National Aeronautics and Space Administration


# Transformative Aeronautics Concepts Program

## University Leadership Initiative (ULI) Technical Interchange

June 25, 2018

| Agenda | | |
|---|---|---|
| Monday 25 June | 930-1000 | Introduction from NASA (Dr. John Cavolowsky, Director, Transformative Aeronautics Concepts Program) |
| | 1000-1100 | Adaptive Aerostructures for Revolutionary Civil Supersonic Transportation (Dr. Dimitris Lagoudas, Texas *A&M* Univ.) |
| | 1115-1215 | Hyper-Spectral Comm, Networking & ATM as Foundation for Safe, Efficient Future Flight (Dr. David Matolak, Univ. of So. Carolina) |
| | 1215-1300 | Lunch Break |
| | 1300-1400 | Panel Discussion - John Langford (President, Aurora Flight Sciences), Scott Drennan (Director, Innovation, Bell), Eric Ringer (Director, Aviation Technology, Skyward) will talk about aviation challenges that industry faces that could serve as future proposal ideas for university led teams |
| | 1400-1500 | Information Fusion for Real-Time National Air Transportation System Prognostics under Uncertainty (Dr. Yongming Liu, Arizona State Univ.) |
| | 1515-1615 | Electric Propulsion: Challenges and Opportunities (Dr. Mike Benzakein, Ohio State Univ.) |
| | 1615-1715 | Advanced Aerodynamic Design Center for Ultra-Efficient Commercial Vehicles (Dr. James Coder, Univ. Of Tennessee, Knoxville) |
| | 1730-1800 | Future ULI discussion and networking |
| | 1830-1930 | Informal ULI networking in the hotel lobby |
| | | |
| Tuesday, 26 June | 1830-2000 | Informal ULI networking at the NASA booth during the Opening Reception in the Exhibit Hall |

