

National Aeronautics and
Space Administration



NASA Space Technology Update

NAC TI&E Meeting

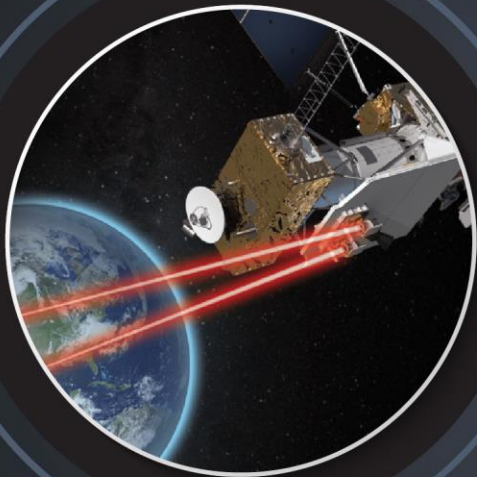
Clayton Turner

Associate Administrator (Acting),
NASA Space Technology Mission Directorate

September 5, 2024

NATIONAL TECH BASE FOR CIVIL SPACE

Space Tech leads the development, demonstration, and infusion of transformational space technologies that solve critical stakeholder needs



ADVANCE US space technology innovation and competitiveness in a global context

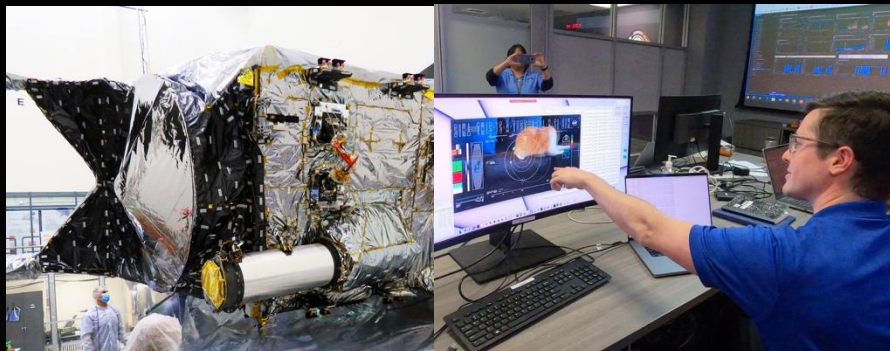


ENCOURAGE technology driven economic growth with an emphasis on the expanding space economy

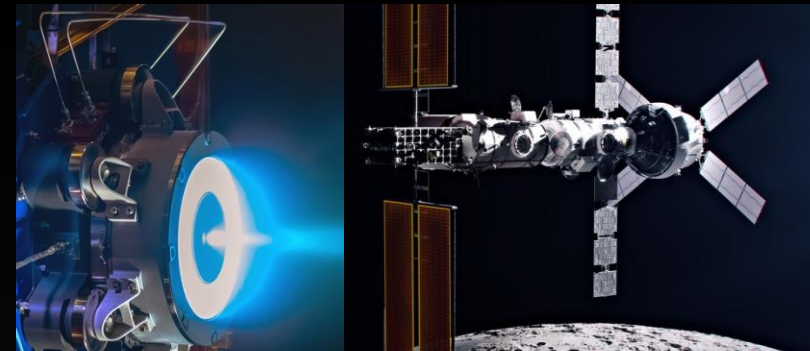


INSPIRE and develop a diverse and powerful US aerospace technology community

Recent Tech Highlights



Deep Space Optical Communications



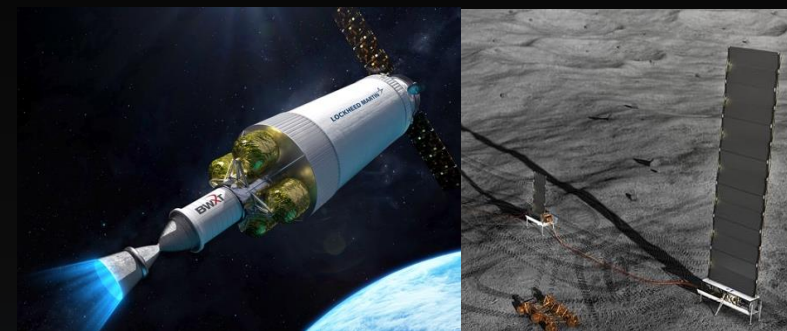
Solar Electric Propulsion



Intuitive Machines 1 CLPS Payloads



Cryogenic Fluid Management Demo



Space Nuclear Technologies



Starling Swarm Demo



Cooperative Robotic Scouts



Solar Sail Deployment



Flight Opportunities

SPACE TECHNOLOGY PORTFOLIO

As currently organized:

EARLY STAGE INNOVATION AND PARTNERSHIPS

- Early Stage Innovation
 - Space Tech Research Grants
 - Center Innovation Fund
 - Early Career Initiative
 - Prizes, Challenges & Crowdsourcing
 - NASA Innovation Advanced Concepts
- Technology Transfer

SBIR/STTR PROGRAMS

- Small Business Innovation Research
- Small Business Technology Transfer

TECHNOLOGY MATURATION

- Game Changing Development
- Lunar Surface Innovation Initiative

TECHNOLOGY DEMONSTRATION

- Technology Demonstration Missions
- Small Spacecraft Technology
- Flight Opportunities

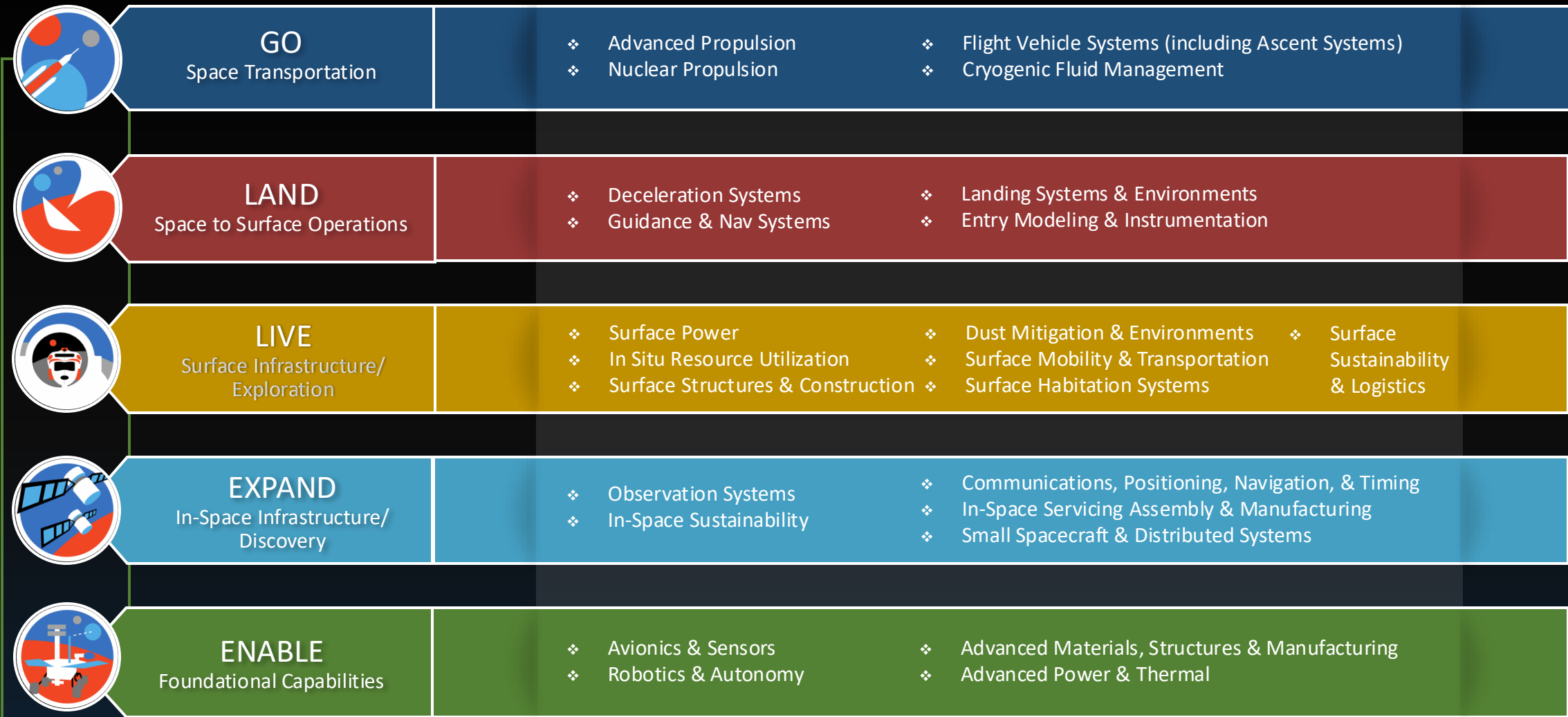
LOW

MID

Technology Readiness Level

HIGH

Tech Base Functional Domains

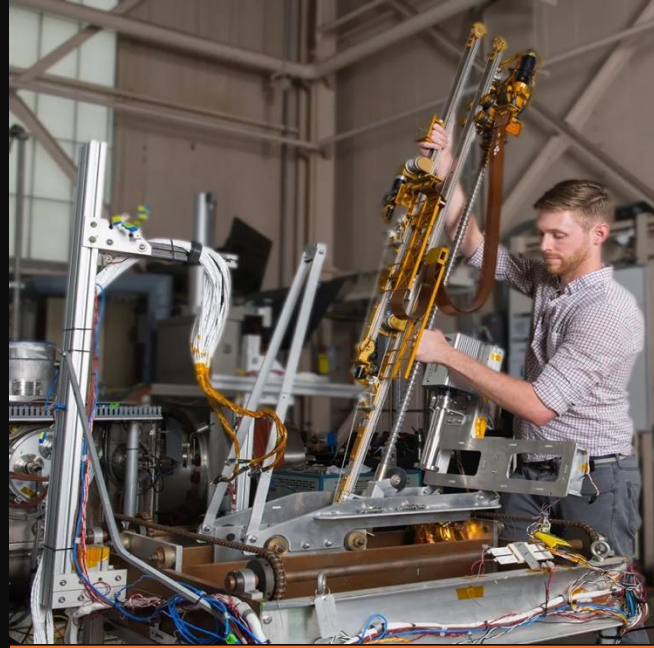


❖ Capability Portfolio

<p>CATALYSTS Innovative Mechanisms</p>	<ul style="list-style-type: none"> • NIAC/CIF/ECI • STRG 	<ul style="list-style-type: none"> • PCC • Tech Transfer 	<ul style="list-style-type: none"> • SBIR/STTR • Flight Opportunities 	<ul style="list-style-type: none"> • TP/ACO • Inclusive Innovation
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STMD Restructuring Plan

- **STMD is going through a transformation** to become more **agile and effective** by re-organizing from a TRL-based structure to a capability-focused management approach.
- The newly **defined Domains** will have the responsibility for **maturing space capabilities across the full technology readiness spectrum from initial concept to mission application.**
- **Organizing the STMD portfolio into functional Domains** rather than by developmental maturity **will enable:**
