. Rehabilitate Production Wastewater Tanks, MAF, Phase 2 (Constellation)
4. Replace Fire Alarm System in Various Buildings, MAF, Phase 3 (Constellation)
5. Replace Transformer, West Master, MAF, Phase 3 (Constellation)
6. Rehabilitate Cranes and Trolleys/Controls, MAF, Phase 1, (Constellation)
7. Replace Substations 25, 454A/45B, MAF (Constellation)
8. Replace and Upgrade Bridge Cranes Control Systems (Constellation)

SPACE OPERATIONS

A. Jet Propulsion Laboratory (JPL), $4.3 million for the following:

1. Modify Power Distribution System, Canberra, Australia (Space Communication)
2. Replace ‘B’ Bank Generator Switchgear, Canberra, Australia (Space Com.)

* The human spaceflight review may result in changes to the budget for Exploration activities.

B. Johnson Space Center (JSC), $9.9 million for the following:

1. Install Firefighting Foam System, Ellington Field Hangers (Human Space Flight Operations (HSFO))
2. Upgrade Utility Tunnel (HSFO)

C. Kennedy Space Center (KSC), $4.3 million for the following:

1. Repair Roof and Gutters Payload Hazardous Servicing Facility (Launch Services)
2. Upgrade Fire Protection Systems Various Buildings (HSFO)

D. Stennis Space Center (SSC), $1.5 million for the following:

1. Modify Fluid Processing Facility (Rocket Propulsion Testing)

Mission Directorate:	Cross-Agency Support
Theme:	Institutional Investments
Program:	Environmental Compliance and Restoration

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	76.5	74.8	71.2	66.3	51.3	51.4	52.6
Environmental Compliance and Restoration	76.5	74.8	71.2	66.3	51.3	51.4	52.6
FY 2009 President's Budget Request	76.5	74.8	71.2	66.3	51.3	51.4	--
Environmental Compliance and Restoration	76.5	74.8	71.2	66.3	51.3	51.4	--
Changes from FY 2009 Request	0.0	0.0	0.0	0.0	0.0	0.0	--

Program Overview

NASA's Environmental Compliance and Restoration (ECR) Program primarily provides for personnel, services, and activities necessary to complete the cleanup of hazardous materials and wastes that have been released to the surface or groundwater at NASA installations, NASA-owned industrial plants supporting NASA activities, and other current or former sites where NASA operations have contributed to environmental problems and where the agency is legally obligated to address these hazardous releases. Liquidating these liabilities is estimated to cost nearly one billion dollars with much of that work planned in the next decade. Specific program activities include projects, studies, assessments, investigations, plans, designs, related engineering, program support, sampling, monitoring, regulatory agency oversight costs, and any land acquisitions necessary to ensure operation of remedial treatment processes and sites as part of the remediation and cleanup measures.

This program also invests in methodologies for sustainably reducing energy intensity and greenhouse gas emissions and supports operational activities by ensuring that advances in chemical risk management are incorporated early in the mission project design phase.

Additional information concerning NASA's ECR program can be found at http://oim.hq.nasa.gov/oia/emd/ecr.html

Mission Directorate:	Cross-Agency Support
Theme:	Institutional Investments
Program:	Environmental Compliance and Restoration

Plans For FY 2010

The FY 2010 funding request represents a prioritized, risk-based approach for addressing a total of 135 cleanup projects remaining at all NASA centers and is based upon the relative urgency and the potential health and safety hazards related to each individual cleanup. As studies, assessments, investigations, plans, regulatory approvals, and designs progress and as new discoveries or regulatory requirements change, it is expected that program priorities may change requiring revisions to planned activities.

Major cleanup activities with the highest priority requirements planned for accomplishment in FY 2010 include the following:

1) Continue decontamination and demolition of NASA's Plum Brook Reactor Facility. FY 2010 funding is projected to move us very close to our goal of Nuclear Regulatory Commission (NRC) license termination and return of the land to productive use.

2) Address ground water and drinking water issues associated with contamination emanating from NASA's Jet Propulsion Laboratory;

3) Continue cleanup of ground water contamination at White Sands Test Facility; and

4) Accelerate cleanup of contamination at Santa Susana Field Laboratory to facilitate property transfer.

Overview

The NASA Office of Inspector General (OIG) budget request for FY 2010 is $36.4 million. The NASA OIG consists of 186 auditors, analysts, specialists, investigators, and support staff at NASA Headquarters in Washington, DC, and NASA Centers throughout the United States. The FY 2010 request supports the OIG mission to prevent and detect crime, fraud, waste, abuse, and mismanagement while promoting economy, effectiveness, and efficiency within the Agency.

The OIG Office of Audits (OA) conducts independent, objective audits and reviews of NASA and NASA contractor programs and projects to improve NASA operations, as well as a broad range of professional audit and advisory services. It also comments on NASA policies and is responsible for the oversight of audits performed under contract. OA helps NASA accomplish its objectives by bringing a systematic, disciplined approach to evaluate and improve the economy, efficiency, and effectiveness of NASA operations.

The OIG Office of Investigations (OI) identifies, investigates, and refers for prosecution cases of crime, waste, fraud, and abuse in NASA programs and operations. The OIG's federal law enforcement officers investigate false claims, false statements, conspiracy, theft, computer crimes, mail fraud, and violations of federal laws, such as the Procurement Integrity Act and the Anti-Kickback Act. Through its investigations, OI also seeks to prevent and deter crime at NASA.

NASA's FY 2010 OIG request is broken out as follows:

- $30.5 million (84 percent) of the proposed budget is dedicated to personnel and related costs, including salaries, benefits, monetary awards, worker's compensation, permanent change of station costs, as well as the Government's contributions for Social Security, Medicare, health and life insurance, retirement accounts, and matching contributions to Thrift Savings Plan accounts. Salaries include the required additional 25 percent law enforcement availability pay for criminal investigators.

- $1.3 million (3 percent) of the proposed budget is dedicated to travel, per diem at current rates, and related expenses. The OIG staff is located at 12 offices on or near NASA installations and contractor facilities.

- $4.6 million (13 percent) of the proposed budget is dedicated to operations and equipment primarily funding for the Agency's annual financial audit, and also includes funding for training, government vehicles, special equipment for criminal investigators, metro subsidies, and information technology equipment unique to the OIG.

FY 2010 Budget Request

Budget Authority ($ millions)	FY 2008 Actual	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
FY 2010 President's Budget Request	**32.6**	**35.6**	**36.4**	**37.0**	**37.8**	**38.7**	**39.6**
Inspector General	32.6	35.6	36.4	37.0	37.8	38.7	39.6
FY 2009 President's Budget Request	**32.6**	**35.5**	**36.4**	**37.3**	**38.3**	**39.2**	**--**
Inspector General	32.6	35.5	36.4	37.3	38.3	39.2	--
Total Change from FY 2009 President's Budget Request	**0.0**	**0.1**	**0.0**	**-0.3**	**-0.5**	**-0.5**	**--**

Note: In all budget tables, the FY 2010 President's Budget Request depicts the September 2008 Operating Plan for the 2008 Actuals and the 2009 Omnibus Appropriations Act (P.L. 111-8) and the American Recovery and Reinvestment Act (P.L. 111-5) for the 2009 enacted. In accordance with the Inspector General Reform Act of 2008 (P.L. 110-409), the Inspector General certifies that the $.4M for staff training and $.1M to support the Council of Inspectors General on Economy and Efficiency included in the budget request satisfies all known training requirements and planned contributions to the Council.

Plans for FY 2010

Inspector General

Inspector General

New Initiatives:

None

Major Changes:

None

Major Highlights for FY 2010

The FY 2010 budget estimates for the IG is a total of $36.4 million:

Personnel and related costs	$30.5 million
Travel	$1.3 million
Operations and Equipment	$4.6 million

SUPPORTING DATA TABLE OF CONTENTS

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FUNDS DISTRIBUTION BY INSTALLATION

($ in Millions)	FY 2009 Current[1]	FY 2010 Estimate[2]
Ames Research Center	**$611.2**	**$615.2**
Science	$159.4	$188.9
Aeronautics Research	$99.4	$104.0
Exploration Systems	$75.9	$70.8
Space Operations	$16.2	$2.3
Education	$5.5	$5.2
Cross-Agency Support	$254.7	$244.2
Dryden Flight Research Center	**$245.9**	**$271.9**
Science	$53.9	$53.8
Aeronautics Research	$44.1	$60.8
Exploration Systems	$39.8	$39.8
Space Operations	$4.0	$4.4
Education	$14.7	$14.8
Cross-Agency Support	$89.3	$98.4
Glenn Research Center	**$580.1**	**$631.6**
Science	$27.2	$26.6
Aeronautics Research	$117.8	$139.0
Exploration Systems	$126.7	$118.5
Space Operations	$29.2	$24.8
Education	$9.3	$15.1
Cross-Agency Support	$269.9	$307.6
Goddard Space Flight Center	**$2,832.7**	**$2,622.2**
Science	$2,035.1	$1,978.4
Aeronautics Research	$0.2	$0.0
Exploration Systems	$28.7	$22.1
Space Operations	$296.2	$121.5
Education	$4.5	$2.3
Cross-Agency Support	$468.0	$497.9
Jet Propulsion Laboratory	**$1,346.4**	**$1,271.7**
Science	$1,116.8	$1,013.3
Exploration Systems	$23.4	$40.9
Space Operations	$170.2	$179.6
Education	$1.0	$9.2
Cross-Agency Support	$34.9	$28.8
Johnson Space Center	**$5,897.1**	**$6,269.7**
Science	$34.5	$27.4
Exploration Systems	$1,846.8	$1,740.3
Space Operations	$3,530.4	$4,034.2
Education	$7.0	$8.7
Cross-Agency Support	$478.4	$459.1

[1] FY 2009 current budget includes $1B in budget authority at Headquarters. These funds will be distributed to Centers upon approval of Recovery plans. In addition, FY 2009 and 2010 estimates include program funds not yet allocated to Centers.

[2] The human spaceflight review may result in changes to the budget for Exploration activities.

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FUNDS DISTRIBUTION BY INSTALLATION (CONTINUED)

($ in Millions)	FY 2009 Current[3]	FY 2010 Estimate[4]
Kennedy Space Center	**$1,415.0**	**$1,369.9**
Science	$312.2	$257.9
Exploration Systems	$308.8	$321.5
Space Operations	$385.6	$361.1
Education	$4.8	$3.8
Cross-Agency Support	$403.6	$425.5
Langley Research Center	**$651.4**	**$648.2**
Science	$58.7	$60.0
Aeronautics Research	$154.5	$170.1
Exploration Systems	$102.6	$77.6
Space Operations	$7.2	$0.9
Education	$9.4	$9.7
Cross-Agency Support	$319.0	$329.9
Marshall Space Flight Center	**$2,522.2**	**$2,785.0**
Science	$132.1	$128.8
Exploration Systems	$845.8	$1,373.0
Space Operations	$1,092.2	$829.1
Education	$3.2	$4.7
Cross-Agency Support	$449.0	$449.4
NASA Headquarters	**$2,462.8**	**$2,001.2**
Science	$969.4	$739.1
Aeronautics Research	$233.9	$33.1
Exploration Systems	$431.3	$73.8
Space Operations	$164.6	$579.1
Education	$108.9	$52.0
Cross-Agency Support	$519.0	$487.8
Inspector General	$35.6	$36.4
Stennis Space Center	**$219.5**	**$199.3**
Science	$3.5	$3.2
Exploration Systems	$75.6	$85.0
Space Operations	$68.9	$38.5
Education	$0.9	$0.6
Cross-Agency Support	$70.6	$72.0
Total	**$18,784.4**	**$18,686.0**

[3] FY 2009 current budget includes $1B in budget authority at Headquarters. These funds will be distributed to Centers upon approval of Recovery plans. In addition, FY 2009 and 2010 estimates include program funds not yet allocated to Centers

[4] The human spaceflight review may result in changes to the budget for Exploration activities.

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CIVIL SERVICE FULL TIME EQUIVALENT DISTRIBUTION BY CENTER

NASA is well on its way toward retirement of the Space Shuttle and the development of the Orion Crew Exploration and Ares I Launch Vehicles, the first two in a suite of vehicles supporting the Agency's Exploration missions. In addition, NASA is still sustaining operations on the International Space Station and continues to support vibrant science and aeronautics programs. NASA continues to plan its workforce needs based on the skills needed to complete all of its missions. Every year, a thorough workforce planning analysis is completed to determine what skills are needed to complete NASA's programs and projects. Over the past couple of years, some of NASA's skill needs have shifted because of the move from a Shuttle based fleet to the design and development of Exploration Vehicles. The resulting shift in workforce competencies have been (and continue to be) accomplished by retraining and reassignment of the critical civil service workforce.

The workforce levels as proposed reflect the results of a grassroots planning activity to match workforce at the centers with demand across all Agency programs and projects. In order to ensure that the necessary skills are available to meet the work demand of current and future programs and projects, maintaining a total workforce level of 17,900 FTE, while reshaping the skills, is vitally important to meeting the challenges of NASA's current and future commitments.

To facilitate this reshaping, NASA is implementing a number of actions to ensure that its future workforce has the needed skills to perform the work, is more flexible to programmatic work demand shifts, and has a younger and healthier age profile. Some of these actions include implementing buyouts in surplus skill areas, implementing strategies for recruiting and retaining critical personnel, excluding students -mainly those in the Student Career Experience Program (SCEP–CO-OP) – from FTE ceilings, and moving toward a goal of having no more than 85% of all Civil Service Science and Engineering employees employed as Full-Time Permanent Employees. These strategies are making good use of the flexibilities granted to the Agency in the NASA Flexibility Act of 2004. Finally, with the implementation of agency workforce planning strategies during the past couple of years, NASA has eliminated previously forecasted uncovered workforce at each location through the budget planning horizon.

	ACTUALS*	FTE ESTIMATES (Excludes Student FTEs)					
Center	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**
ARC	**1,274**	**1,202**	**1,202**	**1,202**	**1,202**	**1,202**	**1,202**
DFRC	**555**	**525**	**525**	**525**	**525**	**525**	**525**
GRC	**1,637**	**1,619**	**1,619**	**1,619**	**1,619**	**1,619**	**1,619**
GSFC	**3,124**	**3,143**	**3,143**	**3,143**	**3,143**	**3,143**	**3,143**
JSC	**3,308**	**3,265**	**3,265**	**3,265**	**3,265**	**3,265**	**3,265**
KSC	**2,201**	**2,106**	**2,106**	**2,106**	**2,106**	**2,106**	**2,106**
LaRC	**1,911**	**1,891**	**1,891**	**1,891**	**1,891**	**1,891**	**1,891**
MSFC	**2,565**	**2,541**	**2,541**	**2,541**	**2,541**	**2,541**	**2,541**
SSC	**268**	**265**	**265**	**265**	**265**	**265**	**265**
HQ	**1,193**	**1,200**	**1,200**	**1,200**	**1,200**	**1,200**	**1,200**
NSSC	**123**	**143**	**143**	**143**	**143**	**143**	**143**
Total	**18,159**	**17,900**	**17,900**	**17,900**	**17,900**	**17,900**	**17,900**

*** FY 2008 FTE actuals include 218 Student FTEs; FY 2009-2014 Estimated FTEs do not include estimated student FTEs of 267 for each fiscal year.**

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BUDGET FOR FY 2010 BY OBJECT CLASS CODE

The following tables reflect projections of obligations for FY 2010 based on FY 2008 actual obligations. The tables and data are organized to reflect the Mission Directorate structure which began in FY 2009 budget.

FY 2010 Total and Mission Directorate Estimates ($M)	NASA	SCIENCE	AERONAUTICS	EXPLORATION *	SPACE OPERATIONS	EDUCATION	CROSS AGENCY SUPPORT
Personnel compensation							
Full-time permanent	$1,820.0	$194.3	$142.2	$361.0	$319.0	$4.3	$799.2
Other than full-time permanent	$149.2	$11.0	$11.2	$38.0	$36.2	$0.5	$52.2
Other personnel compensation	$50.9	$1.1	$0.8	$3.8	$4.3	$0.0	$40.9
Special personal service payments	$0.8	$0.0	$0.0	$0.1	$0.1	$0.0	$0.7
Total Personnel compensation	**$2,020.9**	**$206.4**	**$154.2**	**$402.9**	**$359.5**	**$4.8**	**$893.0**
Civilian personnel benefits	$513.7	$50.9	$37.5	$102.9	$91.9	$1.2	$229.3
Benefits to former personnel	$3.7	$0.1	$0.4	$0.4	$0.1	$0.0	$2.6
Travel & transportation of persons	$105.0	$18.4	$6.4	$22.0	$18.2	$0.5	$39.5
Transportation of things	$222.2	$2.0	$0.3	$137.8	$78.2	$0.0	$3.9
Rental payments to GSA	$36.4	$0.0	$0.0	$0.0	$0.0	$0.0	$36.3
Rental payments to others	$13.0	$5.1	$0.1	$3.0	$2.7	$0.0	$2.2
Communications, utilities & misc charges	$137.5	$3.1	$2.4	$10.2	$54.1	$0.0	$67.5
Printing and reproduction	$10.5	$2.3	$0.3	$1.3	$1.8	$0.1	$4.7
Advisory and assistance services	$681.4	$136.0	$16.9	$302.6	$43.7	$4.1	$178.3
Other services	$881.4	$218.6	$32.8	$119.9	$162.7	$11.5	$335.9
Other purchases of goods & services from Gov accounts	$495.9	$154.3	$9.5	$60.8	$187.7	$1.0	$82.7
Operation and maintenance of facilities	$2,421.6	$12.5	$24.7	$194.6	$1,814.5	$1.5	$373.8
Research & development contracts	$8,467.0	$2,853.0	$170.0	$2,212.0	$2,878.3	$9.7	$344.1
Medical care	$5.3	$0.0	$0.0	$0.0	$0.5	$0.0	$4.8
Operation and maintenance of equipment	$684.6	$54.5	$10.7	$66.8	$203.6	$3.5	$345.4
Supplies and materials	$186.5	$22.6	$14.2	$37.6	$59.6	$0.6	$51.9
Equipment	$333.6	$60.9	$23.4	$29.5	$156.3	$0.4	$63.1
Land and structures	$531.6	$60.2	$4.4	$167.0	$48.5	$0.0	$251.5
Grants, subsidies, and contributions	$969.1	$636.9	$51.2	$90.6	$5.5	$95.7	$89.2
TOTAL DIRECT	**$18,720.8**	**$4,497.7**	**$559.4**	**$3,961.9**	**$6,167.4**	**$134.7**	**$3,399.7**

* The human spaceflight review may result in changes to the budget for Exploration activities.

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STATUS OF UNOBLIGATED FUNDS

The figures below represent actual unobligated balances within NASA's individual appropriation accounts as of September 30, 2008, and estimates for the disposition of those accounts at the future dates specified.

FY 2008 – FY 2010 Appropriations ($ in millions)	Unobligated Balances Sept. 30, 2008	Estimated Unobligated Balances Sept. 30, 2009	Estimated Unobligated Balances Sept. 30, 2010
Science, Exploration, & Aeronautics	345		
Science		110	90
Exploration		78	79
Aeronautics		63	10
Education		34	25
Cross-Agency Support		67	68
Exploration Capabilities	100		
Space Operations		115	124
Inspector General	0	2	1
Total NASA	**445**	**469**	**397**

Prior Year Appropriations ($ in millions)	Unobligated Balances Sept. 30, 2008	Estimated Unobligated Balances Sept. 30, 2009	Estimated Unobligated Balances Sept. 30, 2010
Science, Exploration, & Aeronautics	49		
Science			
Exploration			
Aeronautics			
Education			
Cross-Agency Support			
Exploration Capabilities	64		
Space Operations			
Total NASA	**113**	**0**	**0**

Totals may not add due to rounding

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REIMBURSABLE ESTIMATES

Reimbursable agreements are agreements where the NASA costs associated with the undertaking are borne by the non-NASA partner. NASA undertakes reimbursable agreements when it has equipment, facilities, and services that it can make available to others in a manner that does not interfere with NASA mission requirements. As most reimbursable requests to NASA do not occur until the year of execution, the FY 2010 estimate is based on historical data.

Budget Authority ($ in millions)	FY 2008 Actuals	FY 2009 Enacted	FY 2010
Science, Aeronautics & Exploration	**693.2**		
Science	***556.5***		
Exploration	***16.5***		
Aeronautics	***95.8***		
Cross-Agency Support	***24.4***		
Exploration Capabilities	**321.9**		
Space Operations	***321.9***		
Cross Agency Support		**1,474.6**	**1,575.2**
Office of Inspector General	**0.4**	**1.5**	**1.5**
Total	**1,015.5**	**1,476.1**	**1,576.7**

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ENHANCED USE LEASING

In 2003, NASA was authorized by Congress to demonstrate leasing authority and collections at two Centers. In 2007 and in 2008, that authority was amended by Congress such that NASA may enter into leasing arrangements at all Centers after December 2008. After deducting the costs of administering the leases, Centers are then permitted to retain 65% of net receipt revenue, and the balance is made available agency-wide for NASA. These funds are in addition to annual appropriations. To ensure annual oversight and review, the FY 2009 Appropriations bill, P.L. 111-8 contains a provision that requires NASA to submit a separate accounting of leasing collections and proposed expenditures in its annual budget justification submission to Congress. There are no civil servants funded from EUL income.

FY2010 EUL Expenses and Revenues ($K)	ARC	KSC	Total
Base Rent	$ 5,196.7	35.7	5,232.4
Institutional Support Income	1,803.7	21.0	1,824.7
Total Rent Income	**$ 7,000.4**	**56.7**	**7,057.1**
Institutional Support Costs	$ (1,803.7)	(21.0)	(1,824.7)
Lease Management and Administration	(700.0)	-	(700.0)
Tenant Building Maintenance and Repair	(310.5)	-	(310.5)
Total Cost Associated with Leases	**$ (2,814.2)**	**(21.0)**	**(2,835.2)**
Net Revenue from Lease Activity	**$ 4,186.2**	**35.7**	**4,221.9**
Beginning Balance, Capital Asset Account	**534.2**	**37.7**	**571.9**
Net Revenue from Lease Activity	**$ 4,186.2**	**$ 35.7**	**$ 4,221.9**
- Various Historic Building or Safety Renovation Projects	(3,381.7)		(3,381.7)
- Capital Revitalization & Property Improvements		(49.1)	(49.1)
Center Capital Asset Account Expenditures	**$ (3,381.7)**	**$ (49.1)**	**$ (3,430.8)**
Capital Asset Account Ending Balance	**$ 1,338.7**	**$ 24.3**	**$ 1,363.0**
Additional Reimbursable Demand Services Requested by Leasees (including overhead)	$ 1,814.1		$ 1,814.1
Cost to Fulfill Reimbursable Demand Services (including overhead)	(1,814.1)		(1,814.1)
Net activity due to Reimbursable Demand Services	**$ -**	**$ -**	**$ -**
			-
In Kind	**$ 425.0**	**$ -**	**$ 425.0**

Definitions:

Base Rent - Revenue collected from tenant for rent of land or buildings.
Institutional Support Costs - Cost for institutional shared services such as fire, security, first responder, communications, common grounds, road, and infrastructure maintenance, and routine administrative support and management oversight (i.e., environmental).

Total Rental Income - Total gross proceeds from EUL activities for expenses due to renting NASA property.

In-Kind - Consideration accepted in lieu of rent payment. (Only applies to selected leases signed prior to Jan 1, 2009).
Reimbursable Demand Services - Services such as janitorial, communications, and maintenance that solely benefit the tenant and provided for their convenience. There is no net income received by NASA, as these payments may only cover the costs of NASA and its vendors providing these services.

Overhead - General and administrative costs associated with management of the specified demand services.

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BUDGET FOR MICROGRAVITY SCIENCE

The Exploration Systems Mission Directorate (ESMD) and Space Operations Mission Directorate (SOMD) support research to take advantage of the unique environment of reduced gravity in two broad categories – Exploration and Non-Exploration ISS Research.

$ in millions	FY2008 Actuals	FY2009 Enacted	FY2010*	FY2011*	FY2012*	FY2013*	FY2014*
Exploration ISS Research	$135	$151	$132	$139	$138	$145	$138
Non- Exploration ISS Research	$41	$44	$31	$29	$28	$28	$27
Total	**$177**	**$195**	**$164**	**$168**	**$166**	**$173**	**$165**
% of Non-Exploration to Total	23%	23%	19%	17%	17%	16%	16%

** Funds for ISS research may be re-planned as a result of the review of human spaceflight. At least 15% will still go to non-Exploration research.*

As a result of the FY 2009 appropriations, funding for the ISS Research project under the Exploration Systems Mission Directorate was increased by $20M.

Exploration ISS Research

Exploration ISS Research supports the Agency's need for improved knowledge about working and living in space to enable long-duration human exploration missions in the future.

The Human Research Program will provide research results that reduce risks to crew health and performance that stem from prolonged exposure to reduced gravity, space radiation and isolation during exploration missions. Risk mitigation and countermeasure development will be achieved by conducting ISS research in human health countermeasures, space human factors and habitability, behavioral health and performance, and exploration medicine tools and technologies.

The Exploration Technology Development Program will investigate the underlying gravity-dependent phenomena in the following areas: fire prevention, detection, and suppression, boiling, multiphase flow of fluids and capillary driven flow. These applied research investigations will provide needed data that is useful in the future design of the following space technology areas: life support systems, propellant storage, power generation, thermal control, and advanced environmental monitoring and control. The above table also includes the portion of the Multi-User System Support (MUSS) which supports Exploration ISS Research.

