NASA Aeronautics Overview

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August 30, 2018

Building the NASA Aeronautics Strategic Implementation Plan

Analysis and Stakeholder Dialogue – 2013 Rollout, 2017 Update

Key Trends (Not Exhaustive)	Aviation Mega-Drivers	Analysis & Community Dialogue	Community Vision
Increasingly Urbanized World Rising Global Middle Class Driven by Asia-Pacific Urban Transportation Increasingly Congested	GLOBAL MOBILITY	 **Industry / Gov't Execs What's Needed?**	Safe, Efficient Growth in Global Operations Innovation in Commercial Supersonic Aircraft
Continuing Pressure to Reduce Noise and Local Air Quality Impacts Aviation Industry Sets Challenging CO_2 Reduction Goals through Mid-Century	ENVIRONMENTAL CHALLENGES	 **Industry / Gov't SMEs What's Possible?**	Ultra-Efficient Commercial Aircraft Transition to Alternative Propulsion and Energy
Networked Com and Sensors, Embedded Artificial Intelligence, and Big Data Converging with Traditional Systems and Technologies On-Demand Service Models Disrupting Traditional Industries	TECHNOLOGY CONVERGENCE	 **Systems Analysis**	In-Time System-Wide Safety Assurance Assured Autonomy for Aviation Transformation

NASA Aeronautics - Where Are We Today?

- Clear vision and strategy
  - Reflects visionary aviation opportunities
  - Strong community endorsement and alignment – NRC studies and ARTR, NAC, One-on-One engagement, etc.
- Strong inter-center collaborations
- Motivated and dedicated workforce
- Solid partnerships
  - OGAs, industry, academia, and international partners
- Excellent performance, producing impactful results with robust tech transfer
- Setting best practices for the Agency and the Federal Government
  - e.g., strategic planning, connecting with national economy, cost-sharing partnership and impactful tech transfer (including Fed best practice Research Transition Teams with FAA), inter-center collaboration, celebrating lessons learned through failures