 - ❖ Better prioritization of development efforts to address common stakeholder needs
 - ❖ Avoid programmatic scope expansion beyond assigned TRL range
 - ❖ Efficiently transition technologies along the maturation scale
 - ❖ Increase accountability for performance within a capability roadmap.



STMD FY 2025 PBR Summary (\$M)

	FY 2024 Op Plan	FY 2025 PBR
	1,100.0	1,181.8
SBIR and STTR	217.8	241.8
Early Stage Innovation and Partnerships	116.9	140.1
Agency Technology and Innovation	-	-
Technology Transfer	21.0	23.1
Early Stage Innovation	95.9	117.0
Early Stage Innovation and Commerce	2.7	5.3
Early Career Initiative (ECI) and Center Innovations Fund (CIF)	23.6	28.4
Prizes, Challenges and Crowdsourcing	9.8	12.0
NASA Innovative Advanced Concepts (NIAC)	7.2	9.6
Space Technology Research Grants (STRG)	52.8	61.6
Technology Maturation / Game Changing Development (GCD)	252.7	340.8
Space Transportation	16.4	30.3
Entry, Descent and Landing	35.4	19.7
Sustainable Exploration	117.4	189.9
Transformative Missions and Discoveries	36.3	37.7
Industry & Commerce Innovative Opportunity, Space Tech Management and Integration	47.3	63.2
Technology Demonstration	512.6	459.1
Flight Opportunities and Small Spacecraft Technology	68.1	72.7
Technology Demonstration Missions (TDM)	327.5	386.4
On-Orbit Servicing and Manufacturing Demonstration-1 (OSAM-1)	206.9	11.0
Solar Electric Propulsion (SEP)	8.5	13.0
Cryogenic Fluid Management (CFM)	75.9	82.7
Fission Surface Power	16.0	113.8
Space Nuclear Propulsion (NTP and NEP)	117.0	110.0
MOXIE, LOFTID, DSOC, OSAM-2, LCRD, TDM Selected ACO/TP, TDM Mgt & Integration	20.2	55.9