Non-Exploration ISS Research

NASA allocates at least 15 percent of the funds budgeted for ISS research to ground-based, free-flyer, and ISS life and physical science research that is not directly related to supporting the human space exploration program. The purpose is to ensure the capacity to support ground-based research leading to space-based basic and applied scientific research in a variety of disciplines with potential direct national benefits and applications that can be advanced significantly from the uniqueness of microgravity and the space environment. Also, to carry out, to the maximum extent practicable, basic ISS research in fields such as, animal research, basic fluid physics, combustion science, cellular biotechnology, low-temperature physics, cellular research, materials science and plant research at a level that will sustain the existing United States scientific expertise and research capability in microgravity research. The above table also includes the Alpha Magnetic Spectrometer, and that portion of the MUSS which supports Non-Exploration ISS research.

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BUDGET FOR SAFETY OVERSIGHT

The following tabular information provides the budget planning estimate for civil service and support contractor staffing support needed by NASA to support safety and mission assurance program work associated with the mission of NASA. This includes both the safety management for the institutional safety program as well as the elements of safety, reliability, maintainability and quality support and independent authority for programs and projects managed by NASA' s Mission Directorates. To the extent that we have been able to determine from prime contractors, we have also included resources devoted to safety, reliability, maintainability or quality. The budget run out will be updated as the Agency completes its refinement of transition costs associated with the retirement of the Space Shuttle and the development of Constellation Systems components.

BUDGET SUMMARY FOR SAFETY OVERSIGHT

$ in Millions	FY 2008 Actuals	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Total Safety Oversight	435.3	495.6	481.6	427.8	445.9	459.1	473.5
Aeronautics	0.08	0.12					
Exploration	58.4	134.8	135.5	158.7	176.8	181.4	181.4
Science	45.2	31.4	17.5	13.7	12.0	11.6	10.5
Space Operations	110.2	109.9	105.7	26.5	21.9	22.5	21.9
Agency-wide Safety Oversight	221.5	219.3	222.9	229.0	235.2	243.6	259.7

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Budget for Public Relations by Center

The NASA budget for Public Affairs is not funded by programs. Instead, it is budgeted in two separate accounts under 1) Center Management and Operations (CMO) and 2) Agency Management and Operations. All the Installations listed below except for Headquarters are in the CMO account and the Headquarters budget is in the Agency Management and Operations account.

These budgets include dissemination of information to the news media and the general public concerning NASA programs. Content includes support for public affairs/public relations, Center newsletters, internal communications, guest operations (including bus transportation), public inquiries, NASA TV, nasa.gov portal and other multimedia support.
Funding by installation is shown below.

Center ($ in millions)	FY 2009 Enacted	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Ames Research Center	1.0	1.1	1.1	1.2	1.2	1.2
Dryden Flight Research Center	0.7	0.7	0.7	0.8	0.8	0.8
Glenn Research Center	1.9	2.2	2.3	2.4	2.4	2.5
Goddard Space Flight Center	3.6	4.1	4.3	4.5	4.8	5.0
Headquarters	7.9	8.4	8.3	8.3	8.4	8.8
Johnson Space Center	6.6	4.2	4.2	4.2	4.2	4.2
Kennedy Space Center	4.7	5.5	4.7	5.1	5.3	5.3
Langley Research Center	2.1	1.9	1.9	2.0	2.1	2.1
Marshall Space Flight Center	2.7	2.7	2.7	2.7	2.7	2.7
Stennis Space Center	1.4	1.4	1.3	1.4	1.4	1.4
Total	**32.6**	**32.2**	**31.5**	**32.6**	**33.3**	**34.0**

Totals may not add due to rounding

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Summary of Consulting Services

NASA uses paid experts and consultants to provide advice and expertise to or beyond that which is available from its in-house civil service workforce. Management controls are established which assure that before entering into a consultant or expert services arrangement with an individual that there is ample justification.

A majority of the expert and consultant services are used by the NASA Advisory Council and the Aerospace Safety Advisory Panel. NASA uses experts and consultants to provide expertise on the selection of experiments for future space missions. The use of these experts and consultants provides the Agency with an independent view that assures the selection of experiments likely to have the greatest scientific merit. Other individuals are used to provide independent looks at technical and functional problems in order to give top management the widest possible range of views before making major decisions.

Expert/Consultants (Total NASA)	FY 2008 Actuals	FY 2009 Enacted	FY 2010
Number of Paid Experts and Consultants	42	42	42
Annual FTE Usage	5	5	5
Salaries	$.4	$.4	$.5
Total Salary and Benefits Costs	$.5	$.5	$.5
Travel Costs	$.4	$.4	$.4
Total Costs	**$.8**	**$.8**	**$.9**

Note: Definition of Consultants and Experts

A *consultant* is a person who can provide valuable and pertinent advice generally drawn from a high degree of broad administrative, professional, or technical knowledge or experience. When an agency requires public advisory participation, a consultant also may be a person who is affected by a particular program and can provide useful views from personal experience.

An *expert* is a person who is specially qualified by education and experience to perform difficult and challenging tasks in a particular field beyond the usual range of achievement of competent persons in that field. An expert is regarded by other persons in the field as an authority or practitioner of unusual competence and skill in a professional, scientific, technical or other activity.

These definitions are located under 5 CFR 304.102. The appointments are made under 5 U.S.C. 3109, and the use of this authority is reported to OPM annually.

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E-GOV INITIATIVES AND BENEFITS

NASA is providing funding contributions in FY 2010 for each of the following E-Government Initiatives:

Initiative	2010 Contributions (Includes In-Kind)	2010 Service Fees
E-Rulemaking 026-00-01-99-04-0060-24		$28,625
Business Gateway 026-00-01-99-04-0100-24	$46,894	
Grants.gov 026-00-01-99-04-0160-24	$517,763	
E-Training 026-00-01-99-04-1217-24		$700,000
Recruitment One-Stop		$120,655
EHRI 026-00-01-99-04-1219-24		$434,234
E-Payroll 026-00-01-99-04-1221-24		$3,704,840
E-Travel 026-00-01-99-04-0220-24		$1,862,465
Integrated Acquisition Environment 026-00-01-99-04-0230-24		$1,273,884
IAE-Loans and Grants 026-00-01-99-04-4300-24	$89,973	
E-Authentication 026-00-01-99-04-0250-24		$7,450
Financial Management LoB 026-00-01-99-04-1100-24	$75,000	
Human Resources Management LoB 026-00-01-99-04-1200-24	$65,217	
Grants Management LoB 026-00-01-99-04-1300-24	$59,316	
Geospatial LoB 026-00-01-99-04-3100-24	$15,000	
Budget Formulation and Execution LoB 026-00-01-99-04-3200-24	**$85,000**	
IT Infrastructure LoB 026-00-01-99-04-3300-24		
NASA Total	**$954,163**	**$8,132,153**

* Service Fees are estimates as provided by the E-Government initiative Managing Partners

NASA's FY 2009 Exhibit 300 IT business cases will be posted at: www.nasa.gov/offices/ocio/reports/exhibit300.html within two weeks of the release of the President's Budget. NASA's Congressional Justification, which will be posted online, will include a link to the Exhibit 300s.

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The E-Government initiatives serve citizens, businesses, and federal employees by delivering high quality services more efficiently at a lower price. Instead of expensive "stove-piped" operations, agencies work together to develop common solutions that achieve mission requirements at reduced cost, thereby making resources available for higher priority needs. Benefits realized through the use of these initiatives for NASA in FY 2010 are as follows:

E-Rulemaking (Managing Partner EPA) FY 2010 Benefits

NASA's benefits for the E-Rulemaking initiative are largely focused on public benefits. Providing one-stop access to NASA and other federal agency information on rulemakings and non-rulemaking activities, there are more 1.5 million documents posted on *Regulations.gov*. The rate at which the public uses *Regulations.gov* to submit comments (known as public submissions) is increasing rapidly. The public initially submitted about 1,000 comments per month during the first 18 months of the public site. Now, the public submits nearly 40,000 comments per month. The public has also visited *Regulations.gov* more than 200 million times, averaging 5 million hits per month in 2006, 6.2 million in 2007, and 12.5 million in 2008.

NASA benefits in several ways through its participation and reliance on FDMS and *Regulations.gov*. NASA reaps substantial benefits by improving the transparency of its rulemaking actions as well as increasing public participation in the regulatory process. Direct budget cost savings and cost avoidance result from NASA's transition to FDMS and Regulations.gov, enabling the agency to discontinue efforts to develop, deploy and operate specific individual online docket and public comment systems. Over a five-year period, NASA is estimated to save over 700 thousand dollars over alternative options that would provide similar services.

Business Gateway (Managing Partner SBA) FY 2010 Benefits
For FY2010, Business Gateway will continue to provide a valuable channel for NASA to identify businesses with the interest and expertise to engage in technological development and partnerships. NASA provides a host of programs focused on business from research contracts to Mentor/Protégé programs. Business Gateway provides a powerful outreach channel to match businesses with the various initiatives that are part of NASA's outreach to the business community. By creating a single portal for business information, such as regulatory compliance information Business Gateway directly benefits NASA's stakeholders, including aerospace industry and research labs – many of whom are subject to complex regulatory requirements across multiple agencies.

NASA's stakeholders can potentially receive significant benefits from Business Gateway. These benefits are outlined below. Through increased outreach, more constituents will be able to realize these benefits. The following additional benefit information for NASA (*as of Oct. 27, 2008)* was provided by the Business Gateway initiative, based on calculations from publicly available data and data from the existing Business.gov site. Benefits to NASA include *[NOTE that NASA has not independently verified this data]:*

- <u>Maintenance savings:</u> Business. gov's search technology will provide NASA with valuable user statistics and feedback, enabling it to simplify content management on its business compliance site.
- <u>Cost and time savings:</u> Businesses looking for NASA compliance regulations can save time and money by going to Business.gov. In FY 2008, 74% of Business.gov survey respondents (ACSI) reported saving time at an average of nearly 10 hours per user, totaling 3,960,269 hours; 55% of survey respondents also reported saving money at an average of $753 per user.
- <u>Increased forms management:</u> By making 8 forms available on Forms.gov, NASA saves agency time in forms management, and is expected to produce significant savings in paper and postage. NASA forms were accessed via Forms.gov 4,643 times in FY 2008.

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- Increased exposure: Business.gov houses numerous compliance links providing cross-agency effectiveness to American businesses. In FY 2008, Business.gov directed 87 visits to NASA sites.
- Increased transparency: Business Gateway enables NASA to meet its public service commitment to transparency in government by providing its customers with ready, equal access to information about its compliance requirements.
- Regulatory compliance: The business.gov website enables NASA to comply with the reporting requirement for the Small Business Paperwork Relief Act (SBPRA) and is also consistent with the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA), which called on Federal regulatory agencies to publish small business guides that assist small firms in complying with, and answer small businesses' inquiries about Federal regulations.
- Reduced burden on field offices: By directing compliance-related inquiries to Business.gov, agencies with field offices will save training and staff-time dollars.
- Data harmonization: Business Gateway is in a unique position to support data harmonization efforts indirectly through its content partnerships with various government agencies. NASA has the opportunity to identify and realize data harmonization benefits in many areas, such as the protection of cutting-edge technologies.

Grants.gov (Managing Partner HHS) FY 2010 Benefits

The Grants.gov Initiative benefits NASA and its grant programs by providing a single location to publish grant (funding) opportunities and application packages, awarding more than $450 billion by the 26 grant-making agencies and other federal grant-making organizations. Grants.gov achieved tremendous growth during FY 2008 with 202,366 submissions, exceeding the FY 2007 total of 180,861 submissions by 12 percent increase. By providing a single site for the grants community to apply for grants using common forms, processes and systems, it makes the process easier for applicants to apply to multiple agencies.

The Grants.gov Initiative benefits NASA and its grant programs by providing broader exposure to a wider community who could potentially apply for NASA funding. In addition, Grants.gov provides a single site for the grantee community to apply for grants using a standard set of forms, processes and systems giving greater access and ability to apply for Federal funding. Through the use of Grants.gov NASA is able to reduce operating costs associated with online posting and application of grants. Additionally, the Agency is able to improve operational effectiveness through use of Grants.Gov by increasing data accuracy and reducing processing cycle times. In FY 2008, NASA posted 96 funding opportunities and 87 application packages, and received 302 proposals.

E-Training (Managing Partner OPM) FY 2010 Benefits

The E-Training initiative benefits NASA and other Federal workforce by reducing redundancies and achieving economies of scale in the purchase and/or development of e-learning content and in purchase of learning technology infrastructure. In 2006, NASA streamlined its three separate online training systems into one centralized, learning management system, SATERN, a "one-stop" approach offering Web-based access to training and career development resources. This centralized approach will allow NASA to reduce costs through the consolidation of multiple learning systems.

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Through SATERN, employees can view required training, launch online content, view training history, and self-register for courses. In addition, the system allows NASA to identify offices that have not met training requirements, and bring them in line with federal mandates. SATERN also offers employees access to career planning tools, individual development plans, and competency management. Currently SATERN has more than 2,000 online courses and 10,000 online books in its catalog, and recently added new SkillSoft courses covering a wide variety of topics and subject areas such as business, information technology, and engineering. SkillSoft and Books 24x7 are available through SATERN at anytime, so they can be accessed at the employee's convenience at work or at home.

Recruitment One-Stop (Managing Partner OPM) FY 2010 Benefits

Recruitment One-Stop provides state-of-the-art online recruitment services to federal job seekers that include online job posting, intuitive job searching, resume warehousing, online application submission, and automated eligibility and status feedback. USAJOBS provides federal agencies with a unified system to attract and hire highly qualified and talented individuals. Integration with Recruitment One-Stop allows NASA to better attract individuals who can accomplish the Agency's mission. The USAJOBS interface allows job seekers to view and apply for all NASA employment opportunities, as well as those from other federal agencies. On average, USAJOBS.gov has over 250,000 visitors per day (the online portal serviced over 50 million applications during FY 2008) and over 100,000 resumes are created monthly.

NASA adopted the USAJOBS resume as the basic application document for all NASA positions, except for Astronaut positions, with Phase II implementation completed 2005. To date NASA has not identified any specific savings, either in terms of budgeted savings or cost avoidance. Although the Agency believes that implementation of ROS has resulted in significant intangible benefits in terms of providing better vacancy information to applicants, it has not resulted in any specific cost savings to NASA. However, the numerous intangible benefits ROS provides to NASA and other agencies includes:

- Decreasing hiring time for managers;
- Providing an integrated solution to agency applicant assessment systems;
- Providing a cost effective marketing and recruitment tool;
- Realizing cost savings over commercial job posting boards;
- Reducing the delay associated with filling critical agency vacancies; and
- Enhancing competition with the private sector for the best and brightest talent for Federal service.

Enterprise HR Integration (Managing Partner OPM) FY 2010 Benefits

The Enterprise Human Resources Integration (EHRI) initiative transforms Human Resource (HR) processes from paper-based processes to electronic-based processes. EHRI also provides workforce planning, forecasting, and analytical tools. The initiative streamlines employee transfers and enhances retirement processing throughout the Executive Branch. The initiative has also developed a consolidated EHRI data warehouse containing HR data on all Executive Branch civilian employees and a robust set of tools. EHRI also includes the Electronic Employee Record, or eOPF, to provide a consolidated image and data view that digitally documents the employment actions and history of individuals employed by the Federal government. The initiative is achieving cost savings that are recognized on a per folder basis. The total cost avoidance per folder is estimated at $44.23. In FY 2008, EHRI increased the number of folders converted from paper to electronic to more than 999,000.

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Specific EHRI/eOPF benefits to NASA include improved convenience in searching, better security and safety to electronic files, more economical, streamlined business processes, and the ability to have a central repository of OPF records for the Agency. Specific NASA employee benefits include secure online access to OPFs, automatic notification when documents are added, exchange of retirement and HR data across agencies and systems, and the elimination of duplicate and repetitive personnel data in personnel folders. NASA completed its implementation to eOPF in March 2008, and transitioned personnel actions processing to the NASA Shared Service Center (NSSC).

E-Payroll (Managing Partner OPM) FY 2010 Benefits

The E-Payroll Initiative standardizes and consolidates government-wide federal civilian payroll services and processes by simplifying and standardizing human resources (HR)/payroll policies and procedures and better integrating payroll, HR, and finance functions. Prior to beginning the initiative, 26 federal agencies provided payroll services. Four providers were selected to furnish payroll services for the Executive branch. In 2004, the Department of Interior (DOI) began serving as NASA's payroll provider, using their system, the federal Personnel and Payroll System (FPPS), to process NASA's HR and Payroll transactions. The E-Payroll initiative benefits NASA by permitting the Agency to focus on its mission related activities, rather than on administrative payroll functions. Payroll processing costs are reduced through economies of scale and avoiding the cost of duplicative capital system modernization activities. The initiative also promotes standardization of business processes and practices and unified service delivery.

E-Travel (Managing Partner GSA) FY 2010 Benefits

NASA is currently scheduled to complete migration of its travel services to Electronic Data Systems Corporation (EDS), one of the three designated E-Travel service providers, by March 2009. Upon completion of this migration, NASA will be able to provide more efficient and effective travel management services. The benefits include cost savings associated with cross-government purchasing agreements and improved functionality through streamlined travel policies and processes, strict security and privacy controls, and enhanced Agency oversight and audit capabilities. NASA employees also will also benefit through more efficient travel planning, authorization, and reimbursement processes. The Agency remains committed to implementing eTravel and has made a significant investment to support the project. NASA believes that FedTraveler.com will provide significant benefits to the Agency when the system is stable

Integrated Acquisition Environment (Managing Partner GSA) FY 2010 Benefits

The Integrated Acquisition Environment (IAE) initiative is designed to streamline the process of reporting on subcontracting plans and to provide agencies with access to analytical data on subcontracting performance. Use of the IAE common functions and services allows agencies to focus on agency-specific needs such as strategy, operations, and management while leveraging shared services for common functions. Furthermore, use of a government-wide business focused service environment reduces funding and resources for technical services and support for acquisition systems originally housed by individual agencies. Over 7.8 million hours were saved by the contributing agencies in completing over 18 million recorded acquisition business process transactions. Contributing agencies received estimated benefits of $396,480,257 based upon the processes, personnel, roles, steps, and actions involved. Additionally, agencies realized an estimated cost avoidance of $5,649,656 and estimated operational cost savings of $30,820,828.

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Through adoption of the tools and services provided by IAE, NASA improves its ability to make informed and efficient purchasing decisions and allows it to replace manual processes. If NASA were not allowed to use the IAE systems, they would need to build and maintain separate systems to record vendor and contract information, and to post procurement opportunities. Agency purchasing officials would not have access to databases of important information from other agencies on vendor performance and could not use systems to replace paper-based and labor-intensive work efforts.

Integrated Acquisition Environment – Loans & Grants FY 2010 Benefits

The Federal Funding Accountability and Transparency Act of 2006 (FFATA) requires OMB to "ensure the existence and operation of a single searchable website, accessible by the public at no cost to access" that includes information on each Federal award. The law specifically requires a unique identifier for the entity receiving the award and of the parent entity of the recipient, should the entity be owned by another entity. Since contracts (and some grants) already require Data Universal Numbering System (DUNS) numbers, a decision was made to leverage this to cover loans and the remainder of the grants. This will allow those areas to feed information into the FFATA portal. The Integrated Acquisition Environment (IAE) currently has a contract with Dun and Bradstreet (D&B) that has been expanded for this purpose. OMB initiated funding requests for each agency to reimburse IAE for this additional cost.

The FY2010 funding requirements as it relates to the IAE – Loans and Grants funding line supports the FFATA for the relationship with D&B and DUNS support services. In addition to provision of DUNS numbers, D&B is now providing business and linkage data seamlessly, and the business arrangement supports the quality of data by real-time updates. NASA and other agencies will leverage the linkages to corporate organizational rollups based on parental and subsidiary relationships.

E-Authentication (Managing Partner GSA) FY 2010 Benefits

The Presidential E-Government Initiative, E-Authentication, provides trusted and secure standards-based authentication architecture to support Federal E-Government applications and initiatives. This approach provides a uniform process for establishing electronic identity and eliminates the need for each initiative to develop their own solution for the verification of identity and electronic signatures, saving time and money across the Federal Government. E-Authentication's distributed architecture allows citizens and businesses to use non-government issued credentials to conduct transactions with the Federal Government.

The initiative will ultimately benefit NASA by providing E-Authentication expertise, guidance, and documentation, including project planning and reporting templates, to enable NASA to achieve production implementation of E-Authentication for its NASA Account Management System (NAMS) application to include a tie to all of its back-end applications that require authentication. In addition, the E-Authentication Federation allows NASA to use identity credentials issued and managed by organizations within and outside the federal government, thereby relieving NASA of much of the cost of providing its own identity management solutions.

NOTE: Beginning in Q3 FY 2009, the E-Authentication PMO will no longer enter into contractual agreements with agencies to provide credential services and technical support. To help agencies through the restructuring during Q1 FY 2009, GSA will provide transition support, advice, and guidance, including a procurement template and supporting materials to assist agencies in migrating to their own contracts or inter-agency agreements for identity credential services by March 31, 2009. Agencies will still be responsible for complying with the E-Authentication policy requirements outlined in OMB Memorandum M-04-04 and NIST Special Publication 800-63.

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LINE OF BUSINESS

Financial Management LoB (Managing Partners DOE and DOL) FY 2010 Benefits

Federal agencies began implementing the Financial Management Line of Business (FM LoB) initiative in FY 2006 by actively migrating to centers of excellence service providers and initiating solutions to integrate financial data among and between agency business systems. When the FM LoB goals are fully realized, agencies' data will be more timely and accurate for decision-making and there will be improved government-wide stewardship and accounting. More timely and accurate data will result from the standardization and seamless data integration efforts, including the implementation of centralized interfaces between core financial systems and other systems. These efforts will focus on promoting strong internal controls and ensuring the integrity of accounting data. The easy exchange of data between federal agencies will increase federal managers' stewardship abilities.

The FM LoB initiative will ultimately benefit NASA by providing the reference tools and templates needed to assist the Agency in planning and managing migration to a selected center of excellence. The FM LoB has established an Advisory Board to govern the activities and decision-making process for the initiative. NASA's involvement with this board affords them the opportunity to review critical issues impacting their FM systems, voice their unique needs and concerns, and collaboratively offer recommendations and influence decisions on how best to implement the common solution. In the long term, NASA will have the opportunity to play an active role in standardizing core FM business process and data elements. NASA's involvement in this crucial task ensures their needs and requirements are addressed in the target FM LoB enterprise architecture supporting the FM LoB common solution. This work allows NASA to influence the future direction of financial management across the government from both an information technology and business process perspective.

Human Resources Management LoB (Managing Partner OPM) FY 2010 Benefits

Through the HR LoB, OPM is using enterprise architecture (EA)-based principles and best practices, proven through the E-Gov initiatives and Federal Enterprise Architecture (FEA), to identify common solutions for HR business processes and/or technology-based shared HR services to be made available to government agencies. Driven from a business perspective rather than a technology focus, the solutions will address distinct business improvements that enhance government's performance of HR services in support of agency missions delivering services to citizens. The end result of the HR LoB efforts will be to save taxpayer dollars, reduce administrative burdens, and significantly improve HR service delivery.

NASA has entered into a partnership with NBC for the HR LoB initiative, which will enable NBC to take advantage of innovative HR solutions previously developed and currently in use by NASA; these solutions could then be deployed to customer agencies, accomplishing a major step toward deploying a common HR environment aligned with the HR LoB objective. Deployment of existing, modern, effective solutions provides cost advantages to the government, and provides enhanced capabilities to customer agencies well ahead of solutions that require new development.

NASA will ultimately benefit from the HR LoB through its use of best-in-class HR services and systems provided by one of the approved service providers. Through its adoption of an approved service provider, the agency can achieve the benefits of "best-in-class" HR solutions without the costs of developing and maintaining their own HR systems. In addition, employees across the Agency will benefit from improved HR services.

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Grants Management LoB (Managing Partners HHS and NSF) FY 2010 Benefits

The Grants Management Line of Business will ultimately offer the development of a government-wide solution to support end-to-end grants management activities promoting citizen access, customer service, and financial and technical stewardship for the Agency. The end result is intended to be a government-wide streamlined grant making process providing transparency and efficiency in the grant decision-making process. The benefits of GM LoB include increased service to citizens through standardized processes; cost savings for grant-making agencies through use of shared IT infrastructure; a reduction in the number of redundant grants management systems; and improved reporting on government-wide grant activities and results. The GM LoB adopted a "consortia-based" approach to implementation and developed a process for forming consortia and having agencies participate in consortia as members.

In FY07 NASA signed a Memorandum of Understanding (MOU) with its selected consortia partner, NSF. In 2008 NASA implemented NSF's new research-focused initiative, *Research.gov*, improving public access to detailed information about NASA awards. *Research.gov* is a collaborative partnership of Federal research-oriented agencies working together for the ultimate benefit of the research community. The Research Spending and Results Service lets Congress, the general public, and the broader research community easily search and find grant award information for NASA and NSF in one place.

For 2009 and beyond, NASA and NSF are committed to working together to serve the research community and to provide access to information and services for both agencies in one location. NASA news and information is also now available in *Research.gov's* Policy Library and Research Headlines. Moving forward, NASA will continue to collaborate with NSF to explore and implement future *Research.gov* service offerings based on NASA and research community needs.