# A new era of flight is emerging…..

# Global Growth in Aviation

Opportunities and Challenges

## 2017

**4 BILLION**

**PASSENGER TRIPS**

## 2036

**7.8 BILLION**

**PASSENGER TRIPS**

Airbus / Europe

Bombardier / Canada

Irkut / Russia

Comac / China

Embraer / Brazil

**41,030**
New Aircraft Deliveries

**$6.1 Trillion**
Market Value

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

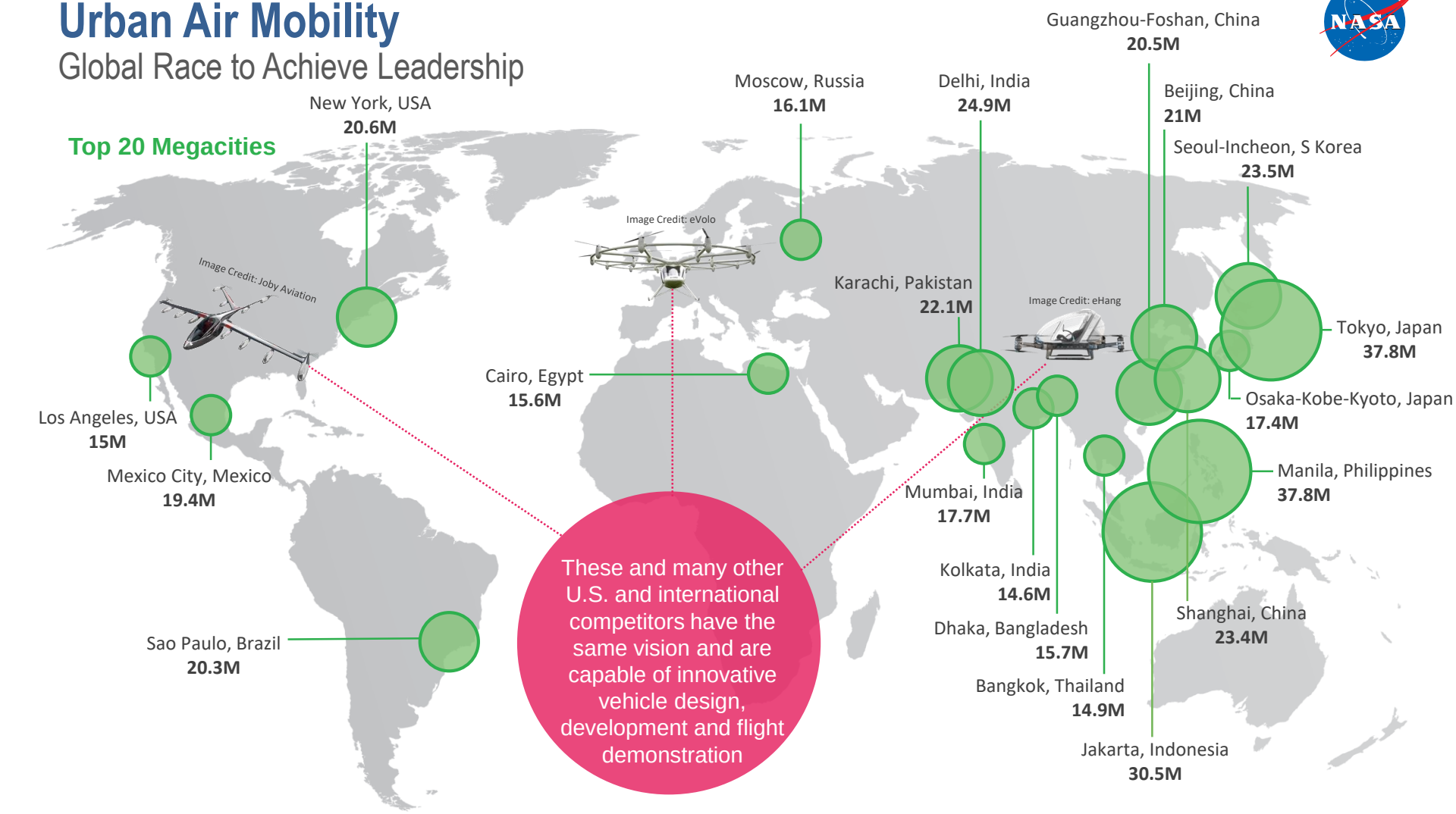
**78% of New Aircraft Deliveries are Single Aisle Class (including Regional Jets)**