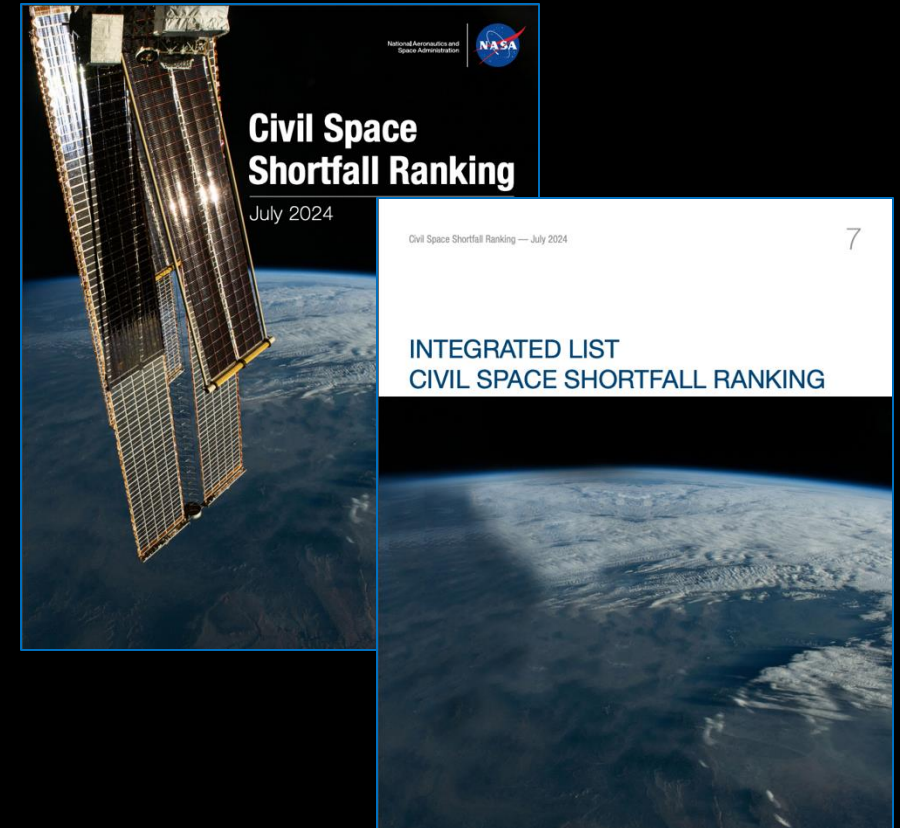
FY 2025 Congressional Markup Status

STMD Appropriations (\$M)	FY 2024 Enacted / Conference	FY 2025 PBR	House Proposal	Senate Proposal
OSAM-1 (Restore and SPIDER)	227.0	11.0	TBD	up to \$174.5M
Nuclear Thermal Propulsion (includes DRACO)	110.0	92.5	110.0	115.0
SBIR/STTR**	224.8	241.8	241.8	241.8
Other Congressional Directions	up to \$137	347.7	up to \$245	276 - 370
<i>Nuclear Electric Propulsion (NEP)</i>				
<i>Space Nuclear Propulsion Program Office</i>				
<i>Nuclear Propulsion Center of Excellence</i>				
<i>Space Nuclear Fuels Technologies (beyond DRACO)</i>				
<i>Lunar Power Systems (Fission Surface Power)</i>				
<i>Regional Economic Development</i>				
<i>Flight Opportunities</i>				
<i>Innovative Nanomaterials</i>				
<i>In-Space Additive Manufacturing (MMPACT)</i>				
<i>Extra-Terrestrial Resource and Manufacturing Engineering (EXTREME)</i>				
<i>New Tipping Point and ACO (M2M, Crosscutting/ISRU/Surface Mobility, electromagnetic tool, additive manuf)</i>				
<i>Lunar Infrastructure Foundational Technologies [LIFT-1]</i>				
<i>Rocket Propulsion Systems (RAMPT/RAMBO/ORCA)</i>				
<i>Additive Manufacturing</i>				
<i>Intellectual Property Protections</i>				
<i>Orbital Debris Inspection</i>				
<i>CAPSTONE Mission Extension</i>				
<i>Space Technology Research Institute (STRI)</i>				
Remaining STMD Programmatic Content	401.0	488.8	up to 399.8	279 - 374
Total Space Technology	1,100.0	1,181.8	1,181.8	1,181.8

Civil Space Shortfall Ranking

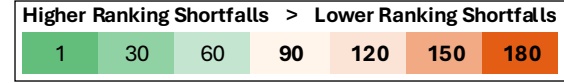
Shortfall: *Identified, problem-focused technology area requiring further developments to meet future exploration, science, and other mission needs*

- Documented 187 shortfalls within 20 capability areas
- Collected stakeholder feedback (1,231 responses) on the importance of each shortfall
- Processed the data to assemble an integrated, ranked civil space problem list
- Integrated list is one of several factors guiding STMD projects and investments
- The results will also inform the development of technology roadmaps
- Using lessons learned to refine the approach and schedule for future years



View the results:
nasa.gov/civilspaceshortfalls

Integrated Top 30 Shortfalls Compared to Stakeholder Group Rank



Not Ranked (NR)

Integrated Rank	Average Score	Shortfall ID	Category
1	8.103	1618: Survive and operate through the lunar night	Thermal Management Systems
2	7.612	1596: High Power Energy Generation on Moon and Mars Surfaces	Power
3	7.435	1554: High Performance Onboard Computing to Enable Increasingly Complex Operations	Avionics