Geospatial LoB (Managing Partner DOL) FY 2010 Benefits

The Geospatial LoB will better serve the agencies' missions and the Nation's interests developing a more strategic, coordinated, and leveraged approach to producing, maintaining, and using geospatial data and services across the Federal government. Specific goals of the Geospatial LoB include establishing a collaborative governance mechanism, coordinating a government-wide planning and investment strategy, and optimizing and standardizing geospatial data and services.

Contributing agencies and bureaus will receive value from the development of the LoB primarily through improved business performance and cost savings. Enhanced governance processes, improved business planning and investment strategies, and optimization and standardization of geospatial business data and services will produce the following results:

- Collaborative management of geospatial investments will be made more adaptable, proactive and inclusive;
- Enterprise business needs and agency core mission requirements will be identified, planned, budgeted, and exploited in a geospatial context;
- Long-term costs of geo-information delivery and access will be reduced while minimizing duplicative development efforts;
- Effective, yet less costly commercial off the shelf systems and contractual business support operations will replace legacy geospatial applications; and
- Business processes will be optimized and knowledge management capabilities will exist for locating geospatial data and obtaining services.

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As a science agency, the work of NASA's science and mission professionals is inherently different from duties and functions performed by operational agencies. These differences lead NASA to organize and manage data to best facilitate science activities rather than a central focus of data dissemination. Scientific inquiry often leads scientist to use different schemas for analyzing data and information produced from remote sensing data (e.g. a common grid or projection). NASA will continue to apply the elements of FGDC standards where these are appropriate. In FY08, NASA signed an MOU with DOL to continue its active participation in the Geospatial LOB.

Budget Formulation & Execution LOB (Managing Partner Education) FY 2010 Benefits

The Budget Formulation and Execution LoB (BFELoB) provides significant benefits to NASA and other partner agencies by encouraging best practices crossing all aspects of Federal budgeting -- from budget formulation and execution to performance to human capital and staffing needs.

To benefit all agencies, BFELoB, in conjunction with Department of Treasury as the system owner, made available the first shared fee-for-service budget formulation system, the Budget Formulation and Execution Manager (BFEM). The BFELoB is providing ongoing support for this fee-for-service budget system, in an effort to develop an execution module and enhance connections with OMB's MAX system. The BFEM system is an option for NASA and any NASA component that is in need of a budget formulation or performance measurement system. To help agencies assess their budget systems requirements, BFELoB LAO created a decision matrix. NASA will benefit from using this matrix as a starting point in determining specific system needs. In 2010, BFELoB will further benefit agencies by evaluating known budget systems against the decision matrix and making that information available so each agency can avoid the cost of performing that step individually.

In addition, BFELoB created a secure government-only collaboration website, known as the "MAX Federal Community." This provides a significant benefit for collaboration across and within agencies. It is used within the budget community, and has been expanded to serve other related communities, such as Grants, Financial Management, Performance, and Planning. NASA currently has 100 users that are registered and eligible to take advantage of the MAX Federal Community. The Community site is commonly used for sharing information, collaboratively drafting documents, supporting workgroups, and much more.

ITI LoB - IT Infrastructure LOB (Managing Partner GSA) FY 2010 Benefits

The IT Infrastructure LoB offers the potential to identify opportunities for IT infrastructure consolidation and optimization, and the development of government-wide common solutions. This LoB will define specific common performance measures for service levels and costs, identify best practices, and develop guidance for transition plans within agencies and/or across agencies. Consolidation and optimization of IT infrastructure represents a significant opportunity to realize future cost savings by taking a more coordinated approach to spending on commodity IT infrastructure. IT infrastructure consolidation and optimization case studies also demonstrate agencies could improve IT service levels and, when relieved of the burden of managing these non-core functions, can concentrate more on mission priorities and results.

Throughout FY 2010, NASA and other agencies will continue gathering information on baseline performance for Mainframes & Servers Services and Support, and Telecommunications Systems and Support. In addition, information on costs and service levels in End User Systems and Support shall be reported using performance metrics developed by ITI LoB. In FY 2010, NASA and other agencies will report information on costs and service levels in all three infrastructure areas. As these targets continue to be refined, NASA and other agencies will update and make progress towards their 5-year optimization plans reports to meet or exceed agency performance targets.

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Based on the objectives and goals of this LoB, NASA believes that there is great potential for numerous benefits from the ITI, both for NASA and for other federal agencies. Some of these benefits are relatively easy to quantify, while others are more indirect and require an extended period of time and some econometric analysis prior to producing an estimate. A few of the anticipated FY 2010 benefits from NASA's viewpoint are: improved performance, enhanced productivity, greater consistency and standardization of infrastructure platforms, aggregate purchasing of infrastructure components, cross-agency integration possibilities, and planned approach to new technology infusion. At this stage of the ITI formulation process, NASA is unable to provide any quantifiable cost savings that may results from these anticipated benefits.

Management and Performance Overview

The Management and Performance section provides a comprehensive record of the past and planned performance for NASA's programs and projects. This section includes: the key NASA FY 2010 Performance Plan; an update to the FY 2009 Performance Plan based on Congressional budget action; a summary of the cost and schedule performance of NASA's projects with estimated life cycle cost above $250 million; and progress on NASA's performance improvement initiatives.

NASA's planning and performance management processes are an essential part of the Agency's governance and strategic management system. The Agency has an integrated system to: plan strategy and implementation; monitor, assess, and evaluate performance toward commitments; identify issues; gauge programmatic and organizational health; and provide appropriate data and information to NASA decision-makers.

Through its strategic management system, NASA: identifies the Agency's long-term Strategic Goals, multi-year Outcomes, and other key performance measures; develops and implements plans to achieve these Goals; and continuously measures the Agency's progress toward these Goals. NASA managers use performance results as a basis for key investment decisions, and NASA performance data provides a foundation for both programmatic and institutional decision-making processes.

NASA's planning and performance management processes provide data to Agency management via: ongoing monthly and quarterly analysis and reviews; annual assessments in support of budget formulation (for budget guidance and issue identification, analysis, and disposition); annual reporting of performance, management issues, and financial position; periodic, in-depth program or special purpose assessments; and recurring or special assessment reports to internal and external organizations.

NASA's performance system is designed to align with the Agency's internally and externally imposed performance measurement and reporting requirements, tools, and practices, including the Government Performance and Results Act, and Executive Order 13450, Improving Government Program Performance.

This section includes the updated FY 2009 and the FY 2010 performance commitments, the target results for the requested resources. The FY 2010 Annual Performance Plan reflects the new account structure, and provide measures for additional content within the Cross-Agency Support Account. Using independent program assessments, which are listed in the theme and program sections of this document and in this section, NASA commits to improvement actions in response to the findings.

NASA strives to find new ways to use performance information to support decisions concerning strategy and budget. A continued focus for NASA in FY 2009 is to improve the policy, metrics, and analysis processes for life cycle cost and schedule performance monitoring and reporting. The Major Program Annual Reports discussed in this section is one of the reporting tools used to determine how NASA performs this task.

Performance Improvement

NASA's Mission demands high levels of performance from our diverse workforce, whose knowledge, skills, and dedication are the backbone of our achievements. NASA has aligned the Agency's performance systems, organizational structure, policies, and processes to ensure programmatic content, institutional capabilities, and other resources are focused on successfully completing the programs and projects tied to our Strategic Goals. The Agency governance councils have joint responsibility for sustaining this alignment through a set of clear, transparent, and repeatable processes that flow to all organizational elements and levels within the Agency. Aligning the entirety of NASA with our Strategic Goals is essential for organizational effectiveness and efficiency. NASA communicates priorities and directions for all components of the Agency through a planning and decision process based on prior year performance and future year objectives. This annual guidance is the benchmark for other processes, including feedback on internal control needs, risk concerns, and safety and mission assurance issues that ripple through our programmatic and institutional framework, ultimately influencing the allocation of resources for each budget year.

In 2009, we continued strengthening processes, procedures, and structures to integrate Agency-wide risk management activities horizontally and vertically, across and within programs, projects, and mission support organizations, and elevating major, systemic, and cross-cutting risks for Agency solution. The risk assessment results are used to inform Agency-level decisions on strategy, policy, program and mission support formulation and implementation approaches, and budget allocations.

The Agency has continued to improve upon its monthly forum, the Baseline Performance Review, to bring performance information forward for discussion and tracking by NASA's senior leaders. NASA created this forum in 2007 as an integrated review of institutional and program activities to help senior leaders understand inter-related issues that impact performance and program risk. Technical and non-technical cross-cutting issues are highlighted and actions are assigned for resolution. Other review topics include an Agency-level review of finance, safety, workforce, and institutional status, and Center and program performance status. The Baseline Performance Review forum fosters communication across organizational boundaries to address mutual concerns and interests.

In FY 2010, NASA will continue to examine its policies and processes to enhance its performance management system and its use in planning and decision making.

Major Program Annual Report Summary

The 2009 Major Program Annual Report (MPAR) is provided to meet the requirements of section 103 of the National Aeronautics and Space Administration Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613; the Act). The 2009 MPAR consists of this summary along with the 2010 Budget Estimates project pages for the eleven projects included in this year's report.

Updated estimates are provided for six projects baselined in previous MPAR reports: the Solar Dynamics Observatory (SDO), the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP), the Wide-field Infrared Survey Explorer (WISE), the Stratospheric Observatory for Infrared Astronomy (SOFIA), the Aquarius mission, and the Mars Science Laboratory 2009. An update is also provided to the Glory mission rebaseline report submitted since the 2008 MPAR was prepared.

Two projects, the Fermi Gamma-ray Large Area Space Telescope (GLAST) and Kepler mission, entered operations and are no longer included in these reports. The Herschel space Observatory and the Lunar Reconnaissance Orbiter (LRO) projects are no longer included in MPAR reporting because they are ready for launch (the LRO launch has been delayed due to the delayed launch of the mission preceding it at the launch pad; the Herschel mission is an European Space Agency (ESA) launch).

Four major projects received authority to proceed into development since the 2008 MPAR was prepared: The James Webb Space Telescope (JWST), Gravity Recovery and Interior Laboratory (GRAIL), Radiation Belt Storm Probes (RBSP), and Juno missions. These four projects are baselined in this report.

The Current Year (2009) Development Cost and Schedule Estimates are based on expected cost and schedule at the time of completion. Consistent with previous MPAR reports, the Base Year Development Cost estimates in the MPAR summary table below are adjusted to reflect cost accounting used in the FY 2010 Budget Estimates in order to allow a direct comparison between the MPAR Base Year and Current Year Development Cost estimates. Both Base Year and Current Year costs reflect direct programmatic costs (including labor, procurement, and travel) for all years except FY 2005 and FY 2006, which also reflect small residual indirect costs.

Five projects included in this year's report (SDO, Aquarius, NPP, MSL, and SOFIA) have had schedule growth in excess of six months from their MPAR baseline. The SOFIA delay resulted from re-design of the project schedule to facilitate earlier delivery of science while the project proceeds towards full operational capability. Delayed performance by NASA partners and a crowded launch manifest contribute to three of these five delays. Three of these five projects (NPP, MSL, and SOFIA) have reported cost growth of 15 percent or more from their MPAR baseline.

The Glory baseline has been re-established, as required by the Act when the Development Cost Estimate for a project exceeds 30% of its original baseline. The Current Year Development Cost and Schedule Estimates for the Glory mission reported here reflects problems with the spacecraft computer boards which occurred after the project was re-baselined.

Project	Base Year	Development Cost Est. ($M)		Cost Change (%)	Key Mile-stone	Key Milestone Date		Schedule Change (mths)	Cost Change > 15%	Schedule Change > 6 mo	Factors Contributing to Change	
		Base	2009			Base	2009				Internal	External
SDO	2006	$624	$6782	9%	LRD*	Aug-08	Oct-09	14		x	Initial delay (Aug to Dec) led to loss of launch vehicle commit – late deliveries of avionics boxes and instruments, other technical issues	Extended delay due to lack of launch vehicle availability from ULA
WISE	2007	$192	$198	3%	LRD	Nov-09	Nov-09	-				
Aquarius	2007	$193	$209	8%	LRD	Jul-09	May-10	10		x		10-month slip in spacecraft development reported by international partner CONAE (Argentina)
Glory	2009	$259	$296	14%	LRD	Jun-09	Nov-09	5				APS instrument contract cost growth and schedule delay; Spacecraft Single Board Computer failures
NPP	2006	$593	$725	22%	LRD	Apr-08	Jan-11	33	x	x		Delay and cost increase reflect schedule extension made by the NPOESS IPO as result of VIIRS instrument problems
MSL	2007	$969	$1,631	68%	LRD	Sep-09	Nov-11	26	x	x	Cost and schedule growth due to underestimated complexities; EDL system, acquisition and processing equipment, avionics	
SOFIA	2007	$920	$1,077	17%	FOC	Dec-13	Dec-14	12	x	x	Decision to rebaseline Full Operating Capability (FOC) to later date in order to obtain earlier Initial Operating Capability (IOC) and resulting science	
JWST	2008	$2,581	$2,581	0.0%	LRD	Jun-14	Jun-14	-				
Juno	2008	$742	$742	0.0%	LRD	Aug-11	Aug-11	-				
GRAIL	2008	$427	$427	0.0%	LRD	Sep-11	Sep-11	-				
RBSP	2009	$534	$534	0.0%	LRD	May-12	May-12	-				

*Launch Readiness Date (LRD)

FY 2009 Performance Plan Update

FY 2009 Performance Plan Update Narrative

The enclosed FY 2009 Performance Plan has been updated to reflect reprioritization of Agency Programs and projects as a result of the FY 2008 and FY 2009 Appropriations. The only program area that has changed performance commitments as a result of Congressional redirection is the Innovative Partnerships Program. The APGs eliminated from this program may be found at the end of this plan. This Performance Plan may be updated as a result of Recovery Act funds.

Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Strategic Goal 1	**Fly the Shuttle as safely as possible until its retirement, not later than 2010.**						
Outcome 1.1	**Assure the safety and integrity of the Space Shuttle workforce, systems and processes, while flying the manifest.**			Green	Green	Yellow	Green
APG 9SSP1	Achieve zero Type-A (damage to property at least $1 million or death) or Type-B (damage to property at least $250 thousand or permanent disability or hospitalization of three or more persons) mishaps in FY 2009.	Space Shuttle	Space Shuttle Program				
APG 9SSP2	Complete 100% of all mission objectives for all Space Shuttle missions in FY 2009 as specified in the Flight Requirements Document for each mission.	Space Shuttle	Space Shuttle Program				
Outcome 1.2	**By December 31, 2010, retire the Space Shuttle.**			None	None	None	Green
APG 9SSP3	A 13 percent reduction in Space Shuttle annual value of Shuttle production contracts for Orbiter, External Tank, Solid Rocket Boosters, Reusable Solid Rocket Motor, Space Shuttle Main Engine and Launch & Landing, while maintaining safe flight.	Space Shuttle	Space Shuttle Program				
APG 9SSP4	Reduce to twenty the number of dedicated Space Shuttle Kennedy Space Center (blocks of) facilities, while maintaining safe flight.	Space Shuttle	Space Shuttle Program				
Strategic Goal 2	**Complete the International Space Station in a manner consistent with NASA's International Partner commitments and the needs of human exploration.**						
Outcome 2.1	**By 2010, complete assembly of the U.S. On-orbit Segment; launch International Partner elements and sparing items required to be launched by the Shuttle; and provide on-orbit resources for research to support U.S. human space exploration.**			None	Green	Green	Green
APG 9ISS1	Based on the actual Space Shuttle flight rate, number of remaining Shuttle flights, and the discussions with the International Partners, update the agreed-to ISS assembly sequence and transportation plan as necessary.	International Space Station	International Space Station Program				
APG 9ISS2	Accomplish a minimum of 90% of the on-orbit research objectives as established one month prior to a given increment.	International Space Station	International Space Station Program				

Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9ISS3	Per the final configuration agreed to by the International Partners, fly the ISS elements and logistics baselined for FY 2009.	International Space Station	International Space Station Program				
APG 9ISS4	Provide increased ISS capability by assembling the remaining two Japanese Exploration Agency (JAXA) elements, the Exposed Facility (EF) and the Experiment Logistics Module-Exposed Section (ELM-ES), and the NASA EXPRESS Logistics Carriers (ELC) as baselined in FY 2009.	International Space Station	International Space Station Program				
Outcome 2.2	**By 2009, provide the on-orbit capability to support an ISS crew of six crewmembers.**			**None**	**None**	**None**	**Green**
APG 9ISS5	Install and make flight ready the following delivered ISS systems for 6 member crew capability in FY 2009: three crew quarters, Galley, Water Recovery System (WRS racks 1 and 2), second Treadmill with Vibration Isolation (TVIS2), and Waste Collection/Hygiene Compartment.	International Space Station	International Space Station Program				
APG 9ISS6	In concert with the International Partners, assure a continuous crew presence on the ISS.	International Space Station	International Space Station Program				
Outcome 2.3	**Conduct basic and applied biological and physical research to advance and sustain U.S. scientific expertise.**			**None**	**None**	**None**	**New**
APG 9AC1	Deliver 3 out of 4 of the following exploration technology payloads to SOMD for launch to the ISS: Multi-User Droplet Combustion Apparatus, Light Microscopy Module / Constrained Vapor Bubble, Boiling Experiment Facility (BXF), Space Acceleration Measurement System accelerometers for CIR, FIR and BXF.	Advanced Capabilities	Exploration Technology Development				
APG 9AC2	Complete the development of 3 out of 4 of the following non-exploration payloads: Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions, Shear History Extensional Rheology Experiment, Advanced Plant Experiments on Orbit, Smoke Point in Coflow Experiment, Binary Critical Aggregation Test - 4.	Advanced Capabilities	Exploration Technology Development				
APG 9AC3	Complete the selection of investigators for the BION (Russian collaboration) flight.	Advanced Capabilities	Exploration Technology Development				
Strategic Goal 3	**Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration.**						
Sub Goal 3A.1	**Study Earth from space to advance scientific understanding and meet societal needs.**						
Outcome 3.1	**Progress in understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition.**			**Green**	**Green**	**Green**	**Green**
APG 9ES1	Demonstrate progress in understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition (based on measurements from presently orbiting NASA and non-NASA assets). Progress will be evaluated by external expert review.	Earth Science	Multiple Programs				

FY 2009 Performance Plan Update

Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9ES2	Develop missions in support of this Outcome, as demonstrated by completing the Orbiting Carbon Observatory (OCO) Launch Readiness Review (LRR).	Earth Science	Earth System Science Pathfinder				
APG 9ES3	Develop missions in support of this Outcome, as demonstrated by completing the Glory mission Launch Readiness Review (LRR).	Earth Science	Earth Systematic Missions				
APG 9ES4	Develop missions in support of this Outcome, as demonstrated by completing the integration and testing of the Aquarius instrument for delivery to the CONAE (Argentina) satellite observatory.	Earth Science	Earth System Science Pathfinder				
APG 9ES5	Develop mission in support of this Outcome, as demonstrated by completing the CLARREO advanced concepts study.	Earth Science	Earth Systematic Missions				
APG 9ES6	Conduct flight program in support of this Outcome as demonstrated by achieving mission success criteria for Aqua and CALIPSO.	Earth Science	Multiple Programs				
Outcome 3.2	**Progress in enabling improved predictive capability for weather and extreme weather events.**			Green	Green	Green	Green
APG 9ES7	Demonstrate progress in enabling improved predictive capability for weather and extreme weather events. Progress will be evaluated by external expert review.	Earth Science	Multiple Programs				
APG 9ES8	Develop missions in support of this Outcome, as demonstrated by completing the Global Precipitation Mission (GPM) Confirmation Review.	Earth Science	Earth Systematic Missions				
APG 9ES9	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Aqua.	Earth Science	Earth Systematic Missions				
Outcome 3A.3	**Progress in quantifying global land cover change and terrestrial and marine productivity, and in improving carbon cycle and ecosystem models.**			**Green**	**Green**	**Green**	**Green**
APG 9ES10	Demonstrate progress in quantifying global land cover change and terrestrial and marine productivity, and in improving carbon cycle and ecosystem models. Progress will be evaluated by external expert review.	Earth Science	Multiple Programs				
APG 9ES11	Develop missions in support of this Outcome, as demonstrated by completing the Landsat Data Continuity Mission (LDCM) Critical Design Review (CDR).	Earth Science	Earth Systematic Missions				
APG 9ES12	Develop missions in support of this Outcome, as demonstrated by completing the DESDynI advanced concept study.	Earth Science	Earth Systematic Missions				
APG 9ES2	Develop missions in support of this Outcome, as demonstrated by completing the Orbiting Carbon Observatory (OCO) Launch Readiness Review (LRR).	Earth Science	Earth System Science Pathfinder				
APG 9ES9	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Aqua.	Earth Science	Earth Systematic Missions				
Outcome 3A.4	**Progress in quantifying the key reservoirs and fluxes in the global water cycle and in improving models of water cycle change and fresh water availability.**			**Green**	**Green**	**Yellow**	**Green**
APG 9 ES13	Demonstrate progress in quantifying the key reservoirs and fluxes in the global water cycle and in improving models of water cycle change and fresh water availability. Progress will be evaluated by external expert review.	Earth Science	Multiple Programs				

Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9ES14	Develop missions in support of this Outcome, as demonstrated by completing the SMAP advanced concepts study.	Earth Science	Earth Systematic Missions				
APG 9ES8	Develop missions in support of this Outcome, as demonstrated by completing the Global Precipitation Mission (GPM) Confirmation Review.	Earth Science	Earth Systematic Missions				
APG 9ES9	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Aqua.	Earth Science	Earth Systematic Missions				
Outcome 3A.5	**Progress in understanding the role of oceans, atmosphere, and ice in the climate system and in improving predictive capability for its future evolution.**			Green	Green	Yellow	Yellow
APG 9ES15	Demonstrate progress in understanding the role of oceans, atmosphere, and ice in the climate system and in improving predictive capability for its future evolution. Progress will be evaluated by external expert review.	Earth Science	Multiple Programs				
APG 9ES16	Develop mission in support of this Outcome, as demonstrated by completing the ICESat II advanced concepts study.	Earth Science	Earth Systematic Missions				
APG 9ES2	Develop missions in support of this Outcome, as demonstrated by completing the Orbiting Carbon Observatory (OCO) Launch Readiness Review (LRR).	Earth Science	Earth System Science Pathfinder				
APG 9ES3	Develop missions in support of this Outcome, as demonstrated by completing the Glory mission Launch Readiness Review (LRR).	Earth Science	Earth Systematic Missions				
APG 9ES4	Develop missions in support of this Outcome, as demonstrated by completing the integration and testing of the Aquarius instrument for delivery to the CONAE (Argentina) satellite observatory.	Earth Science	Earth System Science Pathfinder				
APG 9ES6	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Aqua and CALIPSO.	Earth Science	Multiple Programs				
Outcome 3A.6	**Progress in characterizing and understanding Earth surface changes and variability of Earth's gravitational and magnetic fields.**			None	Green	Green	Green
APG 9ES11	Develop missions in support of this Outcome, as demonstrated by completing the Landsat Data Continuity Mission (LDCM) Critical Design Review (CDR).	Earth Science	Earth Systematic Missions				
APG 9ES12	Develop missions in support of this Outcome, as demonstrated by completing the DESDynI advanced concept study.	Earth Science	Earth Systematic Missions				
APG 9ES17	Demonstrate progress in characterizing and understanding Earth surface changes and variability of Earth's gravitational and magnetic fields. Progress will be evaluated by external expert review.	Earth Science	Multiple Programs				
APG 9ES9	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Aqua.	Earth Science	Earth Systematic Missions				
Outcome 3A.7	**Progress in expanding and accelerating the realization of societal benefits from Earth system science.**			Green	Green	Green	Green
APG 9ES18	Issue twelve reports with partnering organizations that validate using NASA research capabilities (e.g., observations and/or forecast products) could improve their operational decision support systems.	Earth Science	Applied Sciences				

Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9ES19	Increase the number of distinct users of NASA data and services.	Earth Science	Earth Science Research				
APG 9ES20	Maintain a high level of customer satisfaction, as measured by exceeding the most recently available federal government average rating of the Customer Satisfaction Index.	Earth Science	Earth Science Research				
Sub Goal 3B	**Understand the Sun and its effects on Earth and the solar system.**						
Outcome 3B.1	**Progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium.**			Green	Green	Green	Green
APG 9HE1	Demonstrate progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium. Progress will be evaluated by external expert review.	Heliophysics	Multiple Programs				
APG 9HE2	Develop missions in support of this Outcome, as demonstrated by completing the Magnetospheric Multiscale (MMS) Spacecraft Preliminary Design Review (PDR).	Heliophysics	Solar Terrestrial Probes				
APG 9HE3	Develop missions in support of this Outcome, as demonstrated by completing the Geospace Radiation Belt Storm Probes Confirmation Review.	Heliophysics	Living with a Star				
APG 9HE4	Develop missions in support of this Outcome, as demonstrated by completing the Explorer down-select.	Heliophysics	Heliophysics Explorer Program				
APG 9HE5	Conduct flight program in support of this outcome, as demonstrated by achieving mission success criteria for STEREO, AIM, THEMIS and IBEX.	Heliophysics	Multiple Programs				
Outcome 3B.2	**Progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability and planetary magnetic fields.**			Green	Green	Green	Green
APG 9HE2	Develop missions in support of this Outcome, as demonstrated by completing the Magnetospheric Multiscale (MMS) Spacecraft Preliminary Design Review (PDR).	Heliophysics	Solar Terrestrial Probes				
APG 9HE3	Develop missions in support of this Outcome, as demonstrated by completing the Geospace Radiation Belt Storm Probes Confirmation Review.	Heliophysics	Living with a Star				
APG 9HE4	Develop missions in support of this Outcome, as demonstrated by completing the Explorer down-select.	Heliophysics	Heliophysics Explorer Program				
APG 9HE6	Demonstrate progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability and planetary magnetic fields. Progress will be evaluated by external expert review.	Heliophysics	Multiple Programs				
APG 9HE7	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for AIM and THEMIS.	Heliophysics	Multiple Programs				

Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Outcome 3B.3	**Progress in developing the capability to predict the extreme and dynamic conditions in space in order to maximize the safety and productivity of human and robotic explorers.**			None	None	Green	Green
APG 9HE3	Develop missions in support of this Outcome, as demonstrated by completing the Geospace Radiation Belt Storm Probes Confirmation Review.	Heliophysics	Living with a Star				
APG 9HE8	Demonstrate progress in developing the capability to predict the extreme and dynamic conditions in space in order to maximize the safety and productivity of human and robotic explorers. Progress will be evaluated by external expert review.	Heliophysics	Multiple Programs				
APG 9HE9	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for STEREO.	Heliophysics	Multiple Programs				
Sub Goal 3C	**Advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space.**						
Outcome 3C.1	**Progress in learning how the Sun's family of planets and minor bodies originated and evolved.**			Green	Green	Green	Green
APG 9PS1	Demonstrate progress in learning how the Sun's family of planets and minor bodies originated and evolved. Progress will be evaluated by external expert review.	Planetary Science	Multiple Programs				
APG 9PS2	Develop missions in support of this Outcome, as demonstrated by completing the Juno Critical Design Review (CDR).	Planetary Science	New Frontiers				
APG 9PS3	Develop missions in support of this Outcome, as demonstrated by completing the GRAIL mission Preliminary Design Review (PDR).	Planetary Science	Discovery				
APG 9PS4	Develop missions in support of this Outcome, as demonstrated by completing the Mars Science Laboratory (MSL) Launch Readiness Review (LRR).	Planetary Science	Mars Exploration				
Outcome 3C.2	**Progress in understanding the processes that determine the history and future of habitability in the solar system, including the origin and evolution of Earth's biosphere and the character and extent of prebiotic chemistry on Mars and other worlds.**			Green	Green	Green	Green
APG 9PS2	Develop missions in support of this Outcome, as demonstrated by completing the Juno Critical Design Review (CDR).	Planetary Science	New Frontiers				
APG 9PS4	Develop missions in support of this Outcome, as demonstrated by completing the Mars Science Laboratory (MSL) Launch Readiness Review (LRR).	Planetary Science	Mars Exploration				
APG 9PS5	Demonstrate progress in understanding the processes that determine the history and future of habitability in the solar system, including the origin and evolution of Earth's biosphere and the character and extent of prebiotic chemistry on Mars and other worlds. Progress will be evaluated by external expert review.	Planetary Science	Multiple Programs				

Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9PS6	Develop missions in support of this Outcome, as demonstrated by selecting the next Scout mission.	Planetary Science	Mars Exploration				
APG 9PS7	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Phoenix.	Planetary Science	Mars Exploration				
Outcome 3C.3	**Progress in identifying and investigating past or present habitable environments on Mars and other worlds, and determining if there is or ever has been life elsewhere in the solar system.**			Green	Green	Green	Green
APG 9PS2	Develop missions in support of this Outcome, as demonstrated by completing the Juno Critical Design Review (CDR).	Planetary Science	New Frontiers				
APG 9PS4	Develop missions in support of this Outcome, as demonstrated by completing the Mars Science Laboratory (MSL) Launch Readiness Review (LRR).	Planetary Science	Mars Exploration				
APG 9PS6	Develop missions in support of this Outcome, as demonstrated by selecting the next Scout mission.	Planetary Science	Mars Exploration				
APG 9PS7	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Phoenix.	Planetary Science	Mars Exploration				
APG 9PS8	Demonstrate progress in identifying and investigating past or present habitable environments on Mars and other worlds, and determining if there is or ever has been life elsewhere in the solar system. Progress will be evaluated by external expert review.	Planetary Science	Multiple Programs				
Outcome 3C.4	**Progress in exploring the space environment to discover potential hazards to humans and to search for resources that would enable human presence.**			Green	Green	Green	Green
APG 9PS10	Develop missions in support of this Outcome, as demonstrated by selecting instruments for the first Lunar Science Research mission.	Planetary Science	Planetary Science Research				
APG 9PS4	Develop missions in support of this Outcome, as demonstrated by completing the Mars Science Laboratory (MSL) Launch Readiness Review (LRR).	Planetary Science	Mars Exploration				
APG 9PS7	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Phoenix.	Planetary Science	Mars Exploration				
APG 9PS9	Demonstrate progress in exploring the space environment to discover potential hazards to humans and to search for resources that would enable human presence. Progress will be evaluated by external expert review.	Planetary Science	Multiple Programs				
Sub Goal 3D	**Discover the origin, structure, evolution, and destiny of the universe, and search for Earth-like planets.**						
Outcome 3D.1	**Progress in understanding the origin and destiny of the universe, phenomena near black holes, and the nature of gravity.**			Green	Green	Green	Green
APG 9AS1	Demonstrate progress in understanding the origin and destiny of the universe, phenomena near black holes, and the nature of gravity. Progress will be evaluated by external expert review.	Astrophysics	Multiple Programs				

Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9AS2	Develop missions in support of this Outcome, as demonstrated by releasing the Joint Dark Energy Mission (JDEM) Announcement of Opportunity (AO).	Astrophysics	Physics of the Cosmos				
Outcome 3D.2	**Progress in understanding how the first stars and galaxies formed, and how they changed over time into the objects recognized in the present universe.**			Blue	Green	Yellow	Green
APG 9AS3	Demonstrate progress in understanding how the first stars and galaxies formed, and how they changed over time into the objects we recognize in the present universe. Progress will be evaluated by external expert review.	Astrophysics	Multiple Programs				
APG 9AS4	Develop missions in support of this Outcome, as demonstrated by completing the James Webb Space Telescope (JWST) Integrated Science Instrument Module (ISIM) Critical Design Review (CDR).	Astrophysics	Cosmic Origins				
APG 9AS5	Develop missions in support of this Outcome, as demonstrated by beginning Stratospheric Observatory for Infrared Astronomy (SOFIA) open-door testing.	Astrophysics	Cosmic Origins				
Outcome 3D.3	**Progress in understanding how individual stars form and how those processes ultimately affect the formation of planetary systems.**			Green	Green	Yellow	Green
APG 9AS4	Develop missions in support of this Outcome, as demonstrated by completing the James Webb Space Telescope (JWST) Integrated Science Instrument Module (ISIM) Critical Design Review (CDR).	Astrophysics	Cosmic Origins				
APG 9AS5	Develop missions in support of this Outcome, as demonstrated by beginning Stratospheric Observatory for Infrared Astronomy (SOFIA) open-door testing.	Astrophysics	Cosmic Origins				
APG 9AS6	Demonstrate progress in understanding how individual stars form and how those processes ultimately affect the formation of planetary systems. Progress will be evaluated by external expert review.	Astrophysics	Multiple Programs				
Outcome 3D.4	**Progress in creating a census of extra-solar planets and measuring their properties.**			Green	Green	Yellow	Yellow
APG 9AS7	Demonstrate progress in creating a census of extra-solar planets and measuring their properties. Progress will be evaluated by external expert review.	Astrophysics	Multiple Programs				
APG 9AS8	Develop missions in support of this Outcome, as demonstrated by completing Kepler Launch Readiness Review (LRR).	Astrophysics	Exoplanet Exploration				
Sub Goal 3E	**Advance knowledge in the fundamental disciplines of aeronautics, and develop technologies for safer aircraft and higher capacity airspace systems.**						
Outcome 3E.1	**By 2016, identify and develop tools, methods, and technologies for improving overall aircraft safety of new and legacy vehicles operating in the Next Generation Air Transportation System (projected for the year 2025).**			None	None	Green	Green
APG 9AT1	Demonstrate a 10% improvement in estimation accuracy of integrated gas path sensing and diagnostics for aircraft engine health.	Aeronautics	Aviation Safety				

Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9AT2	Conduct a spin test to verify enhanced disk rim attachment strength at component level and show 10% life improvement over criteria established in 2007.	Aeronautics	Aviation Safety				
APG 9AT3	Assess and deliver findings on initial multi-modal presentation formats and interaction methods for uncertainty display concepts and virtual visual environments with statistically significant reductions in communication errors, mental workload, and flight technical error, as well as increases in usability and situation awareness compared with baseline capability.	Aeronautics	Aviation Safety				
APG 9AT4	Design and evaluate preliminary concepts in on-line integrity monitoring (99% failure detection with less than 1% false positives) for adaptive control systems through simulation tests.	Aeronautics	Aviation Safety				
Outcome 3E.2	**By 2016, develop and demonstrate future concepts, capabilities, and technologies that will enable major increases in air traffic management effectiveness, flexibility, and efficiency, while maintaining safety, to meet capacity and mobility requirements of the Next Generation Air Transportation System.**			**None**	**None**	**Green**	**Green**
APG 9AT5	Complete trajectory analysis for service provider-based automated separation assurance with time-based metering with 2-3 times increase in capacity without reduction of baseline metering accuracy or separation violations.	Aeronautics	Airspace Systems				
APG 9AT6	Develop algorithms to generate robust, optimized solutions for surface traffic planning and control. Evaluations will include benefits in both nominal and off-nominal conditions under increased Airportal traffic density and consider environmental constraints and aircraft operator schedule preferences.	Aeronautic	Airspace Systems				
Outcome 3E.3	**By 2016, develop multidisciplinary analysis and design tools and new technologies, enabling better vehicle performance (e.g., efficiency, environmental, civil competitiveness, productivity, and reliability) in multiple flight regimes and within a variety of transportation system architectures.**			**None**	**None**	**Green**	**Green**
APG 9AT10	Complete the CFD pretest predictions of performance and operability of a high Mach fan for a TBCC propulsion system and compare to fan test data from the GRC W8 facility.	Aeronautics	Fundamental Aeronautics				
APG 9AT7	Develop a database for alternative hydrocarbons using accepted testing standards, then characterize the fuels (freezing point, break point, etc) in comparison to current Jet-A.	Aeronautics	Fundamental Aeronautics				
APG 9AT8	Develop and validate transmission tools and technologies to support variable speed drive systems using data from several transmission test cells at GRC.	Aeronautics	Fundamental Aeronautics				
APG 9AT9	Demonstrate an adjoint-based design method for configuration shaping; also establish the capability to design and analyze supersonic vehicles that achieve efficiency improvements within 10% of the defined targets including engine plume effects and verify the results using wind tunnel and flight experiments.	Aeronautics	Fundamental Aeronautics				

Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Outcome 3E.4	**Ensure the continuous availability of a portfolio of NASA-owned wind tunnels/ground test facilities, which are strategically important to meeting national aerospace program goals and requirements.**			None	None	None	Green
APG 9AT11	To sustain the required aeronautics test facilities force measurement capability for the nation, implement a centralized force balance capability by FY 2009.	Aeronautics	Aeronautics Test Program				
Sub Goal 3F	**Understand the effects of the space environment on human performance, and test new technologies and countermeasures for long-duration human space exploration.**						
Outcome 3F.1	**By 2008, develop and test candidate countermeasures to ensure the health of humans traveling in space.**			Green	Green	Green	Green
APG 9AC4	Develop an operational protocol that meets the standards of the Office of the Chief Health and Medical Officer for a countermeasure to lower the risk of renal stone formation due to increased bone loss during long duration missions in microgravity to below 1%.	Advanced Capabilities	Human Research Program				
APG 9AC5	Validate a ground analog fractional-gravity test methodology to assess whether 1/6th g is protective of physiological systems, including bone loss, and if not, what countermeasures are needed.	Advanced Capabilities	Human Research Program				
APG 9AC6	Provide recommendations for optimized EVA suit weight, pressure, center of gravity and kinematics.	Advanced Capabilities	Human Research Program				
Outcome 3F.2	**By 2010, identify and test technologies to reduce total mission resource requirements for life support systems.**			Green	Green	Green	Green
APG 9AC7	Evaluate three alternative distillation technologies for primary water processing as part of closed loop water recovery systems.	Advanced Capabilities	Exploration Technology Development				
Outcome 3F.3	**By 2010, develop reliable spacecraft technologies for advanced environmental monitoring and control and fire safety.**			Green	None	Green	Green
APG 9AC8	Complete the System Design Review for the Colorimetric Solid Phase Extraction Water Biocide Monitor.	Advanced Capabilities	Exploration Technology Development				
Outcome 3F.4	**By 2012, identify and develop tools, methods, and technologies for assessing, improving and maintaining the overall health of the astronaut corps, for mission lengths up to 180 days in microgravity or 1/6 G.**						
APG 9SFS1	Publish volume 5 of the Spacecraft Maximum Allowable Concentrations (SMACs) and volume 3 of the Spacecraft Water Exposure Guidelines (SWEGs).	Space and Flight Support	Crew Health & Safety				
APG 9SFS2	Thirty-seven percent of current and former astronaut medical requirements data will be captured in a comprehensive medical data management infrastructure.	Space and Flight Support	Crew Health & Safety				
APG 9SFS3	Capture 100% of medical and environmental data required by Medical Operations in queriable form.	Space and Flight Support	Crew Health & Safety				

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Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Strategic Goal 4	**Bring a new Crew Exploration Vehicle into service as soon as possible after Shuttle retirement.**						
Outcome 4.1	**No later than 2015, and as early as 2010, transport three crewmembers to the International Space Station and return them safely to Earth, demonstrating an operational capability to support human exploration missions.**			Green	Green	Green	Yellow
APG 9AC11	Deliver a prototype 5-meter diameter ablative heat shield for Orion to the Constellation Systems Program.	Advanced Capabilities	Exploration Technology Development				
APG 9CS1	Complete the Critical Design Review (CDR) for the Orion / Crew Exploration Vehicle (CEV).	Constellation Systems	Constellation Systems Program				
APG 9CS12	Complete the Preliminary Design Review (PDR) for the Constellation Program flight capability (PDR #1).	Constellation Systems	Constellation Systems Program				
APG 9CS2	Complete the Critical Design Review (CDR) for the Ares I Upper Stage (US) element.	Constellation Systems	Constellation Systems Program				
APG 9CS3	Complete the Critical Design Review (CDR) for the Pad B Launch Complex development within the Ground Operations Project.	Constellation Systems	Constellation Systems Program				
APG 9CS4	Complete the Preliminary Design Review (PDR) of the Mission Control Center System (MCCS) within the Mission Operations Project.	Constellation Systems	Constellation Systems Program				
APG 9CS5	Complete the Preliminary Design Review (PDR) for the Extravehicular Activity (EVA) Space Suit Element for CEV.	Constellation Systems	Constellation Systems Program				
APG 9CS6	Complete the launch and flight analysis of the CEV Pad Abort 1 (PA-1) test.	Constellation Systems	Constellation Systems Program				
APG 9CS7	Complete the launch and flight analysis of the Ares 1-X sub-orbital test.	Constellation Systems	Constellation Systems Program				
APG 9SFS3	In FY 2009, maintain agency rocket propulsion test core competencies (both infrastructure and critical skills) at appropriate levels to meet Constellation testing requirements and integrate these with other NASA programs, commercial partners, and DoD requirements and capabilities.	Space and Flight Support (SFS)	Rocket Propulsion Testing				
APG 9SFS4	Coordinate rocket propulsion test activities to support Constellation rocket propulsion testing milestones by providing an agency level Rocket Propulsion Test Plan.	Space and Flight Support (SFS)	Rocket Propulsion Testing				
Outcome 4.2	**By 2010, successfully transition applicable Shuttle components, infrastructure, and workforce to the Constellation Systems program.**						New
APG 9CS8	Demonstrate progress towards the transition of Space Shuttle and Space Station workforce and infrastructure for utilization in Constellation, including the transfer of the Vertical Assembly Building, configuration of Launch Complex 39-B and the Mobile Launch Platform 1 for the Ares 1-X test.	Constellation Systems	Constellation Systems Program				

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Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Strategic Goal 5	**Encourage the pursuit of appropriate partnerships with the emerging commercial space sector.**						
Outcome 5.1	**Develop and demonstrate a means for NASA to purchase launch services from emerging launch providers.**			Green	Green	Green	Green
APG 9SFS5	Establish a contractual mechanism or agreement to provide technical exchanges between NASA's Launch Services Program and emerging launch vehicles/providers to enhance early launch success.	Space and Flight Support (SFS)	Launch Services				
Outcome 5.2	**By 2010, demonstrate one or more commercial space services for ISS cargo and/or crew transport.**			Green	Green	Green	Green
APG 9CS10	Have at least three funded and unfunded Partners receiving technical assistance through the COTS Assistance Team (CAT) and making progress toward orbital demonstrations of commercial crew and cargo systems.	Constellation Systems	Constellation Systems Program				
APG 9CS9	Have at least one Partner complete a minimum of one orbital demonstration flight in FY 2009.	Constellation Systems	Constellation Systems Program				
Strategic Goal 6	**Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations.**						
Outcome 6.1	**By 2008, launch a Lunar Reconnaissance Orbiter (LRO) that will provide information about potential human exploration sites.**			Green	None	Green	Green
APG 9AC12	Launch the Lunar Reconnaissance Orbiter. (LRO)	Advanced Capabilities	Lunar Precursor Robotic Program				
APG 9AC13	Launch the Lunar Crater Observation and Sensing Satellite. (LCROSS)	Advanced Capabilities	Lunar Precursor Robotic Program				
Outcome 6.2	**By 2012, develop and test technologies for in situ resource utilization, power generation, and autonomous systems that reduce consumables launched from Earth and moderate mission risk.**			Green	Green	Green	Green
APG 9AC14	Demonstrate in field tests a proof-of-concept pressurized rover with EVA suitports that could enable surface exploration beyond the vicinity of the lunar outpost and improve EVA work efficiency.	Advanced Capabilities	Exploration Technology Development				
Outcome 6.3	**By 2013, sufficiently develop and test technologies for nuclear power systems to enable an informed selection of systems for flight development to provide power to a lunar outpost.**			Green	White	Green	Green
APG 9AC15	Demonstrate full-scale radiator panels in the laboratory at temperatures and heat transfer rates relevant to the reference 40-kilowatt fission surface power system for the lunar outpost.	Advanced Capabilities	Exploration Technology Development				
Outcome 6.4	**Implement the space communications and navigation architecture responsive to science and exploration mission requirements.**			Green	Green	Green	Green
APG 9SFS6	Complete TDRS Replenishment Preliminary Design Review (PDR).	Space and Flight Support	Space Communications and Navigation				

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Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9SFS7	Re-compete the Space Network, Near Earth Network and NISN operations and maintenance contracts to provide uninterrupted support of those networks.	Space and Flight Support	Space Communications and Navigation				
APG 9SFS8	Complete a consolidated network modernization plan for all SCaN networks to meet existing and future science and exploration mission requirements.	Space and Flight Support	Space Communications and Navigation				
Outcome 6.5	**No later than 2020, demonstrate the capability to conduct an extended human expedition to the lunar surface and lay the foundation for extending human presence across the solar system.**						**None**
APG 9AC16	Begin successful science data collection from the Lunar Reconnaissance Orbiter (LRO) in support of human lunar missions.	Advanced Capabilities	Lunar Precursor Robotic Program				
APG 9AC17	Begin successful science data collection from the Lunar Crater Observation and Sensing Satellite (LCROSS) in support of human lunar missions.	Advanced Capabilities	Lunar Precursor Robotic Program				
APG 9CS11	Conduct the Lunar Capabilities SRR to define the lunar mission architecture transportation requirements.	Constellation Systems	Extended Lunar Stay Capability				

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Cross-Agency Support Programs

Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Center Management and Operations Theme							
Outcome CMO-1	**Under development for release in 2010.**						New
APG 9CMO1	Under development for release in 2010.						
Education Theme							
Outcome ED-1	**Contribute to the development of the Science, Technology, Engineering and Math (STEM) workforce in disciplines needed to achieve NASA's strategic goals, through a portfolio of investments.**			None	Green	Green	Green
APG 9ED1	Support the development of 60 new or revised courses targeted at the STEM skills needed by NASA.	Education					
APG 9ED2	Serve 132 institutions in designated EPSCoR states.	Education					
APG 9ED3	Engage 8,500 underrepresented and underserved students in NASA higher education programs.	Education					
APG 9ED4	Increase the percentage of higher education program participants who have participated in NASA elementary or secondary programs by an additional ten percent above the FY 2007 baseline of eighteen percent.	Education					
APG 9ED5	Achieve thirty five percent of student participants in FY 2009 NASA higher education programs, will be employed by NASA, aerospace contractors, universities, and other educational institutions.	Education					
APG 9ED6	Achieve thirty five percent of undergraduate students in FY 2009 NASA higher education programs move on to advanced education in NASA-related disciplines.	Education					
Outcome ED-2	**Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers and faculty.**			None	Green	None	Green
APG 9ED10	Achieve fifty percent or greater level of interest in science and technology careers among elementary and secondary students participating in NASA education programs.	Education					
APG 9ED7	Increase the percentage of elementary and secondary educators, who receive NASA content-based STEM resources materials or participate in short-duration activities that use these materials in the classroom by four percent above the FY 2007 baseline of fifty five percent.	Education					
APG 9ED8	Increase the number of elementary and secondary student participants in NASA instructional and enrichment activities by 10% above the FY 2007 baseline of 408,774.	Education					
APG 9ED9	Assure seventy percent of elementary and secondary educators who participate in NASA training programs use NASA resources in their classroom instruction, an increase in the FY 2007 baseline of sixty two percent.	Education					

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Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
Outcome ED-3	**Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA's mission.**			None	None	None	Green
APG 9ED11	Assure that at least 350 museums and science centers across the country actively engage the public through NASA content.	Education					
APG 9ED12	Assure that twenty percent of the 460 museums and science centers that participate in NASA networks, use NASA resources in programs and exhibits.	Education					
Agency Management and Operations Theme							
Outcome IEM-1	**By 2012, implement Agency business systems that provide timely, consistent and reliable business information for management decisions.**			None	None	None	Green
APG 9IEM1	Implement all reports into the Human Capital Information Environment and stabilize the project and environment.	Agency Management & Operations	Agency IT Services				
APG 9IEM2	Implement the federal eTravel initiative to provide a standardized, comprehensive tool to support online booking, travel planning, travel expense reimbursement, payment processing, credit card reconciliation, and management reporting for NASA.	Agency Management & Operations	Agency IT Services				
Outcome IEM-2	**Increase efficiency by implementing new business systems and reengineering Agency business processes.**			None	None	Green	Green
APG 9IEM3	Reduce the number of quarterly corrective adjustments to financial statements from the 2006 baseline of 5948 steps to the 2009 goal of 2509 steps (a 58% reduction).	Agency Management & Operation	Agency IT Services				
APG 9IEM4	Improve the timeliness of the funds distribution process (time from receipt of apportionment to distribution of funds to Centers) from 65 days to the 2009 goal of 12 days.	Agency Management & Operations	Agency IT Services				
APG 9IEM5	Achieve cost savings, expected to increase annually with a 2009 goal of $19.3M, resulting from the integration of financial and asset management systems, a reduction in the number of redundant property, plant and equipment (PP&E) systems and process improvements that enable NASA to better manage PP&E assets.	Agency Management & Operations	Agency IT Services				
Outcome IPP-1	**Promote and develop innovative technology partnerships among NASA, U.S. industry, and other sectors for the benefit of Agency programs and projects.**			Blue	Green	Green	Green
APG 9IPP1	Develop twelve technology-related significant partnerships that create value for NASA's programs and projects. Track both quantitative dollar value and qualitative benefits to NASA (e.g. reduced volume or mass, improved safety).	Agency Management & Operations	Innovative Partnerships Program				
APG 9IPP2	Complete thirty technology transfer agreements with the commercial and academic community through such mechanisms as licenses, software use agreements, facility use agreements, and Space Act Agreements.	Agency Management & Operations	Innovative Partnerships Program				

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Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 04	FY 05	FY 06	FY 07
APG 9IPP3	Fully implement a new system for managing NASA's technology transfer and partnership information, that is more user friendly and less costly than the current NASA Technology Transfer System (NTTS).	Agency Management & Operations	Innovative Partnerships Program				
APG 9IPP4	Infuse technologies from the IPP portfolio into NASA's programs and projects, with at least twelve documented infusion successes.	Agency Management & Operations	Innovative Partnerships Program				
Outcome SC-1	**Establish and maintain selected Agency level shared capabilities, across multiple classes of assets (e.g., wind tunnels, vacuum chambers, etc.), to ensure that they will continue to be available to support the missions that require them.**			**None**	**None**	**None**	**Green**
APG 9SC1	Prioritize funding requirements and select classes of assets for inclusion in the Shared Capability Assets Program.	Agency Management & Operations	Strategic Capabilities Assets Program				
APG 9SC2	Identify re-investment/re-capitalization opportunities within and among classes of assets and execute the approved changes (e.g., reallocate funds, upgrade facilities, etc.).	Agency Management & Operations	Strategic Capabilities Assets Program				
SPG 9SC3	Assets identified in FY 2008 that no longer have requirements for use by NASA will be dispositioned (decision made on whether to place on standby, be mothballed, be demolished, etc.).	Agency Management & Operations	Strategic Capabilities Assets Program				
Institutional Investments Theme							
Outcome IINV-1	**Under development for release in 2010.**						**New**
APG 9IINV1	Under development for release in 2010.						