Global Growth in Aviation

Opportunities and Challenges

2017

4 BILLION

PASSENGER TRIPS

Bombardier / Canada

Embraer / Brazil

41,030
New Aircraft Deliveries

$6.1 Trillion
Market Value

Global Competitors

Airbus / Europe

Asia-Pacific Market is Nearly 40% of New Aircraft Deliveries

2036

7.8 BILLION

PASSENGER TRIPS

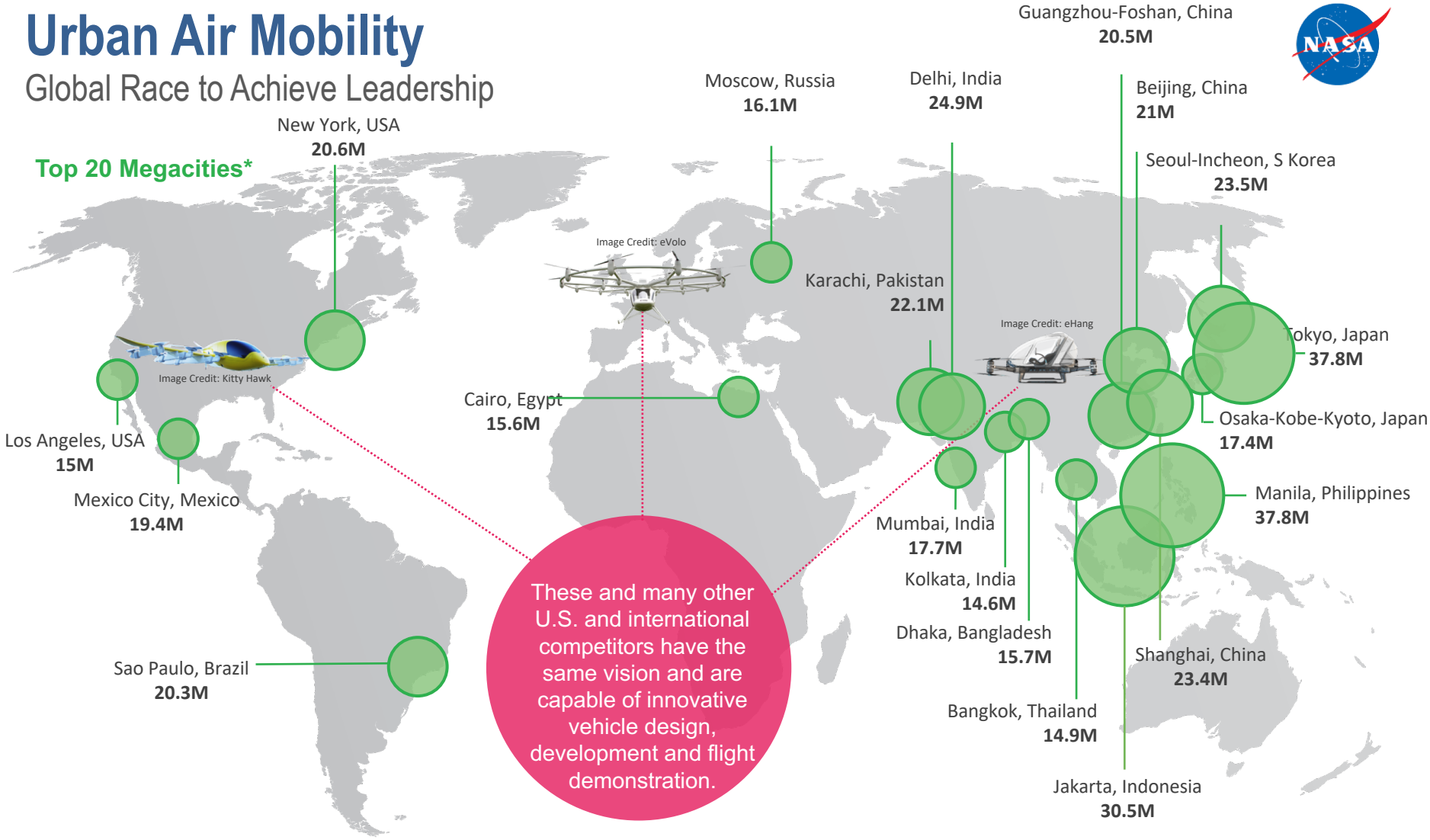
Irkut / Russia

Comac / China

78% of New Aircraft Deliveries are Single Aisle Class (including Regional Jets)

Urban Air Mobility

Global Race to Achieve Leadership



Large projected market–McKinsey analysis of demand by 2030 in 15 major U.S. cities:

- 500 Million annual UAS package deliveries
- 750 Million annual passenger trips

Extrapolation to the global market would likely increase demand by 5 to 10x.

*Top 20 megacities by population; data from allianz.com 03.16.15


Market: High Altitude, Long Endurance UAS
Upper E Airspace
Market: Large Transport & Large UAS
Supersonic Aircraft
Class A Airspace
Subsonic Aircraft
Market: Thin/Short Haul
Asia
U.S.A.
Market: Small / Medium UAS
Market: Urban Air Mobility

A New Era of Flight is Emerging

NASA Aeronautics' vision and leadership have stimulated national and international aviation and non-aviation communities to pursue a new era of aviation.

- **Unmanned Aircraft Systems (UAS) Integration into NAS**
  - NASA has led the Nation in performing the flight experiments required to generate new standards and validate them to enable safe integration.
- **UAS Traffic Management (UTM)**
  - NASA recognized that small UAS operating at low altitude would need an entirely new airspace management construct to enable their operation.
  - NASA developed the UTM idea and developed an expansive National partnership to develop and validate the concept.
  - UTM is now the accepted model all over the world.
- **Supersonic Flight**
  - For many decades, NASA has advanced the science of supersonic flight.
  - The more recent strategic focus NASA has put on solving one of the most challenging problems – reducing sonic boom noise – has shown the industry and the world that commercial supersonic flight is ready to re-emerge.
  - New companies are beginning the development process and ICAO is ready to work on the supersonic flight standards needed to underpin a new era of supersonic transportation.
- **Electric Aircraft**
  - NASA started systems studies and explored this possibility some 20 years ago.
  - Through NASA's strategic focus on the development of technologies required for economic systems, interest from the industry is accelerating and new companies, such as Zunum, are actively developing initial commercial products.