4	7.383	1557: Position, Navigation, and Timing (PNT) for In-Orbit and Surface Applications	Communication and Navigation
5	7.247	1545: Robotic Actuation, Subsystem Components, and System Architectures for Long-Duration and Extreme Environment Operation	Autonomous Systems and Robotics
6	7.208	1552: Extreme Environment Avionics	Avionics
7	7.196	1519: Environmental Monitoring for Habitation	Advanced Habitation Systems
8	7.168	709: Nuclear Electric Propulsion for Human Exploration	Propulsion: Nuclear
9	7.114	1304: Robust, High-Progress-Rate, and Long-Distance Autonomous Surface Mobility	Autonomous Systems & Robotics
10	7.095	1520: Fire Safety for Habitation	Advanced Habitation Systems
11	7.052	1531: Autonomous Guidance and Navigation for Deep Space Missions	Autonomous Systems & Robotics
12	7.045	1591: Power Management Systems for Long Duration Lunar and Martian Missions	Power
13	7.034	702: Nuclear Thermal Propulsion for Human Exploration	Propulsion: Nuclear
14	7.031	1559: Deep Space Autonomous Navigation	Communication and Navigation
15	6.968	1527: Radiation Countermeasures (Crew and Habitat)	Advanced Habitation Systems
16	6.948	1526: Radiation Monitoring and Modeling (Crew and Habitat)	Advanced Habitation Systems
17	6.946	879: In-space and On-surface, Long-duration Storage of Cryogenic Propellant	Cryogenic Fluid Management
18	6.843	1548: Sensing for Autonomous Robotic Operations in Challenging Environmental Conditions	Autonomous Systems & Robotics
19	6.804	1558: High-Rate Communications Across The Lunar Surface	Communication and Navigation
20	6.792	1626: Advanced Sensor Components: Imaging	Sensors and Instruments
21	6.784	792: In-space and On-surface Transfer of Cryogenic Fluids	Cryogenic Fluid Management
22	6.720	1569: High-Mass Mars Entry and Descent Systems	Entry Descent and Landing
23	6.711	1525: Food and Nutrition for Mars and Sustained Lunar	Advanced Habitation Systems
24	6.695	1571: Navigation Sensors for Precision Landing	Entry Descent and Landing
25	6.689	1573: Terrain Mapping Capabilities for Precision Landing and Hazard Avoidance	Entry Descent and Landing
26	6.662	1562: Advanced Algorithms and Computing for Precision Landing	Entry Descent and Landing
27	6.593	1597: Power for Non-Solar-Illuminated Small Systems	Power
28	6.592	1568: Entry Modeling and Simulation for EDL Missions	Entry Descent and Landing
29	6.584	1516: Water and Dormancy Management for Habitation	Advanced Habitation Systems
30	6.569	1524: Crew Medical Care for Mars and Sustained Lunar	Advanced Habitation Systems