Uniform and Efficiency Measures

Measure	Description
Advanced Capabilities Theme	
APG 9AC18	Complete all development projects within 110% of the cost and schedule baseline.
APG 9AC19	Increase the amount of research beam time for space radiation experiments at NSRL, hence science data collection, by reducing the non-science overhead to 25% from 33% for set up, tuning and maintenance.
APG 9AC20	Given an annual constant dollar technology funding, demonstrate improvements in the EVA Work Efficiency Index for humans and robots working cooperatively to deploy the power system infrastructure for the lunar outpost. Work Efficiency Index = (Time to complete a task using humans and robots) / (Time to complete a task using humans only).
Astrophysics Theme	
APG 9AS12	Complete all development projects within 110% of the cost and schedule baseline.
APG 9AS13	Deliver at least 90% of scheduled operating hours for all operations and research facilities.
APG 9AS14	Peer-review and competitively award at least 95%, by budget, of research projects.
APG 9AS15	Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.
Aeronautics Theme	
APG 9AT12	Deliver at least 94% of "on-time availability" for all operations and research facilities.
Constellation Systems Theme	
APG 9CS12	Complete all development projects within 110% of the cost and schedule baseline.
APG 9CS13	Reduction in ground operations cost (through 2012) of the Constellation Systems based on comparison with the Space Shuttle Program.
Education Theme	
APG 9ED13	Reduce the dollar invested per number of people reached via e-education technologies from FY 2008 amounts.
APG 9ES14	Reduce the cost per K-12 program participant over FY 2007 amounts by 1%.
Earth Science Theme	
APG 9ES21	Complete all development projects within 110% of the cost and schedule baseline.
APG 9ES22	Deliver at least 90% of scheduled operating hours for all operations and research facilities.
APG 9ES23	Peer-review and competitively award at least 90%, by budget, of research projects.
APG 9ES24	Reduce time within which eighty percent of NRA research grants are awarded, from proposal due date to selection, by five percent per year, with a goal of 130 days.

Uniform and Efficiency Measures

Measure	Description
Heliophysics Theme	
APG 9HE10	Complete all development projects within 110% of the cost and schedule baseline.
APG 9HE11	Deliver at least 90% of scheduled operating hours for all operations and research facilities.
APG 9HE12	Peer-review and competitively award at least 95%, by budget, of research projects.
APG 9HE13	Reduce time within which eighty percent of NRA research grants are awarded, from proposal due date to selection, by five percent per year, with a goal of 130 days.
Agency Management and Operations Theme	
APG 9IEM8	Complete all development projects within 110% of the cost and schedule baseline.
APG 9IEM9	Reduce the number of financial processing steps/time to perform year end closing from the 2005 baseline of 120 steps to the 2008 goal of 20 steps (an 83% reduction).
APG 9IPP7	For technology partnerships, leverage IPP funding by bringing at least an additional $1.80 (one dollar and eighty cents) for each $1 (one dollar) of IPP funds.
International Space Station Theme	
APG 9ISS7	Achieve an Annual Cost Performance Index (CPI), the ratio of the value of the work accomplished versus the actual cost of the work accomplished, of greater than or equal to one.
APG 9ISS8	Deliver at least 90% of scheduled operating hours for all operations and research facilities.
Planetary Science Theme	
APG 9PS11	Complete all development projects within 110% of the cost and schedule baseline.
APG 9PS12	Deliver at least 90% of scheduled operating hours for all operations and research facilities.
APG 9PS13	Peer-review and competitively award at least 95%, by budget, of research projects.
APG 9PS14	Reduce time within which eighty percent of NRA research grants are awarded, from proposal due date to selection, by five percent per year, with a goal of 130 days.
Space and Flight Support (SFS) Theme	
APG 9SFS10	Achieve at least 99% Space Network proficiency for delivery of Space Communications services.
APG 9SFS11	Complete all development projects within 110% of the cost and schedule baseline.
APG 9SFS12	Ratio of Launch Services program cost per mission to average spacecraft cost, reduced to 6.3 percent.
Space Shuttle Theme	
APG 9SSP5	Annually reduce the Space Shuttle sustaining engineering workforce for flight hardware and software, while maintaining safe flight.
APG 9SSP6	Deliver at least 90% of scheduled operating hours for all operations and research facilities.

Annual Performance Goals Eliminated for FY 2009

Measures	Description	Contributing Theme	Contributing Program(s)
APG 9IPP05	Demonstrate the purchase of services from the emerging commercial space sector for microgravity research and training.	Agency Management and Operations	Agency Management and Operations
APG 9IPP06	Demonstrate benefits of prize competitions by awarding at least one prize and communicating the resulting technology advancements.	Agency Management and Operations	Agency Management and Operations

FY 2010 Performance Plan Narrative

NASA's six Strategic Goals are reflected below. Each is clearly defined and supported by Sub-goals (where appropriate), and supported by multi-year Outcomes. The majority of NASA's long-term performance commitments, the Outcomes, have remained the same from FY 2009. These in turn are supported by annual performance goals (APGs) that enhance NASA's ability to measure and report the Agency's progress in achieving its Strategic Goals.

The FY 2010 Performance Plan adds outcomes and APGs that support the Agency Management & Operations (AM&O), Center Management & Operations (CM&O), and Institutional Investments (II) themes established in FY 2009 under the "Cross-Agency Support (CAS)" Appropriation Account.

To better communicate the contribution of these themes along with other mission support elements, the performance measures were structured as function-based, rather than theme-based, Outcomes. Elements involving management of facilities, infrastructure, and information technology continue from FY 2009, but under more strategic Outcome statements. With the development of more strategic Outcomes, activities such as the Shared Capabilities Assets Program no longer provide APGs at the Agency level, but maintain measures used within the AM&O Program. New Outcomes were also established for human capital management, safety and mission assurance, and for launch services and space communications (a Space Operations Appropriations Account element formerly distributed between Strategic Goals 3, 4, 5, and 6). Each of these Outcomes provides "cross agency" support to programs and projects across NASA Mission Directorates, they are listed under the banner of Agency Support.

The Innovative Partnership Program Outcomes and APGs are now all aligned to Strategic Goal 5 to support partnership activities.

The table below provides a summary of all of the Agency commitments identified in the preceding sections. The table also reflects trend information for the Outcomes. Definitions for the trend ratings are as follows:

Outcomes
Green: NASA achieved most APGs under this Outcome and is on-track to achieve or exceed this Outcome.
Yellow: NASA made significant progress toward this Outcome, however, the Agency may not achieve this Outcome as stated.
Red: NASA failed to achieve most of the APGs under this Outcome and does not expect to achieve this Outcome as stated.
White: This Outcome was cancelled by management directive or is no longer applicable based on management changes to the APGs.
None: The stated Outcome did not exist in the years indicated.

FY 2010 Performance Plan

Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 05	FY 06	FY 07	FY 08
Strategic Goal 1	**Fly the Shuttle as safely as possible until its retirement, not later than 2010.**						
Outcome 1.1	**Assure the safety and integrity of the Space Shuttle workforce, systems and processes, while flying the manifest.**			Green	Yellow	Green	Green
APG 10SSP1	Achieve zero Type-A (damage to property at least $1 million or death) or Type-B (damage to property at least $250 thousand or permanent disability or hospitalization of three or more persons) mishaps in FY 2010.	Space Shuttle	Space Shuttle Program				
APG 10SSP2	Complete 100% of all mission objectives for all Space Shuttle missions in FY 2010 as specified in the Flight Requirements Document for each mission.	Space Shuttle	Space Shuttle Program				
Outcome 1.2	**By December 31, 2010, retire the Space Shuttle.**			None	None	Green	Green
APG 10SSP03	Complete close-out and transfer plans for all remaining Space Shuttle flight hardware elements and other major Space Shuttle property assets, including the disposition plans for the Orbiters and the means by which significant gaps in human spaceflight operations capabilities will be managed until the first operational flight of the Constellation Program.	Space Shuttle	Space Shuttle Program				
APG 10SSP04	Complete 100% of the Transition Property Assessment for Space Shuttle Program property by no later than the second quarter of FY 2010.	Space Shuttle	Space Shuttle Program				
APG 10SSP05	With the Constellation Program, complete and deliver 2 workforce transition strategy report updates to Congress in FY 2010.	Space Shuttle	Space Shuttle Program				
Strategic Goal 2	**Complete the International Space Station in a manner consistent with NASA's International Partner commitments and the needs of human exploration.**						
Outcome 2.1	**By 2010, complete assembly of the U.S. On-orbit Segment; launch International Partner elements and sparing items required to be launched by the Shuttle; and provide on-orbit resources for research to support U.S. human space exploration.**			Green	Green	Green	Green
APG 10ISS01	Based on the actual Space Shuttle flight rate, number of remaining Shuttle flights, and the discussions with the International Partners, update the agreed-to ISS assembly sequence and transportation plan as necessary.	International Space Station	International Space Station Program				
APG 10ISS02	Accomplish a minimum of 90% of the on-orbit research objectives as established one month prior to a given increment.	International Space Station	International Space Station Program				
APG 10ISS03	Per the final configuration agreed to by the International Partners, fly the ISS elements and logistics baselined for FY 2010.	International Space Station	International Space Station Program				
APG 10ISS04	Provide increased ISS capability and utilization by integrating ISS elements, payloads, and spares including the EXPRESS Logistics Carriers 1 through 4, Cupola, Node 3, Multipurpose Pressurized Logistics Module, a COTS demonstration, and Mini-Research Module.	International Space Station	International Space Station Program				

FY 2010 Performance Plan

Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 05	FY 06	FY 07	FY 08
Outcome 2.2	**Through 2015, provide the on-orbit capability to support an ISS crew of 6 crewmembers.**			None	None	Green	Green
APG 10ISS05	Achieve zero Type-A (damage to property at least $1 million or death) or Type-B (damage to property at least $250 thousand or permanent disability or hospitalization of 3 or more persons) mishaps in FY 2010.	International Space Station	International Space Station Program				
APG 10ISS07	In concert with the International Partners, maintain a continuous crew presence on the ISS by coordinating and managing resources, logistics, systems, and operational procedures.	International Space Station	International Space Station Program				
APG 10ISS08	Deliver 100% of planned on-orbit resources (including power, data, crew time, logistics, and accommodations) available to support research.	International Space Station	International Space Station Program				
Outcome 2.3	**Conduct basic and applied biological and physical research to advance and sustain U.S. scientific expertise.**			None	None	New	Green
APG 10AC01	Deliver 2 out of 3 of the following exploration technology payloads to SOMD for launch to the ISS: 1) Boiling Experiment Facility; 2) Capillary Channel Flow, or several test vessels of the Capillary Flow Experiment-2; or 3) Conduct the tests for the Flame Extinguishment Experiment exploration payload on ISS.	Advanced Capabilities	Exploration Technology Development				
APG 10AC02	Conduct 3 out of 4 of the following non-exploration experiments on the ISS: 1) Dynamical Selection of Interface Patterns; 2) Two samples from Microstructure Formation in Castings of Technical Alloys under Diffusive and Magnetically-Controlled Convective Conditions (MICAST)/Columnar-Equiaxed Transition in Solidification Processing experiment; 3) Binary Critical Aggregation Test-5; or 4) Investigating the Structures of Paramagnetic Aggregates from Colloidal Emulsions-3.	Advanced Capabilities	Exploration Technology Development				
APG 10AC03	Develop for flight two ISS/Shuttle/Free Flyer payloads: Develop the Animal Enclosure Module for launch on the Space Shuttle, to conduct immunology research on rodents; and develop a nano-satellite as a secondary Free Flyer payload to conduct fundamental biological research.	Advanced Capabilities	Exploration Technology Development				

FY 2010 Performance Plan

Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 05	FY 06	FY 07	FY 08
Strategic Goal 3	**Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration.**						
Strategic Goal 3A	**Study Earth from space to advance scientific understanding and meet societal needs.**						
Outcome 3A.1	**Progress in understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition.**			None	Green	Green	Green
APG 10ES01	Demonstrate progress in understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition (based on measurements from presently orbiting NASA and non-NASA assets). Progress will be evaluated by external expert review.	Earth Science	Multiple Programs				
APG 10ES02	Develop missions in support of this Outcome, as demonstrated by completing Aquarius Operational Readiness Review (ORR).	Earth Science	Earth System Science Pathfinder				
APG 10ES03	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Aura.	Earth Science	Earth Systematic Missions				
Outcome 3A.2	**Progress in enabling improved predictive capability for weather and extreme weather events.**			None	Green	Green	Green
APG 10ES04	Demonstrate progress in enabling improved predictive capability for weather and extreme weather events. Progress will be evaluated by external expert review.	Earth Science	Multiple Programs				
APG 10ES05	Develop missions in support of this Outcome, as demonstrated by completing the NPOESS Preparatory Project (NPP) Operational Readiness Review (ORR).	Earth Science	Earth Systematic Missions				
APG 10ES06	Develop missions in support of this Outcome, as demonstrated by completing the Global Precipitation Mission (GPM) Critical Design Review (CDR).	Earth Science	Earth Systematic Missions				
Outcome 3A.3	**Progress in quantifying global land cover change and terrestrial and marine productivity, and in improving carbon cycle and ecosystem models.**			None	Green	Green	Green
APG 10ES07	Demonstrate progress in quantifying global land cover change and terrestrial and marine productivity, and in improving carbon cycle and ecosystem models. Progress will be evaluated by external expert review.	Earth Science	Multiple Programs				
APG 10ES05	Develop missions in support of this Outcome, as demonstrated by completing the NPOESS Preparatory Project (NPP) Operational Readiness Review (ORR).	Earth Science	Earth Systematic Missions				
APG 10ES08	Develop missions in support of this Outcome, as demonstrated by completing the Landsat Data Continuity Mission (LDCM) Confirmation Review.	Earth Science	Earth Systematic Missions				

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Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 05	FY 06	FY 07	FY 08
Outcome 3A.4	**Progress in quantifying the key reservoirs and fluxes in the global water cycle and in improving models of water cycle change and fresh water availability.**			None	Yellow	Green	Green
APG 10ES09	Demonstrate progress in quantifying the key reservoirs and fluxes in the global water cycle and in improving models of water cycle change and fresh water availability. Progress will be evaluated by external expert review.	Earth Science	Multiple Programs				
APG 10ES02	Develop missions in support of this Outcome, as demonstrated by completing Aquarius Operational Readiness Review (ORR).	Earth Science	Earth System Science Pathfinder				
APG 10ES06	Develop missions in support of this Outcome, as demonstrated by completing the Global Precipitation Mission (GPM) Critical Design Review (CDR).	Earth Science	Earth Systematic Missions				
APG 10ES10	Develop missions in support of this Outcome, as demonstrated by completing the SMAP Preliminary Design Review (PDR).	Earth Science	Earth Systematic Missions				
Outcome 3A.5	**Progress in understanding the role of oceans, atmosphere, and ice in the climate system and in improving predictive capability for its future evolution.**			None	Yellow	Yellow	Yellow
APG 10ES11	Demonstrate progress in understanding the role of oceans, atmosphere, and ice in the climate system and in improving predictive capability for its future evolution. Progress will be evaluated by external expert review.	Earth Science	Multiple Programs				
APG 10ES05	Develop missions in support of this Outcome, as demonstrated by completing the NPOESS Preparatory Project (NPP) Operational Readiness Review (ORR).	Earth Science	Earth Systematic Missions				
APG 10ES12	Develop missions in support of this Outcome, as demonstrated by completing the ICESat-II Initial Confirmation Review.	Earth Science	Earth System Science Pathfinder				
APG 10ES03	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Aura.	Earth Science	Earth Systematic Missions				
Outcome 3A.6	**Progress in characterizing and understanding Earth surface changes and variability of Earth's gravitational and magnetic fields.**			None	Green	Green	Green
APG 10ES08	Develop missions in support of this Outcome, as demonstrated by completing the Landsat Data Continuity Mission (LDCM) Confirmation Review.	Earth Science	Earth Systematic Missions				
APG 10ES13	Demonstrate progress in characterizing and understanding Earth surface changes and variability of Earth's gravitational and magnetic fields. Progress will be evaluated by external expert review.	Earth Science	Multiple Programs				

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Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 05	FY 06	FY 07	FY 08
Outcome 3A.7	**Progress in expanding and accelerating the realization of societal benefits from Earth system science.**			None	Green	Green	Green
APG 10ES14	Issue 12 reports with partnering organizations that validate using NASA research capabilities (e.g., observations and/or forecast products) could improve their operational decision support systems.	Earth Science	Applied Sciences				
APG 10ES15	Increase the number of distinct users of NASA data and services.	Earth Science	Earth Science Research				
APG 10ES16	Maintain a high level of customer satisfaction, as measured by exceeding the most recently available federal government average rating of the Customer Satisfaction Index.	Earth Science	Earth Science Research				
Strategic Goal 3B	**Understand the Sun and its effects on Earth and the solar system.**						
Outcome 3B.1	**Progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium.**			Green	Green	Green	Green
APG 10HE01	Demonstrate progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium. Progress will be evaluated by external expert review.	Heliophysics	Multiple Programs				
APG 10HE02	Develop missions in support of this Outcome, as demonstrated by completing the Magnetospheric Multiscale (MMS) spacecraft Critical Design Review (CDR).	Heliophysics	Solar Terrestrial Probes				
APG 10HE03	Develop missions in support of this Outcome, as demonstrated by completing the Geospace Radiation Belt Storm Probes Critical Design Review (CDR).	Heliophysics	Living with a Star				
APG 10HE04	Develop missions in support of this Outcome, as demonstrated by awarding Solar Probe instrument contracts.	Heliophysics	Heliophysics Explorer Program				
APG 10HE05	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Hinode (Solar-B), THEMIS, and IBEX.	Heliophysics	Multiple Programs				
Outcome 3B.2	**Progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability and planetary magnetic fields.**			Green	Green	Green	Green
APG 10HE02	Develop missions in support of this Outcome, as demonstrated by completing the Magnetospheric Multiscale (MMS) spacecraft Critical Design Review (CDR).	Heliophysics	Solar Terrestrial Probes				
APG 10HE03	Develop missions in support of this Outcome, as demonstrated by completing the Geospace Radiation Belt Storm Probes Critical Design Review (CDR).	Heliophysics	Living with a Star				

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Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 05	FY 06	FY 07	FY 08
APG 10HE04	Develop missions in support of this Outcome, as demonstrated by awarding Solar Probe instrument contracts.	Heliophysics	Heliophysics Explorer Program				
APG 10HE06	Demonstrate progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability and planetary magnetic fields. Progress will be evaluated by external expert review.	Heliophysics	Multiple Programs				
APG 10HE07	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for THEMIS.	Heliophysics	Multiple Programs				
Outcome 3B.3	**Progress in developing the capability to predict the extreme and dynamic conditions in space in order to maximize the safety and productivity of human and robotic explorers.**			Green	Green	Green	Green
APG 10HE03	Develop missions in support of this Outcome, as demonstrated by completing the Geospace Radiation Belt Storm Probes Critical Design Review (CDR).	Heliophysics	Living with a Star				
APG 10HE08	Demonstrate progress in developing the capability to predict the extreme and dynamic conditions in space in order to maximize the safety and productivity of human and robotic explorers. Progress will be evaluated by external expert review.	Heliophysics	Multiple Programs				
Strategic Goal 3C	**Advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space.**						
Outcome 3C.1	**Progress in learning how the Sun's family of planets and minor bodies originated and evolved.**			Green	Green	Green	Green
APG 10PS01	Demonstrate progress in learning how the Sun's family of planets and minor bodies originated and evolved. Progress will be evaluated by external expert review.	Planetary Science	Multiple Programs				
APG 10PS02	Develop missions in support of this Outcome, as demonstrated by completing the Juno Systems Integration Review (SIR).	Planetary Science	New Frontiers				
APG 10PS03	Develop missions in support of this Outcome, as demonstrated by completing the GRAIL Critical Design Review (CDR).	Planetary Science	Discovery				
APG 10PS04	Develop missions in support of this Outcome, as demonstrated by selecting New Frontiers 3 concept studies.	Planetary Science	New Frontiers				
APG 10PS05	Develop missions in support of this Outcome, as demonstrated by selecting Discovery 12 concept studies.	Planetary Science	Discovery				
APG 10PS06	Develop missions in support of this Outcome, as demonstration by completing the Mars Science Laboratory flight hardware builds and flight system assemblies.	Planetary Science	Mars Exploration				

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Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 05	FY 06	FY 07	FY 08
Outcome 3C.2	**Progress in understanding the processes that determine the history and future of habitability in the solar system, including the origin and evolution of Earth's biosphere and the character and extent of prebiotic chemistry on Mars and other worlds.**			Green	Green	Green	Green
APG 10PS02	Develop missions in support of this Outcome, as demonstrated by completing the Juno Systems Integration Review (SIR).	Planetary Science	New Frontiers				
APG 10PS07	Demonstrate progress in understanding the processes that determine the history and future of habitability in the solar system, including the origin and evolution of Earth's biosphere and the character and extent of prebiotic chemistry on Mars and other worlds. Progress will be evaluated by external expert review.	Planetary Science	Mars Exploration				
APG 10PS08	Develop missions in support of this Outcome, as demonstrated by completing the Mars Atmosphere and Volatile Evolution Mission (MAVEN) Preliminary Design Review (PDR).	Planetary Science					
APG 10PS06	Develop missions in support of this Outcome, as demonstration by completing the Mars Science Laboratory flight hardware builds and flight system assemblies.	Planetary Science	Mars Exploration				
Outcome 3C.3	**Progress in identifying and investigating past or present habitable environments on Mars and other worlds, and determining if there is or ever has been life elsewhere in the solar system.**			Green	Green	Green	Green
APG 10PS02	Develop missions in support of this Outcome, as demonstrated by completing the Juno Systems Integration Review (SIR).	Planetary Science	New Frontiers				
APG 10PS06	Develop missions in support of this Outcome, as demonstration by completing the Mars Science Laboratory flight hardware builds and flight system assemblies.	Planetary Science	Mars Exploration				
APG 10PS07	Develop missions in support of this Outcome, as demonstrated by completing the Mars Atmosphere and Volatile Evolution Mission (MAVEN) Preliminary Design Review (PDR).	Planetary Science	Mars Exploration				
APG 10PS09	Demonstrate progress in identifying and investigating past or present habitable environments on Mars and other worlds, and determining if there is or ever has been life elsewhere in the solar system. Progress will be evaluated by external expert review.	Planetary Science	Multiple Programs				
Outcome 3C.4	**Progress in exploring the space environment to discover potential hazards to humans and to search for resources that would enable human presence.**			Green	Green	Green	Green
APG 10PS11	Develop missions in support of this Outcome, as demonstrated by completing the LADEE Critical Design Review (CDR).	Planetary Science	Lunar Quest				

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Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 05	FY 06	FY 07	FY 08
APG 10PS10	Demonstrate progress in exploring the space environment to discover potential hazards to humans and to search for resources that would enable human presence. Progress will be evaluated by external expert review.	Planetary Science	Multiple Programs				
APG 10PS06	Develop missions in support of this Outcome, as demonstration by completing the Mars Science Laboratory flight hardware builds and flight system assemblies.	Planetary Science	Mars Exploration				
Strategic Goal 3D	**Discover the origin, structure, evolution, and destiny of the universe, and search for Earth-like planets.**						
Outcome 3D.1	**Progress in understanding the origin and destiny of the universe, phenomena near black holes, and the nature of gravity.**			**Green**	**Green**	**Green**	**Green**
APG 10AS01	Demonstrate progress in understanding the origin and destiny of the universe, phenomena near black holes, and the nature of gravity. Progress will be evaluated by external expert review.	Astrophysics	Multiple Programs				
APG 10AS02	Develop missions in support of this Outcome, as demonstrated by completing the NuSTAR Critical Design Review (CDR).	Astrophysics	Astrophysics Explorer				
APG 10AS03	Develop missions in support of this Outcome, as demonstrated by selecting Joint Dark Energy Mission (JDEM) science investigations.	Astrophysics	Beyond Einstein				
APG 10AS04	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for GLAST.	Astrophysics	Gamma-ray Large Space Telescope				
Outcome 3D.2	**Progress in understanding how the first stars and galaxies formed, and how they changed over time into the objects recognized in the present universe.**			**Green**	**Yellow**	**Green**	**Green**
APG 10AS05	Demonstrate progress in understanding how the first stars and galaxies formed, and how they changed over time into the objects we recognize in the present universe. Progress will be evaluated by external expert review.	Astrophysics	Multiple Programs				
APG 10AS06	Develop missions in support of this Outcome, as demonstrated by completing the James Webb Space Telescope (JWST) Optical Telescope Element Critical Design Review (CDR).	Astrophysics	James Webb Space Telescope				
APG 10AS07	Develop missions in support of this Outcome, as demonstrated by completing the first competed Early Science observations on the Stratospheric Observatory for Infrared Astronomy (SOFIA).	Astrophysics	Stratospheric Observatory for Infrared Astronomy				
APG 10AS08	Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for WISE.	Astrophysics	Cosmic Origins				