Global Competitors

# Urban Air Mobility

## Global Race to Achieve Leadership

### Top 20 Megacities




**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

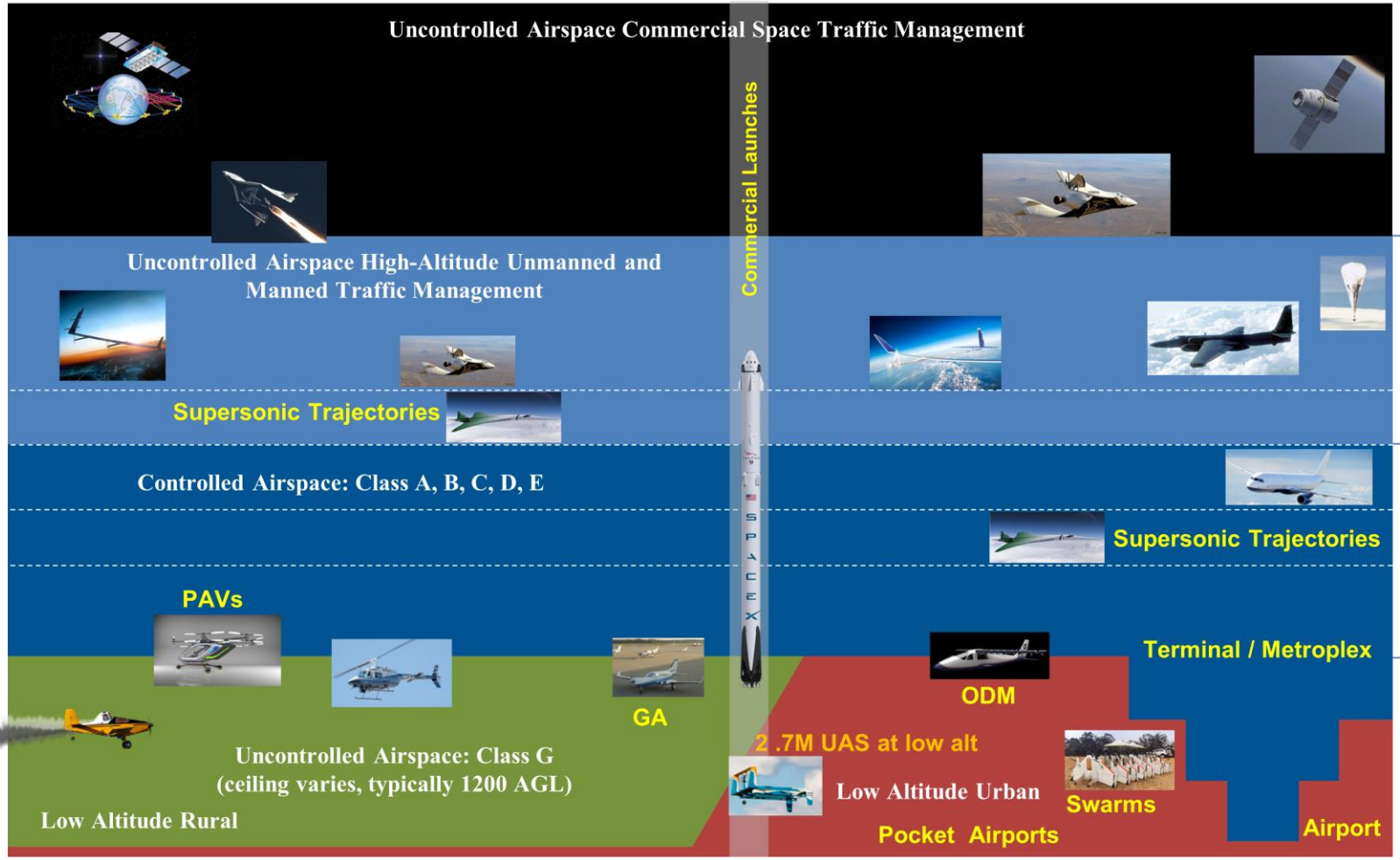
**Extrapolation to the global market would likely increase demand by 5 to 10x**