Stakeholder Group Rank								
Academia	Small Industry	Large Industry	OGA	Other	NASA Centers	ESDMD	SMD	Other MDs
4	2	2	2	9	6	4	9	1
13	1	1	40	20	4	21	NR	16
80	28	21	27	13	3	34	1	56
9	11	15	29	67	10	28	NR	3
34	27	28	63	10	40	13	9	49
176	49	6	38	23	54	6	9	62
20	101	72	75	61	49	17	19	13
43	131	23	4	52	32	7	NR	7
27	42	30	121	91	34	25	25	66
23	24	78	12	12	12	29	55	14
47	67	24	3	89	42	64	23	15
40	12	10	52	24	68	35	NR	27
36	114	36	14	78	62	7	NR	11
62	129	27	5	120	38	64	23	10
5	23	22	6	2	5	63	NR	6
6	53	41	81	1	13	27	38	35
21	37	3	95	22	1	59	NR	2
42	17	26	90	16	44	14	26	57
25	73	29	77	162	20	5	NR	51
18	75	12	45	160	22	NR	18	68
17	29	4	51	26	2	62	NR	29
152	156	48	117	5	33	16	NR	12
8	32	116	41	45	30	11	NR	58
14	62	37	23	4	31	45	28	9
30	31	9	12	8	11	45	28	53
54	65	45	23	3	25	45	28	8
85	26	5	39	125	47	93	12	20
101	115	76	60	15	50	45	5	45
49	98	127	158	53	69	26	51	22
12	64	94	1	11	21	58	NR	17

ESDMD and SMD provided ranked lists (numbers shown above) in addition to shortfall scores (used for integrated list). ESDMD and SMD did not score all shortfalls. Unscored shortfalls were also not ranked.

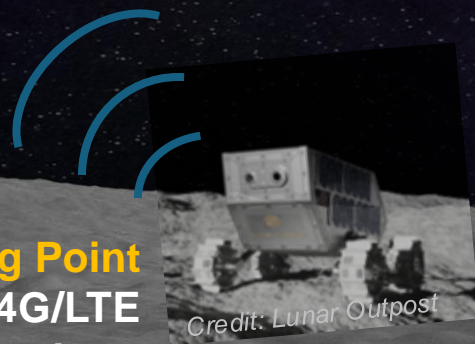
Upcoming Space Technology Demos on Intuitive Machines 2

Intuitive Machines
Nova-C lunar lander



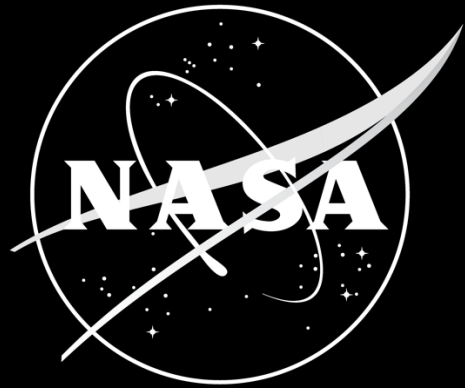
Intuitive Machines
Tipping Point
Micro-Nova Hopper

Nokia Tipping Point
4G/LTE
Communications
System



NASA Polar Resources
Ice Mining Experiment 1
(PRIME-1)

Planned for late 2024, Intuitive Machines' second mission will deliver STMD investments to the lunar South Pole



www.nasa.gov/civilspaceshortfalls