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Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 05	FY 06	FY 07	FY 08
Outcome 3D.3	**Progress in understanding how individual stars form and how those processes ultimately affect the formation of planetary systems.**			**Green**	**Yellow**	**Green**	**Green**
APG 10AS06	Develop missions in support of this Outcome, as demonstrated by completing the James Webb Space Telescope (JWST) Optical Telescope Element Critical Design Review (CDR).	Astrophysics	James Webb Space Telescope				
APG 10AS07	Develop missions in support of this Outcome, as demonstrated by completing the first competed Early Science observations on the Stratospheric Observatory for Infrared Astronomy (SOFIA).	Astrophysics	Stratospheric Observatory for Infrared Astronomy				
APG 10AS09	Demonstrate progress in understanding how individual stars form and how those processes ultimately affect the formation of planetary systems. Progress will be evaluated by external expert review.	Astrophysics	Multiple Programs				
Outcome 3D.4	**Progress in creating a census of extra-solar planets and measuring their properties.**			**Green**	**Yellow**	**Yellow**	**Green**
APG 10AS10	Demonstrate progress in creating a census of extra-solar planets and measuring their properties. Progress will be evaluated by external expert review.	Astrophysics	Multiple Programs				
Strategic Goal 3E	**Advance knowledge in the fundamental disciplines of aeronautics, and develop technologies for safer aircraft and higher capacity airspace systems.**						
Outcome 3E.1	**By 2016, identify and develop tools, methods, and technologies for improving overall aircraft safety of new and legacy vehicles operating in the Next Generation Air Transportation System (projected for the year 2025).**			**None**	**Green**	**Green**	**Green**
APG 10AT01	Using 2008 as a baseline, demonstrate, on a representative current generation electro-mechanical system test bed, improved IVHM via Bayesian methods and/or models for varying operating conditions and demonstrate fault detection/diagnosis on at least three faults types and examine tradeoff between accuracy and diagnosis time.	Aeronautics	Aviation Safety				
APG 10AT02	Develop an atomistically-based model capable of predicting within 25%, the degradation caused by environmental effects on interfaces in selected polymer matrix composite materials.	Aeronautics	Aviation Safety				
APG 10AT03	Deliver and validate through analysis flight deck guidelines, information, and display requirements that meet NextGen operational needs as established in 2007 baseline assessment, and without a measurable increase to safety risk.	Aeronautics	Aviation Safety				
APG 10AT04	Develop a tool suite that provides an order of magnitude reduction in analysis time over current Monte-Carlo simulation methods that would be used to locate failure points in the flight envelope for a chosen adaptive control system and a set of adverse events.	Aeronautics	Aviation Safety				

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Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 05	FY 06	FY 07	FY 08
Outcome 3E.2	**By 2016, develop and demonstrate future concepts, capabilities, and technologies that will enable major increases in air traffic management effectiveness, flexibility, and efficiency, while maintaining safety, to meet capacity and mobility requirements of the Next Generation Air Transportation System.**			None	Green	Green	Green
APG 10AT05	Conduct simulations of automated separation assurance with sequencing, spacing, and scheduling constraints.	Aeronautics	Airspace Systems				
APG 10AT06	Determine the feasibility and benefits of one or more candidate Multi-Sector Planner concepts.	Aeronautics	Airspace Systems				
Outcome 3E.3	**By 2016, develop multidisciplinary analysis and design tools and new technologies, enabling better vehicle performance (e.g., efficiency, environmental, civil competitiveness, productivity, and reliability) in multiple flight regimes and within a variety of transportation system architectures.**			None	Green	Green	Green
APG 10AT07	Complete new suite of integrated multidisciplinary analysis tools to predict noise, NOx, takeoff/landing performance, cruise performance, and Take-Off Gross Weight (TOGW) for conventional (“tube and wing”) aircraft and unconventional aircraft (e.g. hybrid wind-body).	Aeronautics	Fundamental Aeronautics				
APG 10AT08	Demonstrate control concepts through flight simulation that would contribute towards development of a flight control optimization tool for variable speed engine and transmission with no negative handling quality effects.	Aeronautics	Fundamental Aeronautics				
APG 10AT09	Develop computational models to predict integrated inlet and fan performance and operability and compare models to experimental data.	Aeronautics	Fundamental Aeronautics				
APG 10AT10	Complete CFD predictions of ramjet-to-scramjet mode-transition and compare to wind tunnel and/or X-51 flight test data.	Aeronautics	Fundamental Aeronautics				
Outcome 3E.4	**Ensure the continuous availability of a portfolio of NASA-owned wind tunnels/ground test facilities, which are strategically important to meeting national aerospace program goals and requirements.**			None	None	None	Green
APG 10AT11	Achieve test customer evaluation ratings averaging greater than 90% for overall quality and timeliness of ATP facility operations, based on feedback received in post-test customer surveys.	Aeronautics	Aeronautics Test Program				
Outcome 3E.5	**For vehicle and propulsion technologies that simultaneously reduce fuel burn, noise, and emissions, by 2016 develop a well-informed trade space, document performance potential, and identify technical risks to a level that enables incorporation of the technologies into the design of new aircraft.**						
APG 10AT12	In FY 2010, award a contract to conduct N+2 vehicle systems-studies.	Aeronautics	Integrated Systems Research Program				

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Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 05	FY 06	FY 07	FY 08
Strategic Goal 3F	**Understand the effects of the space environment on human performance, and test new technologies and countermeasures for long-duration human space exploration.**						
Outcome 3F.1	**By 2016, develop and test candidate countermeasures to ensure the health of humans traveling in space.**			None	Green	Green	Green
APG 10AC04	Deliver a Human Interface Design Handbook for use in designing exploration vehicles.	Advanced Capabilities	Human Research Program				
APG 10AC05	Deliver and publish an initial version of the acute radiation risk projection model for lunar missions.	Advanced Capabilities	Human Research Program				
APG 10AC06	Deliver a device for launch to ISS to test the technology of producing medical grade water on a spacecraft.	Advanced Capabilities	Human Research Program				
APG 10AC07	Complete the assessment study of a capability to test bone & muscle countermeasures in simulated lunar gravity.	Advanced Capabilities	Human Research Program				
APG 10AC08	Complete the 2010 quantitative assessment of the uncertainties in cancer risk projections for space radiation exposures in support of lunar exploration missions.	Advanced Capabilities	Human Research Program				
Outcome 3F.2	**By 2012, identify and test technologies to reduce total mission resource requirements for life support systems.**			Green	Green	Green	Green
APG 10AC09	As part of technology development for closed-loop air revitalization for lunar surface habitats, conduct a trade study to evaluate candidate technologies for carbon dioxide reduction in support of down selection for development of a breadboard unit.	Advanced Capabilities	Exploration Technology Development				
APG 10AC10	Develop and test candidate technologies for production of high-pressure gases for potential use for recharge of oxygen for Extra Vehicular Activity (EVA) portable life support systems for planetary surface missions.	Advanced Capabilities	Exploration Technology Development				
Outcome 3F.3	**By 2012, develop reliable spacecraft technologies for advanced environmental monitoring and control and fire safety.**			None	Green	Green	Green
APG 10AC11	Demonstrate 6 months of experimental operation of the Electronic Nose (ENose) on orbit.	Advanced Capabilities	Exploration Technology Development				
APG 10AC12	Demonstrate 1 year of experimental operation of the Vehicle Cabin Atmosphere Monitoring (VCAM) system on orbit.	Advanced Capabilities	Exploration Technology Development				
Outcome 3F.4	**By 2012, identify and develop tools, methods, and technologies for assessing, improving and maintaining the overall health of the astronaut corps, for mission lengths up to 180 days in microgravity or 1/6 G.**						
APG 10SFS01	Capture 43% of current and former astronaut medical requirements data will be captured in a comprehensive medical data management infrastructure.	Space & Flight Support	Crew Health & Safety				

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Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 05	FY 06	FY 07	FY 08
APG 10SFS02	Create a set of clinical practice guidelines for monitoring known risks associated with space flight.	Space & Flight Support	Crew Health & Safety				
APG 10SFS03	Capture 100% of medical and environmental data required by Medical Operations in a form capable of queries.	Space & Flight Support	Crew Health & Safety				
APG 10SFS04	Create an integrated concept of operations to use ultrasound for ground-based clinical care as a test bed for in flight uses.	Space & Flight Support	Crew Health & Safety				
Strategic Goal 4	**Bring a new Crew Exploration Vehicle into service as soon as possible after Shuttle retirement.**						
Outcome 4.1	**No later than 2015, transport three crewmembers to the International Space Station and return them safely to Earth, demonstrating an operational capability to support human exploration missions.**			Green	Green	Yellow	Yellow
APG 10CS01	Complete Pad Abort-1 test for the Orion Crew Exploration Vehicle.	Constellation Systems	Constellation (Cx) Systems Program				
APG 10CS02	Complete the integrated Preliminary Design Review (PDR) for the Constellation Program.	Constellation Systems	Cx Systems Program				
APG 10CS03	Complete Ares 1 First Stage Development Motor (DM 1) test firing.	Constellation Systems	Cx Systems Program				
APG 10CS04	Complete the Thrust Oscillation Preliminary Design Review (PDR) for Ares I.	Constellation Systems	Cx Systems Program				
APG 10CS05	Complete the Preliminary Design Review (PDR) for the Ground Operations (GO) Project.	Constellation Systems	Cx Systems Program				
APG 10CS06	Complete the Preliminary Design Review (PDR) for the Mission Operations (MO) Project.	Constellation Systems	Cx Systems Program				
Strategic Goal 5	**Encourage the pursuit of appropriate partnerships with the emerging commercial space sector.**						
Outcome 5.1	**Develop and demonstrate a means for NASA to purchase launch services from emerging launch providers.**			Green	Green	Green	Green
APG 10SFS05	The Launch Service Program will capture 100% of significant technical interchange information with emerging launch providers as provided under existing contract mechanisms. The Engineering Review Board Information System (ERBIS) will be used to capture specific technical recommendations and opportunities for risk reduction.	Space & Flight Support	Launch Services				
Outcome 5.2	**By 2010, demonstrate one or more commercial space capabilities for ISS cargo and/or crew transport.**			Green	Green	Green	Green
APG 10CS07	In FY 2010, have at least one partner demonstrate flight proximity operations with ISS.	Constellation Systems	Cx Systems Program				
APG 10CS08	By the end of FY 2010, conduct one or more demonstration flights to, and berth with, the ISS.	Constellation Systems	Cx Systems Program				

FY 2010 Performance Plan

Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 05	FY 06	FY 07	FY 08
Outcome 5.3	**Promote and develop innovative technology partnerships among NASA, U.S. industry, and other sectors for the benefit of Agency programs and projects.**			Green	Green	Green	Green
APG 10IPP01	Document 40 notable technology transfer successes documented in NASA's Spinoff publication.	Agency Management & Operations (AMO)	Innovative Partnerships Program (IPP)				
APG 10IPP02	Produce 1100 New Technology Reports (NTRs) produced, representing the new technologies available for potential transfer.	AMO	IPP				
APG 10IPP03	Ratio of total number of licenses generated from the Intellectual Property (IP) portfolio of patents from the last five years relative to the number of patents in that portfolio is equivalent to 40%.	AMO	IPP				
APG 10IPP04	Initiate or expand 29 SBIR/STTR Phase III contracts.	AMO	IPP				
APG 10IPP05	Achieve 175 technology readiness level (TRL) advancements from the Innovative Partnerships Program portfolio of technology development.	AMO	IPP				
APG 10IPP06	Infuse 68 technologies into NASA programs/projects from total Innovative Partnerships Program portfolio.	AMO	IPP				
APG 10IPP07	Ratio of SBIR/STTR technologies successfully infused into NASA programs/projects relative to the prior five years of SBIR/STTR Phase II contracts issued is equivalent to 21%.	AMO	IPP				
Strategic Goal 6	**Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations.**						
Outcome 6.1	**By 2012, complete the transition of applicable Shuttle components, infrastructure, and workforce to the Constellation Systems program.**						
APG 10CS09	Complete the Exploration Requirements for Institutional Capabilities (ERIC) database update and develop a coordinated final SOMD/ESMD report that incorporates the ERIC update with the Space Shuttle Program's final assessment of real property.	Constellation Systems	Cx Systems Program				
APG 10CS10	Complete the Constellation Assessment of Personal Property (CAPP) for Space Shuttle Program property.	Constellation Systems	Cx Systems Program				
APG 10CS11	With the Space Shuttle Program, complete and deliver 2 agency workforce transition strategy report updates to Congress.	Constellation Systems	Cx Systems Program				
Outcome 6.2	**By 2016, develop and test technologies for in situ resource utilization, power generation, and autonomous systems that reduce consumables launched from Earth and moderate mission risk.**			Green	Green	Green	Green
APG 10AC13	Demonstrate autonomous hazard avoidance system for Altair lunar lander in helicopter flight test.	Advanced Capabilities	Exploration Technology Development				

FY 2010 Performance Plan

Measure	Description	Contributing Theme	Contributing Program(s)	Multi-year Outcome ratings FY 05	FY 06	FY 07	FY 08
Outcome 6.3	**By 2013, sufficiently develop and test technologies for nuclear power systems to enable an informed selection of systems for flight development to provide power to a lunar outpost.**			**None**	**None**	**None**	**Green**
APG 10AC14	Liquid-metal pump Demonstration – Complete final report of performance testing of a prototypic annular linear induction pump with sodium-potassium fluid at operating temperatures and flow rates that are relevant to a future 40 kilowatt fission surface power system.	Advanced Capabilities	Exploration Technology Development				
Outcome 6.4	**No later than 2020, demonstrate the capability to conduct an extended human expedition to the lunar surface and lay the foundation for extending human presence across the solar system.**					**None**	**Green**
APG 10CS12	Conduct the Lunar Capabilities SRR to define the lunar mission architecture requirements.	Constellation Systems	Cx Systems Program				
APG 10AC15	Develop concepts for manufacturing 10-meter diameter composite structures for the Ares V launch vehicle.	Advanced Capabilities	Lunar Precursor Robotic Program (LPRP)				
APG 10AC16	Test prototype main engine for Altair lunar lander ascent stage using liquid oxygen and liquid methane propellants.	Advanced Capabilities	LPRP				
APG 10AC17	Complete LRO's primary mission and deposit 50% of the data to the Planetary Data System.	Advanced Capabilities	LPRP				
APG 10AC18	Complete the Lunar Crater Observation and Sensing Satellite (LCROSS) mission.	Advanced Capabilities	LPRP				
APG 10DIO01	Conduct at least 3 multilateral workshops with international space agencies to discuss the potential for international participation in the exploration of the lunar surface.	Constellation Systems	Cx Systems Program				
APG 10OER01	Facilitate the exchange of at least 10 letters between the NASA Administrator and his/her international space agency counterparts, introducing the Administrator and outlining his/her vision for international cooperation.	AMO	Agency Management				

FY 2010 Performance Plan

Measure	Description	Contributing Theme(s)	Contributing Program(s)	Multi-year Outcome ratings FY 05	FY 06	FY 07	FY 08
	EDUCATION						
Outcome ED.1	**Contribute to the development of the Science, Technology, Engineering and Math (STEM) workforce in disciplines needed to achieve NASA's Strategic Goals, through a portfolio of investments.**			Green	Green	Green	Green
APG 10ED01	Support the development of 60 new or revised courses targeted at the STEM skills needed by NASA.	Education	Education Program				
APG 10ED02	Serve 200 institutions in designated EPSCoR states.	Education	Education Program				
APG 10ED03	Serve 8,500 under-represented and under-served students in NASA higher education programs.	Education	Education Program				
APG 10ED04	Achieve 60% employment of student participants in FY 2009 NASA higher education programs by NASA, aerospace contractors, universities, and other educational institutions.	Education	Education Program				
APG 10ED05	Achieve 45% pursuit of advanced education in NASA-related disciplines of undergraduate students in FY 2009 NASA higher education programs	Education	Education Program				
APG 10WF11	Provide equal opportunity (EO) onsite assessment and technical assistance to three STEM programs receiving NASA funding, and EO technical assistance to an additional 25 NASA-funded STEM programs.	AMO	Agency Management				
Outcome ED.2	**Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers and faculty.**						Green
APG 10ED06	Achieve 50% or greater level of interest in science, technology, engineering and math (STEM) careers among elementary and secondary students participating in NASA education programs.	Education	Education Program				
APG 10ED07	Increase to 60% the percentage of elementary and secondary educators who either obtain NASA content-based education resources or participate in short-duration NASA education activities, and use NASA resources in their classroom instruction (a 1% annual increase above the FY 2007 baseline of 55%).	Education	Education Program				
APG 10ED08	Increase to 470,000 the number of elementary and secondary student participants in NASA instruction and enrichment activities (a 5% annual increase above the FY 2007 baseline of 408,774).	Education	Education Program				
APG 10ED09	Assure, in FY 2010, 75% of elementary and secondary educators who participate in NASA training programs use NASA resources in their classroom instruction, an annual increase of 5% in the FY 2007 baseline of 62%.	Education	Education Program				

FY 2010 Performance Plan

Measure	Description	Contributing Theme(s)	Contributing Program(s)	Multi-year Outcome ratings FY 05	FY 06	FY 07	FY 08
Outcome ED.3	**Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA's mission.**			Green	None	Green	Green
10ED10	Assure that at least 350 museums and space centers across the country actively engage the public through NASA content.	Education	Education Program				
	AGENCY SUPPORT (Contributions from Cross Agency Support (CAS) and Programmatic Appropriation Accounts)						
Outcome AS.1	**Develop, implement, and maintain modern, secure, and high-quality information technology systems and infrastructure to achieve agency mission objectives with the lowest life-cycle cost and least risk.**						
APG 10IT01	Complete migration to the NASA Consolidated Active Directory.	AMO; Center Management & Operations (CMO)	Agency IT Services (AITS)				
APG 10IT02	Complete Operational Readiness Review (ORR) for the NASA Communications Initiative.	AMO; CMO	AITS				
APG 10IT03	Complete integration of Personal Identity Verification (PIV) cards with the desktop.	AMO; CMO	AITS				
APG 10IT04	Complete planned capacity increase to the NASA Wide Area Network.	AMO; CMO	AITS				
APG 10IT05	Complete planned upgrades to networks at Ames Research Center, Glenn Research Center, Goddard Space Flight Center, Kennedy Space Center, Marshall Space Flight Center, and Stennis Space Center.	AMO; CMO	AITS				
APG 10IT06	Complete Operational Readiness Review (ORR) for the NASA Security Operations Center.	AMO; CMO	AITS				
APG 10IT07	By 2010, increase reutilizations of accountable personal property by 2% from the baseline of 5%.	AMO; CMO	AITS				
APG 10IT08	In FY 2010, increase the percentage of total travel bookings completed on-line to at least 60% (baseline is 1.8%).	AMO; CMO	AITS				
APG 10IT09	In FY 2010, increase the total number of solicitations developed in PRISM to at least 80%.	AMO; CMO	AITS				
APG 10IT10	Reduce runtimes of the most heavily accessed Business Warehouse reports by at least 40%.	AMO; CMO	AITS				
Outcome AS.2	**Develop and align workforce strategies, programs, policies and processes to be consistent with the Agency's mission.**						
APG 10WF01	Complete all FY 2010 planned actions for the FY 2008-FY 2010 NASA Model EEO Agency Plan.	AMO; CMO	Agency Management				
APG 10WF02	Complete development of the Agency strategy for deployment of a diversity and inclusion framework.	AMO; CMO	Agency Management				
APG 10WF03	Complete implementation of a certification program to ensure that Program and Project Managers meet Federal Acquisition Certification Requirements before or within one year of assuming leadership of major acquisition projects.	AMO; CMO	Safety & Mission Success (SMS)				

FY 2010 Performance Plan

Measure	Description	Contributing Theme(s)	Contributing Program(s)	Multi-year Outcome ratings FY 05	FY 06	FY 07	FY 08
APG 10WF04	Complete full roll-out of the new mid-level leadership development program, targeted at the GS13 through GS15 levels, to ensure continued development of a cadre of potential future NASA leaders and support succession management efforts.	AMO; CMO	Agency Management				
APG 10WF05	Engage with the Mission Directorates, Centers and Mission Support offices in the development of a 5-year workforce plan, matching workforce capabilities with mission needs. Eliminate unassigned civil service workforce in all years of the planning horizon.	AMO; CMO	Agency Management				
APG 10WF06	By March 2010, complete Phase 4 of Shuttle Transition workforce mapping to identify final detailed Shuttle workforce composition and disposition issues and any required actions.	AMO; CMO	Agency Management				
Outcome AS. 3	**Ensure the strategic availability and maintenance of facilities which are necessary to meet the long-term needs and requirements of the Agency.**						
APG 10FAC01	Assure that at least 50% of the NASA Centers have updated their Master Plans to implement Agency Strategic Direction from the Facilities Program Board.	Institutional Investments; AMO; CMO	Agency Management				
APG 10FAC02	Perform a test case review of one of the Agency's major technical portfolios to determine consolidations and/or investments.	AMO; CMO; Strategic Capabilities Assets Program	Agency Management				
APG 10FAC03	Conduct a facility requirements review for the Altair Project requirements through qualification testing.	AMO; CMO	Agency Management				
Outcome AS.4	**While promoting mission success, protect the public, NASA workforce, high-value equipment and property from potential harm as a result of NASA activities and operations by factoring safety, quality, risk, reliability and maintainability as integral features of programs, projects, technologies, operations, and facilities.**						
APG 10SMS01	No fatalities or permanent disabling injuries to the public resulting from NASA activities during fiscal year.	AMO; CMO	SMS				
APG 10SMS02	No fatalities or permanent disabling injuries to the NASA workforce resulting from NASA activities during fiscal year.	AMO; CMO	SMS				
APG 10SMS03	Reduce damage to NASA assets by 10% per fiscal year.	AMO; CMO	SMS				
APG 10SMS04	Maximize achievement of mission success criteria for all NASA programs/projects in the fiscal year.	AMO; CMO	SMS				

FY 2010 Performance Plan

Measure	Description	Contributing Theme(s)	Contributing Program(s)	Multi-year Outcome ratings FY 05	FY 06	FY 07	FY 08
Outcome AS.5	**Implement the space communications and navigation architecture and provide space launch capabilities responsive to existing and future science and space exploration mission requirements.**						
APG 10SFS06	Complete the assessment of Array Antenna size in support of the long term plans for the 70 meter antenna decommissioning and replacement.	Space & Flight Support	Space Com-munications & Navigation (SCaN)				
APG 10SFS07	Complete TDRS K/L Project Mission Operations Review (MOR).	Space & Flight Support	SCaN				
APG 10SFS08	Complete SN Ground Segment Sustainment project (SGSS) Mission Definition Review (MDR).	Space & Flight Support	SCaN				
APG 10SFS09	Identify agency rocket propulsion test core capabilities (both infrastructure and critical skills) and maintain them at appropriate levels to be able to meet NASA's current and future rocket testing requirements, and deliver an integrated agency-level Rocket Propulsion Test Plan that spans the next ten years and includes DoD and commercial partner requirements and capabilities, as appropriate.	Space & Flight Support	Rocket Propulsion Testing				
APG 10SFS10	Maintain or acquire launch services capabilities (both infrastructure and skills) at levels needed to meet NASA's current and future launch services requirements efficiently and effectively.	Space & Flight Support	Rocket Propulsion Testing				
APG 10SFS11	Complete 100% of Launch Service objectives for all NASA-managed expendable launches in FY 2010 as specified in the Interface Control Document for each mission.	Space & Flight Support	Rocket Propulsion Testing				

FY 2010 Performance Plan

Uniform and Efficiency Measures

Measure	Description
Advanced Capabilities Theme	
APG 10AC13	Complete all development projects within 110% of the cost and schedule baseline.
APG 10AC14	Demonstrate improvements in the EVA Work Efficiency Index for astronauts using a small, pressurized rover with suit-ports compared to astronauts using an unpressurized rover. Work efficiency index=(time to complete a task)/(total time to prepare for EVA).
Aeronautics Theme	
APG 10AT13	Deliver at least 96% of "on-time availability" for all operations and research facilities.
Agency Management & Operations Theme	
APG 10IT11	Complete all development projects within 110% of the cost and schedule baseline.
APG 10IT12	In 2010, reduce the amount of system execution time during the year end close process by six hours.
APG 10IT13	Deliver at least 90% of scheduled operating hours for all operations.
APG 10WF07	Using the Agency's Staffing and Recruitment System, NASA STARS, complete hiring actions–from date of vacancy announcement closing to the time an offer is made–within 45 days.
APG 10IPP08	Achieve a number of technology commercialization success from SBIR/STTR Phase II contracts through FY 2010 to equal 21% of the total number of SBIR/STTR contracts issued over the prior 5 years, including FY 2010.
Astrophysics Theme	
APG 10AS11	Complete all development projects within 110% of the cost and schedule baseline.
APG 10AS12	Deliver at least 90% of scheduled operating hours for all operations and research facilities.
APG 10AS13	Peer-review and competitively award at least 95%, by budget, of research projects.
APG 10AS14	Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.
Constellation Systems Theme	
APG 10CS13	Complete all development projects within 110% of the cost and schedule baseline.
APG 10CS14	Total annual cost of Constellation operations activities for the first full year after full operational capability, will be no greater than 70% of comparable annual shuttle operations costs (reference year FY 2007).
Earth Science Theme	
APG 10ES17	Complete all development projects within 110% of the cost and schedule baseline.
APG 10ES18	Deliver at least 90% of scheduled operating hours for all operations and research facilities.
APG 10ES19	Peer-review and competitively award at least 90%, by budget, of research projects.
APG 10ES20	Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 227 days.
Education Theme	
APG 10ED11	Reduce the dollar invested per number of page views for the NASA Education website.
APG 10ED12	Reduce the cost per elementary and secondary school program participant over FY 2009 amounts by 2%.
Heliophysics Theme	
APG 10HE09	Complete all development projects within 110% of the cost and schedule baseline.
APG 10HE12	Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.