ARMD Research Programs & Projects Align with ARMD Strategy

MISSION PROGRAMS

AIRSPACE OPERATIONS & SAFETY

AOSP

PROJECTS

ATM Tech Demonstrations

UTM

ATM-X Project

System-Wide Safety

ADVANCED AIR VEHICLES

AAVP

PROJECTS

Advanced Air Transport Technology

Commercial Supersonic Technologies

Revolutionary Vertical Lift

Advanced Composites

Hypersonic Technology

Aerosciences Evaluation & Test Capabilities

INTEGRATED AVIATION SYSTEMS

IASP

PROJECTS

UAS in the NAS

Flight Demonstrations and Capabilities

Low Boom Flight Demonstrator

Integration and Flight

SEEDLING PROGRAM

TRANSFORMATIVE AERONAUTICS CONCEPTS

TACP

PROJECTS

Convergent Aeronautics Solutions

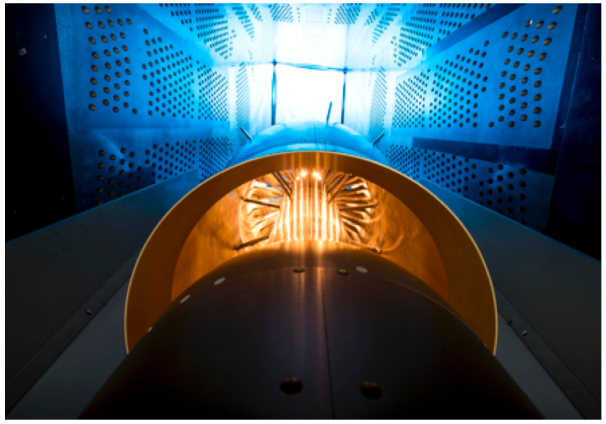
Transformational Tools and Technologies

University Innovation and Challenges

Convergent Innovation and Revolutionary Analysis Tools

Project Performance Delivers Relevant, High Value Results

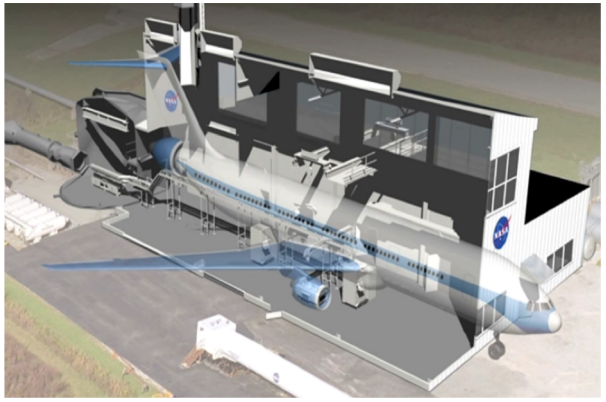
Delivers out commitments for American technical leadership



Boundary Layer Ingestion Test

UTM National Flight Campaign

Sonic Boom Propagation Flight Experiments



NASA Electric Aircraft Testbed (NEAT) Facility

Juncture Flow Validation Experiment

ATM Tech Demo - 1 Flight Campaign

Aeronautics Budget History

Reflects growing relevancy and value

FY09 PBR – lowest level formulated in CY07

ARMD Strategic Implementation Plan Released

NAH proposed

	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
PBR, $M	959	919	852	724	554	446	507	579	569	551	566	551	571	790	624	634
Enacted, $M	946	906	884	593	511	650[1]	507	533	569	530	566	651	634	656	685	715/ 725[2]
Agency $B	15.4	15.6	15.1	15.9	17.8	17.8	18.7	18.4	17.8	16.9	17.6	18.0	19.3	19.7	20.7	21.5/ 21.3

ERA began

UAS and V&V began

UTM began

1. $500M + $150M Recovery Act
2. House and Senate Appropriations Marks Respectively

Laying the Ground Work for Aviation in 2040

- The global aviation system of 2040 is emerging today – new companies and new systems built on advanced technologies pioneered by NASA and strengthened by steady U.S. investment.
- Based on what is emerging today, in 2040 we could see:
  - An Urban Air Mobility system that is all electric, autonomous and environmentally friendly moving billions of commuters and packages across the world's megacities. As a result, ground-based traffic congestion will be reduced, local air quality will be improved, and urban areas will be transformed.
  - Transformative subsonic airliners developed by U.S. industry that approach near-optimal levels of efficiency, reducing cost and environmental impact. As a result, more people will travel around the world supporting a vibrant and growing U.S. and global economy.
  - A growing segment of increasingly affordable and environmentally friendly supersonic air travel. This will once again shrink our world and project U.S. technological leadership.
  - A transformed airspace system that supports all innovations, providing the access and efficiency to enable this broad range of business models. This system provides proactive and prognostic "in-time" safety assurance, providing all citizens confidence that every flight is safe and secure.