FY 2010 Performance Plan

Uniform and Efficiency Measures

Measure	Description
International Space Station Theme	
APG 10ISS09	Deliver at least 90% of scheduled operating hours for all operations and research facilities.
Planetary Science Theme	
APG 10PS11	Complete all development projects within 110% of the cost and schedule baseline.
APG 10PS12	Deliver at least 90% of scheduled operating hours for all operations and research facilities.
APG 10PS13	Peer-review and competitively award at least 95%, by budget, of research projects.
APG 10PS14	Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.
Space and Flight Support Theme	
APG 10SFS12	Achieve at least 99% Space Network proficiency for delivery of Space Communications services.
APG 10SFS13	Complete all development projects within 110% of the cost and schedule baseline.
APG 10SFS14	Ratio of Launch Services program cost per mission to average spacecraft cost, reduced to 6.2%.
Space Shuttle Theme	
APG 10SSP06	Deliver at least 90% of scheduled operating hours for all operations and research facilities.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION PROPOSED APPROPRIATION LANGUAGE

SCIENCE

For necessary expenses, not otherwise provided for, in the conduct and support of science research and development activities, including research, development, operations, support, and services; maintenance; construction of facilities including repair, rehabilitation, revitalization, and modification of facilities, construction of new facilities and additions to existing facilities, facility planning and design, and restoration, and acquisition or condemnation of real property, as authorized by law; environmental compliance and restoration; space flight, spacecraft control, and communications activities; program management; personnel and related costs, including uniforms or allowances therefore, as authorized by 5 U.S.C. 5901–5902; travel expenses; purchase and hire of passenger motor vehicles; and purchase, lease, charter, maintenance, and operation of mission and administrative aircraft, $4,477,200,000 to remain available until September 30, 2011.

AERONAUTICS

For necessary expenses, not otherwise provided for, in the conduct and support of aeronautics research and development activities, including research, development, operations, support, and services; maintenance; construction of facilities including repair, rehabilitation, revitalization, and modification of facilities, construction of new facilities and additions to existing facilities, facility planning and design, and restoration, and acquisition or condemnation of real property, as authorized by law; environmental compliance and restoration; space flight, spacecraft control, and communications activities; program management; personnel and related costs, including uniforms or allowances therefore, as authorized by 5 U.S.C. 5901–5902; travel expenses; purchase and hire of passenger motor vehicles; and purchase, lease, charter, maintenance, and operation of mission and administrative aircraft, $507,000,000 to remain available until September 30, 2011.

EXPLORATION

For necessary expenses, not otherwise provided for, in the conduct and support of exploration research and development activities, including research, development, operations, support, and services; maintenance; construction of facilities including repair, rehabilitation, revitalization, and modification of facilities, construction of new facilities and additions to existing facilities, facility planning and design, and restoration, and acquisition or condemnation of real property, as authorized by law; environmental compliance and restoration; space flight, spacecraft control, and communications activities; program management, personnel and related costs, including uniforms or allowances therefore, as authorized by 5 U.S.C. 5901–5902; travel expenses; purchase and hire of passenger motor vehicles; and purchase, lease, charter, maintenance, and operation of mission and administrative aircraft, $3,963,100,000 to remain available until September 30, 2011.

SPACE OPERATIONS

For necessary expenses, not otherwise provided for, in the conduct and support of space operations research and development activities, including research, development, operations, support and services; space flight, spacecraft control and communications activities including operations, production, and services; maintenance; construction of facilities including repair, rehabilitation, revitalization and modification of facilities, construction of new facilities and additions to existing facilities, facility planning and design, and restoration, and acquisition or condemnation of real property, as authorized by law; environmental compliance and restoration; program management; personnel and related costs, including uniforms or allowances therefore, as authorized by 5 U.S.C. 5901–5902; travel expenses; purchase and hire of passenger motor vehicles and purchase, lease, charter, maintenance and operation of mission and administrative aircraft, $6,175,600,000, to remain available until September 30, 2011.

EDUCATION

For necessary expenses, not otherwise provided for, in carrying out aerospace and aeronautical education research and development activities, including research, development, operations, support, and services; program management; personnel and related costs, uniforms or allowances therefore, as authorized by 5 U.S.C. 5901–5902; travel expenses; purchase and hire of passenger motor vehicles; and purchase, lease, charter, maintenance, and operation of mission and administrative aircraft, $126,100,000, to remain available until September 30, 2011.

CROSS AGENCY SUPPORT

For necessary expenses, not otherwise provided for, in the conduct and support of science, aeronautics, exploration, space operations and education research and development activities, including research, development, operations, support, and services; maintenance; construction of facilities including repair, rehabilitation, revitalization, and modification of facilities, construction of new facilities and additions to existing facilities, facility planning and design, and restoration, and acquisition or condemnation of real property, as authorized by law; environmental compliance and restoration; space flight, spacecraft control, and communications activities; program management; personnel and related costs, including uniforms or allowances therefore, as authorized by 5 U.S.C. 5901–5902; travel expenses; purchase and hire of passenger motor vehicles; not to exceed $70,000 for official reception and representation expenses; and purchase, lease, charter, maintenance, and operation of mission and administrative aircraft, $3,400,600,000, to remain available until September 30, 2011.

OFFICE OF INSPECTOR GENERAL

For necessary expenses of the Office of Inspector General in carrying out the Inspector General Act of 1978, $36,400,000, to remain available until September 30, 2011.

ADMINISTRATIVE PROVISIONS
(INCLUDING TRANSFER OF FUNDS)

Notwithstanding the limitation on the duration of availability of funds appropriated to the National Aeronautics and Space Administration for any account in this Act, except for “Office of Inspector General,” when any activity has been initiated by the incurrence of obligations for environmental compliance and restoration activities as authorized by law, such amount available for such activity shall remain available until expended.

Notwithstanding the limitation on the duration of availability of funds appropriated to the National Aeronautics and Space Administration for any account in this Act, except for “Office of Inspector General,” the amounts appropriated for construction of facilities shall remain available until September 30, 2014.

Funds for announced prizes otherwise authorized shall remain available, without fiscal year limitation, until the prize is claimed or the offer is withdrawn.

Not to exceed 5 percent of any appropriation made available for the current fiscal year for the National Aeronautics and Space Administration in this Act may be transferred between such appropriations, but no such appropriation, except as otherwise specifically provided, shall be increased by more than 10 percent by any such transfers. Any transfer pursuant to this provision shall be treated as a reprogramming of funds under section 505 of this Act and shall not be available for obligation except in compliance with the procedures set forth in that section.

The unexpired balances of the Science, Aeronautics, and Exploration account, for activities for which funds are provided under this Act, may be transferred to the new accounts established in this Act that provide such activity. Balances so transferred shall be merged with the funds in the newly established accounts, but shall be available under the same terms, conditions and period of time as previously appropriated.

Funding designations and minimum funding requirements contained in any other Act shall not be applicable to funds appropriated by this title for the National Aeronautics and Space Administration.

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Reference: Acronyms

AA	Associate Administrator
AAD	Aircraft Aging and Durability
ABS	Advanced Business System
AC	Advanced Capabilities
ACCESS	Advanced Collaborative Connections for Earth System Science
ACE	Advanced Composition Explorer
ACES	Airspace Concepts Evaluation System
ACIS	Advanced CCD Imaging Spectrometer
ACRIMSat	Active Cavity Radiometer Irradiance Monitor Satellite
ACS	Advanced Camera for Surveys (Hubble Space Telescope instrument)
ADA	Associate Deputy Administrator
ADCAR	Astrophysics Data Curation and Archival Research
ADFT	Ascent Development Flight Test
ADP	Advanced Development Project
ADS	Astrophysics Data System
AEDC	Arnold Engineering Development Center
AEH	Advanced Environmental Health
AEMC	Advanced Environmental Monitoring and Control
AESP	Aerospace Education Services Program
AFB	Air Force Base
AFOSR	Air Force Office of Scientific Research
AFRL	Air Force Research Laboratory
AIA	Atmospheric Imaging Assembly (Solar Dynamics Observatory instrument)
AIM	Aeronomy of Ice in the Mesosphere
AirSAR	Airborne Synthetic Aperture Radar
AISR	Applied Information Systems Research
AITS	Agency Information Technology Services
ALI	Advanced Land Imager
ALS	Aircraft Logistics System
ALV	Air Launch Vehicle
AMM	Aircraft Management Module
AMMOS	Advanced Multi-Mission Operations System
AMMP	Aircraft Maintenance and Modification Program
AMO	Agency Management and Operations
AMR	Advanced Microwave Radiometer (Ocean Surface Topography Mission instrument)
AMS	Alpha Magnetic Spectrometer
AMSR-E	Advanced Microwave Scanning Radiometer for the Earth Observing System
ANSP	Air Navigation Service Provider
AO	Announcement of Opportunity
APG	Annual Performance Goal
APL	Applied Physics Laboratory (Johns Hopkins University)
APPEL	Academy of Program/Project and Engineering Leadership
APR	Annual Performance Report
APS	Advanced Polarimeter Sensor (Glory instrument)
ARC	Ames Research Center
ARISS	Amateur Radio on the International Space Station
ARMD	Aeronautics Research Mission Directorate
AS&T	Aeronautics Science and Technology
ASAP	Aerospace Safety Advisory Panel
ASE	Aero-Servo-Elastic
ASI	Agenzia Spaziale Italiana (Italian Space Agency)
ASP	Airspace Systems Program
ASPERA-3	Analyzer of Space Plasma and Energetic Atoms-3
ASR	Aviation Safety Report
ASRG	Advanced Stirling Radioisotope Generator
ASSP	Architecture for Survivable System Processing
AST	Advanced Subsonic Technology
ASTER	Advanced Spaceborne Thermal Emission Reflection Radiometer
ASVM	Aircraft and Systems Vulnerability Mitigation
ATG	Airspace Traffic Generator
ATLO	Assembly, Test and Launch Operations
ATM	Air Traffic Management
ATMS	Advanced Technology Microwave Sounder (NPOESS Preparatory Project instrument)
ATP	Aeronautics Test Program
ATV	Automated Transfer Vehicle
AU	Astronomical unit
AuRA	Autono Robust Avionics
AVIRIS	Airborne Visible/Infrared Imaging Spectrometer
AvSP	Aviation Safety Program
AvSa	Aviation Safety
BARREL	Balloon Array for Radiation-belt Relativistic Electron Losses
BATC	Ball Aerospace and Technology Corporation
BCAT-4	Binary Critical Aggregation Test- 4
BCP	Ball Commercial Platform
BE	Beyond Einstein
BEPAC	Beyond Einstein Program Assessment Committee
BFELoB	Budget Formulation and Execution Line of Business
BFEM	Budget Formulation Execution Manager
BHP	Behavioral Health and Performance
BPI	Budget Performance and Integration
BSIG	Business Systems Integration Group
BWB	Blended Wing Body
BWG	Beam Wave Guide
C&DH	Command and Data Handling
C3I	Command, Control, Communication Information
C3P	Commercial Cargo Crew Project
C3PO	Commercial Cargo Crew Program Office
C3S	Command, Control, and Communication Segment
C4P	Commercial Cargo Crew Capability Project

CAEP	Committee on Aviation Environmental Protection
CALIOP	Cloud-Aerosol LIdar with Orthogonal Polarization
CALIPSO	Cloud–Aerosol Lidar and Infrared Pathfinder Satellite Observations
CaLV	Cargo Launch Vehicle
CAN	Cooperative Agreement Notice
CAPTEM	Curation and Analysis Planning Team for Extraterrestrial Materials
CARA	California Association for Research in Astronomy
CARD	Constellation Architectural Requirements Document
CAS	Cross-Agency Support
CASP	Cross Agency Support Programs
CAST	Commercial Aviation Safety Team
CCD	Charge Coupled Device
CCMC	Community Coordinated Modeling Center
CCRI	Climate Change Research Initiative
CCSP	Climate Change Science Program
CDAP	Cassini Data Analysis Program
CDC	Centers for Disease Control
CDI	Congressionally Directed Items
CDL	Center for Distance Learning
CDR	Critical Design Review
CERES	Clouds and the Earth's Radiant Energy System
CESR	Centre d'Etude Spatiale des Rayonnements
CEU	Combined Electronics
CEV	Crew Exploration Vehicle
CFD	Computational Fluid Dynamics
CFE	Capillary Flow Experiment
CFM	Cryogenic Fluid Management
CFO	Chief Financial Officer
CGA	Corporate G&A
CGRO-EGRET	Compton Gamma-Ray Observatory–Energetic Gamma-Ray Experiment Telescope
ChemCam	Chemistry Camera
CheMin	Chemistry & Mineralogy Instrument
CHIPS	Cosmic Hot Interstellar Plasma Spectrometer
CHS	Crew Health and Safety
CI	Counter-intelligence
CICT	Computing, Information and Communications Technology
CINDI	Coupled Ion Neutral Dynamics Investigation
CIO	Chief Information Officer
CIPAIR	Curriculum Improvement Partnership Award for the Integration of Research
CIR	Combustion Integrated Rack
CIRA	Cooperative Institute for Research in the Atmosphere
CLARREO	Climate Absolute Radiance and Refractivity Observatory
CLV	Crew Launch Vehicle
CM&O	Center Management and Operations
CMAO	Contract Management Assistance Officer
CMB	Cosmic Microwave Background
CMC	Cargo Mission Contract
CME	Continuing Medical Education
CME	Coronal Mass Ejection
CMM	Contract Management Module
CMO	Center Management and Operations
CNES	Centre Nationale D'Etudes Spatiale (French Space Agency)
CO	Carbon Monoxide
CO2	Carbon Dioxide
COBE	Cosmic Background Explorer
CoF	Construction of Facilities
CONAE	Argentina's National Committee of Space Activities
CoNNeCT	Communication Navigation and Networking Reconfigurable Testbed
CONTOUR	Comet Nucleus Tour
CO-OP	Cooperative-Education
CORE	Central Operation of Resources for Educators
COS	Cosmic Origins Spectrograph
COTF	Classroom of the Future
COTR	Contracting Officer Technical Representative
COTS	Commercial Orbital Transportation Services
CPHS	Committee on the Protection of Human Subjects
C/NOFS	Communication/Navigation Outage Forecast System
CRaTER	Cosmic Ray Telescope for the Effects of Radiation
CRI	Center for Rotorcraft Innovation
CrIS	Cross-track Infrared Sounder (NPOESS Preparatory Project instrument)
CSA	Canadian Space Agency
CSAR	Cost and Schedule Analysis Report
CSC	Computer Sciences Corporation
CSI	Constellation Services International
CSPE	Colorimetric Solid Phase Extraction
CT	Counter-terrorism
CVB	Constrained Vapor Bubble
Cx	Constellation Systems
CxRS	Constellation Reconfiguration System
CxTF	Constellation Training Facility
CY	Calendar Year
CZAP	Center Zoned Architecture Project
DAAC	Distributed Active Archive Centers
DAFT	Dust and Aerosol Measurement Facility Test
DAN	Dynamic Albedo of Neutrons
DAP	Data Analysis Program
DARPA	Defense Advanced Research Projects Agency
DCAA	Defense Contract Audit Agency
DCAS	Defense Contract Audit Service
DDAP	Discovery Data Analysis Program
DDT&E	Design, Development, Test, and Evaluation
DERA	Defense Evaluation and Research Agency

DESDynI	Deformation, Ecosystem Structure, and Dynamics of Ice
DEVELOP	Digital Earth Virtual Environment and Learning Outreach Program
DFRC	Dryden Flight Research Center
DIXI	Deep Impact Extended Investigation of Comets
DLN	Digital Learning Network
DLR	Deutches Zentrum für Luft- Raumfahrt (German Aerospace Center)
DM	Demonstration motors
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of Interior
DOL	Department of Labor
DORIS	Doppler Orbitography by Radiopositioning Integrated by Satellite (Ocean Surface Topography Mission instrument)
DOT	Department of Transportation
DPR	Dual-frequency Precipitation Radar (Global Precipitation Measurement instrument)
DRS	Disturbance Reduction System
DSI	Deutsches SOFIA Institut
DSMS	Deep Space Mission System
DSN	Deep Space Network
DSX	Deployable Structures Experiment
DTN	Disruption Tolerant Networking
DUNS	Data Universal Numbering System
D&B	Dun and Bradstreet
E&PO	Education and Public Outreach
EA	Enterprise Architecture
EAFB	Elmendorf Air Force Base
EAP	Educator Astronaut Program
EarthKAM	Earth Knowledge Acquired by Middle School Students
EAS	Efficient Aircraft Spacing
EASI	Efficient Aerodynamic Shapes and Integration
ECANS	Exploration Communication and Navigation Systems
ECC	Education Coordinating Committee
ECLSS	Environmental Control and Life Support System
ECR	Environmental Compliance and Restoration
ECT	Energetic Particle, Composition and Thermal Plasma
ED	Education
EDL	Entry, Descent, and Landing
EDMD	Exploration Technology Development Program
EDS	Earth Departure Stage
EEE	Evolution of EOSDIS Elements
EELV	Evolved Expendable Launch Vehicle
EEO	Equal Employment Opportunity
EFASC	Electric Field and Search Coil
EF	Exposed Facility
EFI	Electric Field Instrument (Thermal Emission Imaging System instrument)
EFPO	Education Flight Projects
EFPM	Efficient Flight Path Management
EFW	Electric Field and Waves
EGRET	Energetic Gamma Ray Experiment Telescope
EHRI	Enterprise Human Resources Integration
EIRB	Extragalactic Infrared Background
EIS	Extreme Ultraviolet Imaging Spectrometer
EJSM	Europa Jupiter System Mission
ELC	ExPRESS Logistics Carrier
ELM-ES	Experiment Logistics Module- Exposed Section
ELC	ExPRESS Logistics Carriers
ELV	Expendable Launch Vehicle
EMA	Educational Media Archives
EMC	Exploration Medical Capability
EMFISIS	Electric and Magnetic Field Instrument Suite and Integrated Science
ENA	Energetic Neutral Atom
ENose	Electronic nose
EO-1	Earth Observing One Mission
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
EP/TOMS	Earth Probe/ Total Ozone Mapping Spectrometer
EPA	Environmental Protection Agency
EPN	Effective Perceived Noise
EPNdB	Effective Perceived Noise in Decibels
e-PD	e-Professional Development
EPOCh	Extrasolar Planet Observations and Characterization
EPOXI	Extrasolar Planet Observation and Deep Impact Extended Investigation
EPSCoR	Experimental Program to Stimulate Competitive Research
ERA	Environmentally Responsible Aviation
ERBS	Earth Radiation Budget Sensor
ESA	European Space Agency
ESAS	Exploration Systems Architecture Study
ESES	Electrical Systems Engineering Services
ESD	Earth Science Division
ESDR	Earth System Data Records
ESM	Earth Systematic Missions
ESMD	Exploration Systems Mission Directorate
ESRT	Exploration Systems Research and Technology
ESS	Earth Systems Science
ESSAC	NASA Earth System Science and Applications Advisory Committee
ESSP	Earth System Science Pathfinder
ESTCP	Endeavor Science Teach Certificate Program
ESTO	Earth Science Technology Office
ESTP	Earth Science Technology Program
ET	External Tank
ETD	Exploration Technology Development
ETDP	Exploration Technology Development Program
ETM	Enhanced Thematic Mapper

EUSO	Extreme Universe Space Observatory
EUV	Extreme-Ultraviolet
EVA	Extravehicular Activity
EVE	Extreme-ultraviolet Variability Experiment (Solar Dynamics Observatory instrument)
EVM	Earned Value Management
EXEP	Exoplanet Exploration Program
ExPRESS	Expedite the Processing of Experiments to the Space Station
FA	Fundamental Aeronautics
FAA	Federal Aviation Administration
FACET	Future Air Traffic Management Concepts Evaluation
FAP	Fundamental Aeronautics Program
FAR	Faculty Awards for Research
FAR	Federal Acquisition Regulation
FAST	Facilitated Access to the Space Environment for Technology Development and Training
FAST	Fast Auroral Snapshot
FC	Framing camera
FCIP	Federal Career Intern Program
FCOD	Flight Crew Operations Directorate
FDA	Federal Drug Administration
FDCC	Federal Desktop Core Configuration
FDMS	Federal Data Management System
FEA	Federal Enterprise Architecture
FEAC	Federal Enterprise Architecture Certification
FFATA	Federal Funding Accountability and Transparency Act
FFMIA	Federal Financial Management Improvement Act of 1996
FFS	Fee for service
FGM	Fluxgate Magnetometer (Thermal Emission Imaging System instrument)
FGS	Fine Guidance Sensor
FIPS	Federal Information Processing Standard
FIRST	For Inspiration and Recognition of Science andTechnology
FLEX	Flame Extinguishment Experiment
FLITECAM	First Light Infrared Test Experiment Camera
FLX	Flight Experiment
FMA	Force = Mass x Acceleration
FMI	Finnish Meteorological Institute
FMLoB	Financial Management Line of Business
FOC	Full Operational Capability
FOSS	Fiber Optic Strain System
FPA	Focal Plane Array
FPP	Focal Plane Package
FPPS	Federal Personnel and Payroll System
FS	First Stage
FTE	Full Time Equivalency
FTP	Foundational Technology Program
FTV	Flight Test Vehicle
FUSE	Far Ultraviolet Spectroscopic Explorer
FUV	Far Ultraviolet
FY	Fiscal Year
G&A	General and Administrative
GALEX	Galaxy Evolution Explorer
GAO	Government Accountability Office
GBM	Gamma-ray Burst Monitor (Gamma-ray Large Area Telescope instrument)
GCCE	Global Climate Change Education
GCRP	Global Change Research Program
GEO	Geosynchronous Earth Orbit
GEOSS	Global Earth Observation System of Systems
GES DAAC	GSFC Earth Science Distributed Active Archive Center
GeV	Gigaelectron volt
GHz	Gigahertz
GI	Guest Investigator
GIFTS	Geosynchronous Imaging Fourier Transform Spectrometer
GIP	Guest Investigator Program
GISS	Goddard Institute for Space Studies
GLAST	Gamma–ray Large Area Space Telescope
GLOBE	Global Learning and Observations to Benefit the Environment
GMAO	Global Modeling and Assimilation Office
GMI	GPM Microwave Imager (Global Precipitation Measurement instrument)
G-MOO	Geospace Missions of Opportunity
GN	Ground Networks
GNC	Guidance, navigation and control
GO	Ground Operations
GOES	Geostationary Operational Environmental Satellite
GOLD	Global-scale Observations of the Limb and Disk
GOME-2	Global Ozone Monitoring Experiment-2
GP–B	Gravity Probe–B
GPM	Global Precipitation Measurement
GPRA	Government Performance Results Act of 1993
GPS	Global Positioning System
GRACE	Gravity Recovery and Climate Experiment
GRAIL	Gravity Recovery and Interior Laboratory
GRaND	Gamma Ray and Neutron Detector
GRB	Gamma Ray Burst
G-RBSP	Geospace- Radiation Belt Storm Probes
GRC	Glenn Research Center
GRC-PBS	Glenn Research Center–Plum Brook Station
GREAT	German Receiver for Astronomy at Terahetz
GRGT	Guam Remote Ground Terminal
GSA	General Services Administration
GS	Ground Support
GSFC	Goddard Space Flight Center
GSRP	Graduate Student Research Project
GSSR	Goldstone Solar System Radar
GWAC	Government Wide Acquisition Contracts
HALE	High-Altitude, Long-Endurance
HBCU	Historically Black Colleges and Universities

HCAS	Human Capital Accountability System
HCIE	Human Capital Information Environment
HE	Higher Education Project
HECC	High End Computing Capability
HETE–2	High Energy Transient Explorer
HETG	High Energy Transmission Grating
HFFF	Hyper-velocity Free Flight Facility
HFI	High Frequency Instrument
HFT	Hypersonic Tunnel Facility
HgCdTe	Mercury-Cadmium-Telluride
HHC	Health and Human Countermeasures
HH&P	Human Health & Performance
HHS	Health and Human Services
HIFI	Heterodyne Instrument for the Far Infrared
HIPO	High-speed Imaging Photometer for Occultation
HIRDLS	High Resolution Dynamic Limb Sounder
HIRES	High Resolution Echelle Spectrometer
HiRISE	High Resolution Imaging Science Experiment
HMI	Helioseismic and Magnetic Imager (Solar Dynamic Observatory instrument)
HMMES	High-Mass Mars Entry Systems
HMP	Human Measures and Performance
HPS	Heliophysics Subcommittee
HQ	NASA Headquarters
HR	Human Resource
HRC	High Resolution Camera
HRIS	Human Resources Information System
HRLoB	Human Resources Management Line of Business
HRP	Human Research Program
HRRLS	Highly Reliable Reusable Launch Systems
HSB	Humidity Sounder for Brazil
HSFO	Human Space Flight Operations
HSI	Hispanic Service Institutions
HSPD	Homeland Security Presidential Directive
HSR	High-Speed Research
HSRT	Human Systems Research and Technology
HST	Hubble Space Telescope
HSTS	Heuristic Scheduling Test-bed System
HTF	Hypersonic Test Facility
HTV	H-II Transfer Vehicle
HVAC	Heating, Ventilating and Air Conditioning
HVGR	Hypervelocity Gun Range
HWB	Hybrid Wing Body
Hy-BoLT	Hypersonic Boundary Layer Transition Flight Experiment
I&T	Integration and test
IAE	Integrated Acquisition Environment
IAM	Integrated Asset Management
IAR	Independent Annual Review
IBEX	Interstellar Boundary Explorer
IBPD	Integrated Budget and Performance Document
ICAO	International Civil Aviation Organization
ICC-VLC	Integrated Cargo Carrier - Vertical Light Deployable
ICESat	Ice, Cloud, and Land Elevation Satellite
ICSMR	Budget/management review
IDIQ	Indefinite Delivery Indefinite Quantity
IDPS	Interface Data Processing Segment
IDS	Interdisciplinary Science
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IEMP	Integrated Enterprise Management Program
IFMP	Integrated Financial Management Program
IG	Inspector General
IIFD	Integrated Intelligent Flight Deck
IIRT	Integrated Independent Review Team
ILN	International Lunar Network
IMAGE	Imager for Magnetopause–to–Aurora Global Exploration
IMD	Institutional Management and Dissemination
INPE	Brazilian Institute for Space Research
INSPIRE	Interdisciplinary National Science Program Incorporating Research and Education Experiences
InSPACE-2	Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions - 2
IOC	Initial Operational Capability
IOM	Institute of Medicine
IP	Intellectual Property
IPAC	Infrared Processing and Analysis Center
IPAO	Independent Program Assessment Office
IPCC	International Panel on Climate Change
IPD	Integrated Powerhead Demonstrator
IPIA	Improper Payments Improvement Act
IPO	Integrated Program Office
IPP	Innovative Partnerships Program
IPS	Integrated Planning System
IPY	International Polar Year
IR	Infrared
IRA	Institutional Research Awards
IRAC	Integrated Resilient Aircraft Controls
IRAS	Infrared Astronomical Satellite
IRD	Interface Requirement Document
IRM	Information Resources Management
IRMA	Integrated Risk Management Application
IRSA	NASA/IPAC Infrared Science Archive
IRT	Independent Review Team
ISAS	Institute of Space and Astronautical Science
ISIM	Integrated Science Instrument Module
ISM	Interstellar Medium
ISP	In-Space Propulsion Project
ISRO	Indian Space Research Organization
ISRP	Integrated Systems Research Program
ISRU	In-Situ Resource Utilization
ISS	International Space Station
ISSC	International Space Science Collaboration

ISSMP	International Space Station Medical Program
ISTP	Integrated Space Transportation Plan
IT	Information Technology
ITA	Independent Technical Authority
ITAR	International Traffic in Arms Regulation
ITAS	Integrated Tailored Aerostructures
ITF	Integrated Training Facility
ITI	Integrated Technology Infrastructure
ITILoB	Integrated Technology Infrastructure Line of Business
IUVS	Imaging Ultraviolet Spectrometer
IVHM	Integrated Vehicle Health Management
IV&V	Independent Verification and Validation
IXO	International X-ray Observatory
JADE	Jovian Auroral Distributions Experiment
JAXA	Japan Aerospace Exploration Agency
JBOSC	Joint Base Operations Support Contract
JCAA	Joint Council on Aging Aircraft
JCSDA	Joint Center for Satellite Data Assimilation
JDAP	Jupiter Data Analysis Project
JDEM	Joint Dark Energy Mission
JEDI	Jupiter Energetic particle Detector Instrument
JEM PM	Japanese Experiment Module Pressured Module
JHU	John Hopkins University
JHU-APL	Johns Hopkins University–Applied Physics Laboratory
JOI	Jupiter Orbit Insertion
JPDO	Joint Planning and Development Office
JPFP	Harriet Jenkins Pre-doctoral Fellowship Program
JPL	Jet Propulsion Laboratory
JSC	Johnson Space Center
JSC-WSTF	Johnson Space Center–White Sands Test Facility
JSG	Joint Steering Group
JSOST	Joint Sub-Committee on Ocean Science And Technology
JWST	James Webb Space Telescope
KaPR	Ka-band Precipitation Radar
KDP	Key Decision Point Review
KeV	Kiloelectron Volts
KHz	Kilohertz
KI	Keck Interferometer
KNMI	Royal Netherlands Meteorological Institute
KSC	Kennedy Space Center
KuPR	Ku precipitation radar
kW	Kilowatt
LADEE	Lunar Atmosphere and Dust Environment Explorer
LAMP	Lyman-Alpha Mapping Project
LAN	Local Area Network
LANL	Los Alamos National Laboratory
LaRC	Langley Research Center
LAS	Launch Abort System
LASER	Lunar Advanced Science and Exploration Research
LASP	Laboratory for Atmospheric and Space Physics (University of Colorado, Boulder)
LAT	Large Area Telescope (Gamma-ray Large Area Telescope instrument)
LBT	Large Binocular Telescope
LBTI	Large Binocular Telescope Interferometer
LCC	Launch Control Center
LCC	Life-Cycle-Cost
LCCR	Lunar Capability Concept Review
LCROSS	Lunar Crater Observation and Sensing Satellite
LDCM	Landsat Data Continuity Mission
LDEX	Lunar Dust EXperiment
LEAP	Low Emissions Alternative Power
LEARN	Learning Environments and Research Network
LEED	Leadership in Energy and Environment Design
LEND	Lunar Exploration Neutron Detector
LEO	Low Earth Orbit
LETG	Low Energy Transmission Grating
LFI	Low Frequency Instrument
LH2	Liquid Hydrogen
LISA	Laser Interferometer Space Antenna
LMM	Light Microscopy Module
LMS	Launch and Mission Systems
LN2	Liquid Nitrogen
LOLA	Lunar Orbiter Laser Altimeter
LoB	Lines of Business
LOX	Liquid Oxygen
LPRP	Lunar Precursor Robotic Program
LQP	Lunar Quest Program
LRA	Laser Retroreflector Array (Ocean Surface Topography Mission instrument)
LRD	Launch Readiness Date
LRO	Lunar Reconnaissance Orbiter
LROC	Lunar Reconnaissance Orbiter Camera
LRR	Launch Readiness Review
LSAH	Longitudinal Study of Astronaut Health
LSAM	Lunar Surface Access Module
L-SDT	Lunar Science Definition Team
LSCE	Laboratoire des Sciences du Climat et de l'Environment
LSH	Life Support and Habitation
LSP	Launch Services Program
LTP	Learning Technologies Project
LV	Launch Vehicle
LWS	Living with a Star
MA	Multiple Access
MAF	Manufacturing Facility
MAG	Magnetometer
MARDI	Mars Descent Imager
MAVEN	Mars Atmosphere and Volatile EvolutioN

MASTAP	Math Science Teacher and Curriculum Enhancement Program
MCC	Mission Control Center
MCR	Mission Confirmation Review
MD	Mission Directorate
MDAO	Multidisciplinary Design Analysis and Optimization
MDCA	Multi-User Droplet Combustion Apparatus
MDI	Mission Dependency Index
MdM	Metadata Manager
MDR	Mission Design Review
MEaSUREs	Making Earth System data records for Use in Research Environments
MECA	Mars Environmental Compatibility Assessment
MEO	Most Efficient Organization
MEP	Mars Exploration Program
MEPAG	Mars Exploration Program Analysis Group
MESSENGER	Mercury Surface, Space Environment, Geochemistry and Ranging
MET	Meteorology Package
METI	Ministry of Economy Trade and Industry (Japan)
MeV	Mega Electron Volts
MEX	Mars Express
MFMTC	National Force Measurement Technology Capability
MI	Minority Institutions
MIC	Mission Integration Contract
MIDEX	Medium-Class Explorer
Mini-RF	Radiation Frequency
MIRI	Mid-infrared Instrument (James Webb Space Telescope instrument)
MIs	Minority Institutions
MIT	Massachusetts Institute of Technology
MLP	Mobile Launch Platform
MLS	Microwave Limb Sounder
MMOD	Micrometeoroid/ Orbital Debris
MMRTG	Multi-missions Radioisotope Thermoelectric Generators
MMS	Magnetospheric Multiscale
MO	Missions of Opportunity
MO&DA	Mission Operations and Data Analysis
MOA	Memorandum of Agreement
MOE	Mission Operations Element
MoO	Mission of Opportunity
MoonROx	Moon Regolith Oxygen
MOPITT	Measurements of Pollution in the Troposphere
MOR	Mission Operations Review
MOU	Memorandum of Understanding
MPAR	Major Program Annual Report
MPE	Max-Planck-Institut für Extra-terrestriche Physik (Germany)
MPESS	Multi-Purpose Experiment Support Structure
MPLM	Multi-Purpose Logistics Module
MPS	Max-Planck-Institut für Sonnensystemforschung
MRO	Mars Reconnaissance Orbiter
MRM	Mini Research Module
MRR	Mission Requirement Request
MS	Missions Systems
MSFC	Marshall Space Flight Center
MSG	Magnetic Spectrometer
MSI	Minority-Serving Institute
MSL	Mars Science Laboratory
MSR	Mars Sample Return
MSRR	Materials Science Research Rack
MUREP	Minority University Research and Education Program
MUSES-C	Mu Space Engineering Spacecraft–C
MUSS	Multi-User Systems and Support
MUST	Motivating Undergraduate in Science and Technology
NAC	NASA Advisory Committee
NACC	NASA Ames Conference Center
NAFP	NASA Administrator's Fellowship Program
NAMMA	NASA African Monsoon Multidisciplinary Analyses
NAPA	National Academy of Public Administration
NAR	Non-Advocacy Review
NAS	National Airspace System
NASSMC	National Alliance of State Science and Mathematics Coalitions
NCAR	National Center for Atmospheric Research
NCAS	NASA Contract Assurance Services
NCI	NASA Communications Improvement
NCSER	National Center for Space Exploration Research
NEAR	Near-Earth Asteroid Rendezvous
NED	NASA/IPAC Extragalactic Database
NEI	NASA Explorer Institute
NEN	Near Earth Network
NEO	Near-Earth Object
NEOO	Near-Earth Object Observations
NEPER	NASA Education Program Evaluation Review
NES	NASA Explorer School
NESC	NASA Engineering and Safety Center
NETS	NASA Educational Technology Services
NExT	NASA Evolutionary Xenon Thruster
NextGen	Next Generation Air Transportation System
NFS	NASA FAR Supplement
NG	Northrop Grumman
NGATS	Next Generation Air Transportation System
NGIMS	Neutral Gas and Ion Mass Spectrometer
NGLT	Next Generation Launch Technology
NGST	Northrop Grumman Space Technology
NIA	National Institute of Aerospace
NICMOS	Near Infrared Camera and Multi-Object Spectrometer (Hubble Space Telescope instrument)

NIH	National Institute for Health
NIP	New Investigator Program
NIRCam	Near-Infrared Camera
NIRSpec	Near-Infrared Spectrometer
NISN	NASA Integrated Services Network
NIST	National Institute of Science and Technology
NIVR	Netherlands Agency for Aerospace Programmees
NLS	NASA Launch Services
NLSI	NASA Lunar Science Institute
NLT	NASA Learning Technologies
NMO	NASA Management Office
NMP	New Millennium Program
NMSU	New Mexico State University
NOAA	National Oceanic and Atmospheric Administration
NOAA-N	National Oceanic and Atmospheric Administration - NASA
NOFS	Navigation Outage Forecast System
NORCAT	Northern Centre for Advanced Technology, Inc.
NOx	Nitrogen Oxide
NPAT	National Partnership for Aeronautic Testing
NPD	NASA Policy Directive
NPOESS	National Polar–orbiting Operational Environmental Satellite System
NPP	NPOESS Preparatory Project
NPR	NASA Procedural Requirement
NRA	NASA Research Announcement
NRC	National Research Council
NRC	Nuclear Regulatory Commission
NRL	Naval Research Laboratory
NRO	National Reconnaissance Office
NSBRI	National Space Biomedical Research Institute
NSC	NASA Safety Center
NSF	National Science Foundation
NSRL	NASA Space Radiation Laboratory
NSSC	NASA Shared Services Center
NSSDC	National Space Science Data Center
NSTA	National Science Teachers Association
NSTC	National Science and Technology Council
NSTI-MI	NASA Science and Technology Institute for Minority Institutions
NSWPC	National Space Weather Program Council
NuSTAR	Nuclear Spectroscopic Telescope Array
NVO	National Virtual Observatory
NWP	Numerical Weather Prediction
O&SS	Operations and Sustaining Support
OA	Office of Audits
OCE	Office of the Chief Engineer
OCFO	Office of Chief Financial Officer
OCHMO	Office of the Chief Health and Medical Officer
OCIO	Office of Chief Information Officer
OCO	Orbiting Carbon Observatory
OFT	Orbital Flight Test
OGAs	Other Government Agencies
OHCM	Office of Human Capital Management
OI	Office of Investigations
OIG	Office of Inspector General
OLI	Operational Land Imager (Landsat Data Continuity Mission instrument)
OMB	Office of Management and Budget
OMC	Operations Management Council
OMI	Ozone Monitoring Instrument
OMPS	Ozone Mapping and Profiler Suite (NPOESS Preparatory Project instrument)
OMU	Other Minority Universities
ONERA	Office National d'Études et de Recherches Aérospatiales
OPAG	Outer Planets Assessment Group
OPF	Outer Planet Flagship
OPF	Orbiter Processing Facility
OPM	Office of Personnel Management
ORR	Operations Readiness Review
OSC	Orbital Sciences Corporation
OSD	Office of Secretary of Defense
OSIRIS	Origins Spectral Interpretation Resource Identification and Security
OSMA	Office of Safety and Mission Assurance
OSPP	Security and Program Protection
OSTM	Ocean Surface Topography Mission
OSTP	Office of Science and Technology Policy
OSTST	Ocean Surface Topography Science Team
OSU	Ohio State University
OTE	Optical Telescope Element
OVWST	Ocean Vector Winds Science Team
PAAC	Program Analysis And Control
PACS	Photodetector Array Camera and Spectrometer
PA&E	Program Analysis and Evaluation
PAIR	Partnership Awards for the Integration of Research into Undergraduate Education
PAR	Performance and Accountability Report
PAR	Program Acceptance Review
PARASOL	Polarization & Anisotropy of Reflectances for Atmospheric Sciences coupled with Observations from a Lidar
PART	Program Assessment Rating Tool
PB	President’s Budget
PBR	President’s Budget Request
PBS	President’s Budget Submit
PCA	Program Commitment Agreement
PCOS	Physics of the Cosmos Program
PDR	Preliminary Design Review
PDS	Planetary Data System
PDT	Procurement Development Team
P&F	Particles and Fields
PI	Principal Investigator
PIC	Program Integration Contract
PICA	Phenolic Impregnated Carbon Ablator

PII	Performance Improvement Initiative
PIR	Program Implementation Review
PIV	Personal Identification Verification
PLM	Project Lifecycle Management
PLdB	Perceived Level in decibels
PMA	President's Management Agenda
PMC	Program Management Council
PMCs	Polar Mesospheric Clouds
PMO	Program Management Office
PMP	Program Management Plan
PMS	Program Mission Support
PNAR	Preliminary Non-Advocate Review
PNT	Positioning, Navigation, and Timing
POES	Polar Operational Environmental Satellites
PP&E	Property, Plant, and Equipment
PPAR	Preliminary Program Acceptance Review
PPBE	Planning Programming Budget and Evaluation
PPS	Precipitation Processing System
PR	Precipitation Radar
PROX	Proximity Communication System
PRV	Plant Replacement Value
PSBR	Proton Spectrometer Belt Research
PSM	Program Science Management
PSR	Physical Sciences Research
PTF	Plan, Train, Fly
PWR	Pratt and Whitney Rocketdyne
QAT	Quiet Aircraft Technology
QTR	Quarter
QuickSCAT	Quick Scatterometer
R&A	Research and Analysis
R&D	Research and Development
RAC	Robotic Arm Camera
RBSP	Radiation Belt Storm Probes
RBSPICE	Radiation Belt Science of Protons, Ions, Composition, and Electrons
REASoN	Research, Education and Applications Solutions Network
REMS	Rover Environmental Monitoring System
RF	Radio Frequency
RFI	Request for Information
RFP	Request for Proposal
RHESSI	Reuven Ramaty High Energy Solar Spectroscopic Imager
RI	Research Institutions
RLEP	Robotic Lunar Exploration Program
RMB	Reimbursable
RMP	Risk Mitigation Phase
RND	Results Not Demonstrated
ROA	Remotely Operated Aircraft
ROSES	Research Opportunities in Space and Earth Science
Roskomos	Russian Federal Space Agency
RPCT	Radioisotope Power Conversion Technology
RpK	Rocket Plane-Kistler
RPS	Radioisotope Power System
RPT	Rocket Propulsion Testing
RR	Readiness Review
RS	Russian Segment
RSDO	Rapid Spacecraft Development Office
RSP	Radioisotope Power Systems
RSRB	Reusable Solid Rocket Booster
RSRM	Reusable Solid Rocket Motor
RTG	Radioisotope Thermoelectric Generators
RW	Reaction Wheel
RXTE	Rossi X–ray Timing Explorer
S&MA	Safety and Mission Assurance
SA	Single Access
SAA	Space Act Agreement
SAC-D	Satellite de Aplicaciones Cientificas–D (Argentina)
SAGE	Stratospheric Aerosol and Gas Experiment
SAIC	Science Applications International Corporations
SALMON	Stand Alone Missions of Opportunity
SAM	Sample Analysis at Mars
SAMPEX	Solar Anomalous and Magnetospheric Particle Explorer
SAMS	Space Acceleration Measurement System
SAO	Smithsonian Astrophysical Observatory
SAP	Core Financial System Software
SAR	Synthetic Aperture Radar
SATERN	System for Administrative Training and Educational Resources for NASA
SATS	Small Aircraft Transportation System
SAU	Strategic Airspace Usage
SBA	Small Business Administration
SBC	Small Business Concern
SBIR	Small Business Innovative Research
SBPRA	Small Business Paperwork Relief Act
SBRS	Santa Barbara Remote Sensing
SBT	Space-Based Technology
SBUV	Solar Backscatter Ultraviolet
SC	Shared Capabilities
SCaN	Space Communications and Navigation
SCAP	Strategic Shared Capability Assets Program
SCEM	Scientific Context for Exploration of the Moon
SCEP-CO-OP	Student Career Experience Program Cooperative
SCFO	Space Flight Crew Operations
SCIP	Space Communications Constellation Integration Project
SCM	Search Coil Magnetometer (Thermal Emission Imaging System instrument)
SCP	Space Communications Program
SDL	Space Dynamics Laboratory
SDLC	System Development Life Cycle
SDO	Solar Dynamics Observatory
SDR	System Design Review

SDSC	Satish Dhawan Space Center
SDT	Science Definition Team
SEC	Sun–Earth Connection
SE&I	System Engineering and Integration
SELENE	Selenological and Engineering Explorer (Japan)
SEMAA	Science Engineering Mathematics Aerospace Academy
SES	Senior Executive Service
SESFA	Space Environments Simulation Facilities Alliance
SET	Space Environmental Spacecraft
SETI	Search for Extra-Terrestrial Intelligence
SEWP	Solutions for Enterprise-Wide Procurement
SFS	Space and Flight Support
SFW	Subsonic Fixed Wing
SGSS	Space Network Ground Segment Sustainment
SHERE	Shear History Extensional Rheology Experiment
SHFH	Space Human Factors and Habitability
SHM	Scalar Helium Magnetometer
SIG	Systems Integration Group
SIM	Space Interferometry Mission
SIMBAD	Set of Identifications, Measurements, and Bibliography for Astronomical Data
SIR	System Integration Review
SIRTF	Space Infrared Telescope Facility
SLI	Student Launch Initiative
SLR	Satellite Laser Ranging
SM-4	Servicing Mission–4
SMA	Safety and Mission Assurance
SMAP	Soil Moisture Active and Passive
SMC/TEL	Space and Mission Command/Test and Evaluation Directorate
SMD	Science Mission Directorate
SMEX	Small Explorer
SMOR	Science Management Operations Review Team
SMOV	Servicing Mission Orbital Verification
SMP	Software Management Plan
SMS	Safety and Mission Success
SN	Space Network
SNI	Simultaneous, non-interfering
SNSB	Swedish National Space Board
SOAREX	Sub-Orbital Aerodynamic Re-entry Experiment
SOC	Security Operations Center
SOC	Solar Orbiter Collaboration
SOFIA	Stratospheric Observatory for Infrared Astronomy
SOHO	Solar Heliospheric Observer
SOMD	Space Operations Mission Directorate
SORCE	Solar Radiation and Climate Experiment
SORT	SOFIA Options Review Team
SpaceX	Space Exploration and Technology
SPC	Solar Orbiter Collaboration
SPD	Space Product Development
SPDF	Space Physics Data Facility
SPDM	Special Purpose Dexterous Manipulater
SPF	Software Production Facility
SPIRE	Spectral and Photometric Imaging Receiver
SPL	Solar Probe Lite
SPOC	Space Program Operations Contract
SPoRT	Short-term Prediction Research and Transition Center
SR	Senior Review
SR	Space Radiation
SRB	Solid Rocket Booster
SRB	Standing Review Board
SRD	Systems Requirements Document
SRG	Stirling Radioisotope Generator
SRLI	Surgical Research Laboratory, Inc.
SRR	System Requirement Review
SRU	Stellar Reference Unit
SRW	Subsonic Rotary Wing
SS	Steady State
SSC	Stennis Space Center
SSE	Solar System Exploration
SSME	Space Shuttle Main Engines
SSP	Space Shuttle Program
SSS	Sea Surface Salinity
SST	Solid State Telescope (Thermal Emission Imaging System instrument)
ST	Space Technology
STATIC	SupraThermal And Thermal Ion Composition
STaR	Shuttle Transition and Retirement
STEM	Science, Technology, Engineering, and Mathematics
STEREO	Solar Terrestrial Relations Observatory
STI	Scientific and Technical Information
STIS	Space Telescope Imaging Spectrograph (Hubble Space Telescope instrument)
STOCC	Space Telescope Operations Control Center
STOL	Short take-off and landing
STP	Solar Terrestrial Probes
STS	Space Transportation System
STScI	Space Telescope Science Institute
STSS	Space Tracking Surveillance System
STTR	Small Business Technology Transfer Program
SVA	Strategic Vehicle Architecture
SVD	System Vulnerability Detection
SwRI	Southwest Research Institute
SXS	Soft X-ray Spectrometer
T2	Technology transfer
TA	Technical Authority
TAA	Technology Assistance Agreements
TBD	To Be Determined
TBM	Time-based metering

TCU	Tribal Colleges and Universities
TDRS	Tracking and Data Relay Satellite
TDRSS	Tracking and Data Relay Satellite System
TE	Technical Excellence
TEGA	Thermal and Evolved Gas Analyzer
THEMIS	Time History of Events and Macroscale Interactions during Substorms
TIM	Total Irradiance Monitor (Glory instrument)
TIMED	Thermosphere, Ionosphere, Mesosphere, Energetics and Dynamics
TIMS	Thermal Infrared Multispectral Scanner
TIRS	Thermal Infrared Sensor
TLI	Trans-Lunar Injection
TMC	Technical, Management and Cost
TM	Technical Monitors
TMI	TRMM Microwave Imager
T-NAR	Technology Non-Advocate Review
TNO TPD	Netherlands Organization for Applied Scientific Research - Institute of Applied Physics
TOC	Test Operations Contract
TO	Thrust Oscillation
TOF	Time of Flight
TOMS	Total Ozone Mapping Spectrometer
TOMS-EP	Total Ozone Mapping Spectrometer - Earth Probe
TOPEX	Topographic Experiment for ocean circulation
TPF	Terrestrial Planet Finder
TPS	Thermal Protection System
T&R	Transition and Retirement
TRACE	Transition Region and Coronal Explorer
TRL	Technology Readiness Level
TRMM	Tropical Rainfall Measuring Mission
TSDIS	TRMM Science Data and Information System
TTA	Technical Task Agreement
TT&C	Flight Tracking Telemetry and Command
TVC	Thermal Vacuum Chambers
TWINS	Two Wide–angle Imaging Neutral–atom Spectrometers
UAS	Uninhabited Air Systems
UAV	Unmanned Aerial Vehicle
UAZ	University of Arizona
UCLA	University of California at Los Angeles
UEET	Ultra–efficient Engine Technology
UI	University of Iowa
ULA	United Launch Alliance
ULDB	Ultra Long Duration Balloon
ULF	Utilization and Logistics Flight
UNCFSP	United Negro College Fund Special Programs
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNITeS	Unified NASA Information Technology Services
UPS	Uninterruptible power supply
URC	University Research Center
URETI	University Research Engineering, and Technology Institute
USA	United Space Alliance
USAF	United States Air Force
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
USGS	United States Geological Survey
USOS	United States Orbital Segment
USRA	Universities Space Research Association
USRP	Undergraduate Student Research Project
UTD	University of Texas at Dallas
UTMB	University of Texas Medical Branch
UV	Ultraviolet
UVS	UV Spectrometer
VAB	Vehicle Assembly Building
VAMS	Virtual Airspace Modeling and Simulation
VAO	Virtual Astronomical Observatory
VCAMS	Vehicle Cabin Atmosphere Monitoring
VCL	Vegetation Canopy Lidar
VExAG	Venus Exploration Analysis Group
VI	Vehicle Integration
VIIRS	Visible-Infrared Imager Radiometer Suite (NPOESS Preparatory Project instrument)
VIR	Visible and Infrared mapping spectrometer
VSE	Vision for Space Exploration
VSP	Vehicle Systems Program
VST	Vehicle Safety Technologies
WATR	Western Aeronautical Test Range
WAVES	Radio and Plasma Waves Instrument (Wind)
WCF	Working Capital Fund
WFC-3	Wide Field Camera–3 (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations instrument)
WISE	Wide-field Infrared Survey Explorer
WMAP	Wilkinson Microwave Anisotropy Probe
WRS	Water Recovery System
WSC	White Sands Complex
WST	Weather Safety Technologies
WSTF	White Sands Test Facility
XRT	X-Ray Telescope
XMM	X-ray Multi-mirror Mission (Newton Observatory)

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