Top 20 Megacities by population data from allianz.com 03.16.15

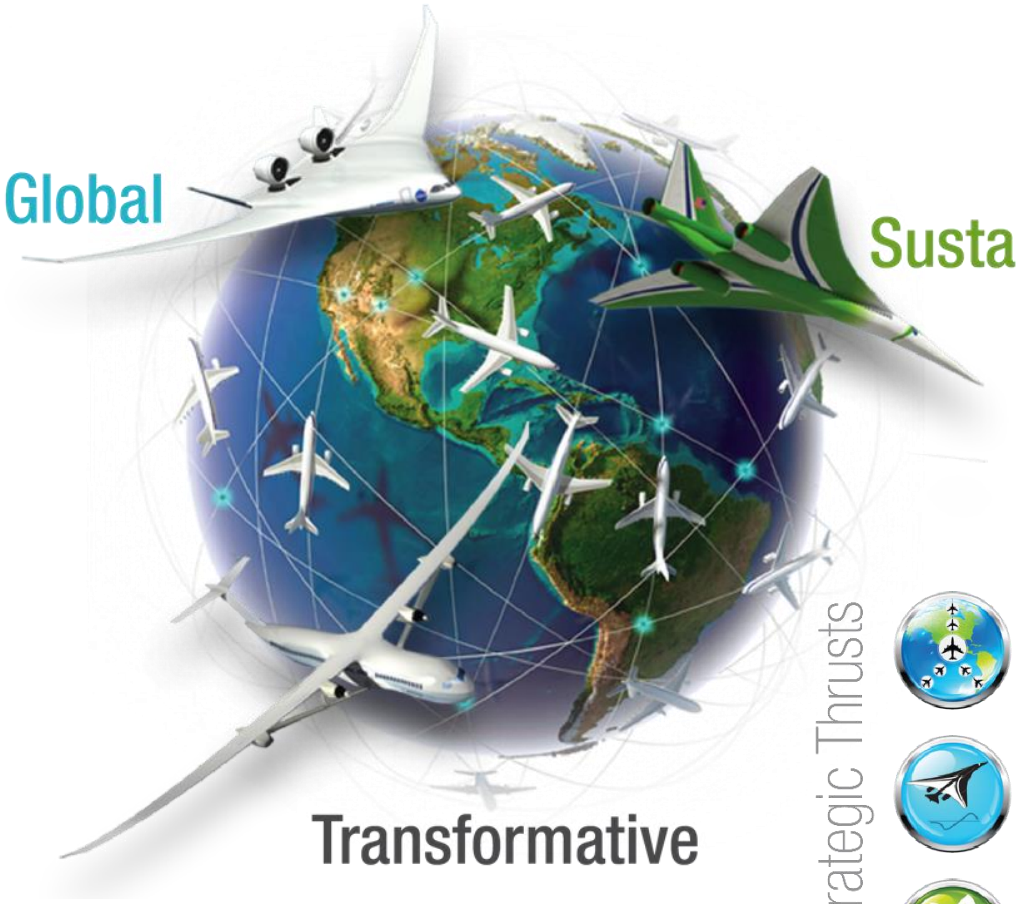
# Airspace System

Providing Access and Efficiency to Enable an ***Increasingly Broad Range of Business Models***



# NASA Aeronautics

NASA Aeronautics Vision for Aviation in the 21st Century




ARMD continues to evolve and execute the Aeronautics Strategy *https://www.nasa.gov/aeroresearch/strategy*

6 Strategic Thrusts

- Safe, Efficient Growth in Global Operations
- Innovation in Commercial Supersonic Aircraft
- Ultra-Efficient Commercial Transports
- Transition to Alternative Propulsion and Energy
- In-Time System-Wide Safety Assurance
- Assured Autonomy for Aviation Transformation

U.S. leadership for a new era of flight

**The global aviation system of 2040 is emerging today – new companies and new systems built on advanced technologies many with "NASA DNA" and enabled by steady U.S. investment**

# Subsonic Transport Technology Strategy

Ensuring U.S. technological leadership

Energy usage reduced by more than 60%

Harmful emissions reduced by more than 90%

Objectionable noise reduced by more than 65%

***Prove out transformational propulsion technologies***

***Prove out transformational airframe technologies***

**Current Generation**

**Next Generation -Transitional-**

**Future Generations -Transformational-**


Image Credit: Denis Fedorko

Image Credit: pjs2005 from Hampshire, UK


Image Credit: Weimeng


Image Credit: Don-vip

Create technology pathway for U.S. competitive leadership

2040

2030

2020

# Transforming Propulsion – A Breakthrough Opportunity

Turbo-Electric Propulsion Architecture


Boundary-Layer Ingesting Propulsor(s)

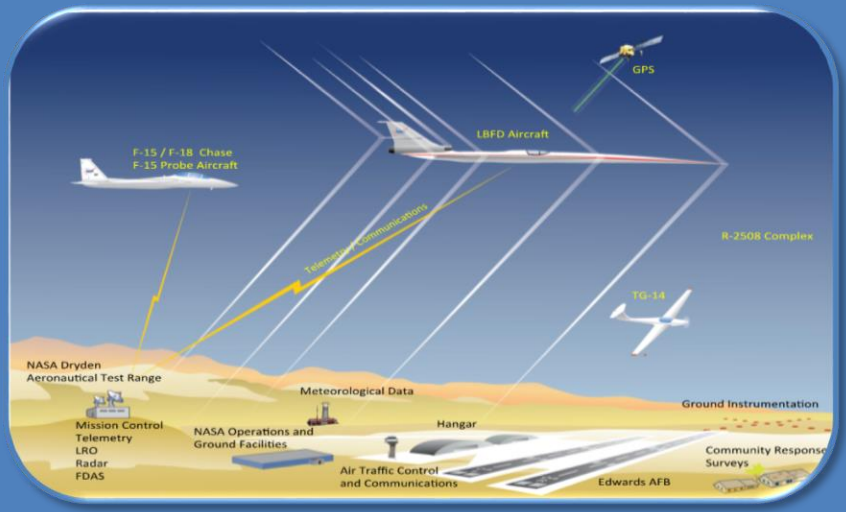
Ultra-Efficient “Small Core” Turbofan

**In whole or in part, transformational propulsion enables the next generation transitional subsonic transport configuration and enables future generation transformational subsonic transports**

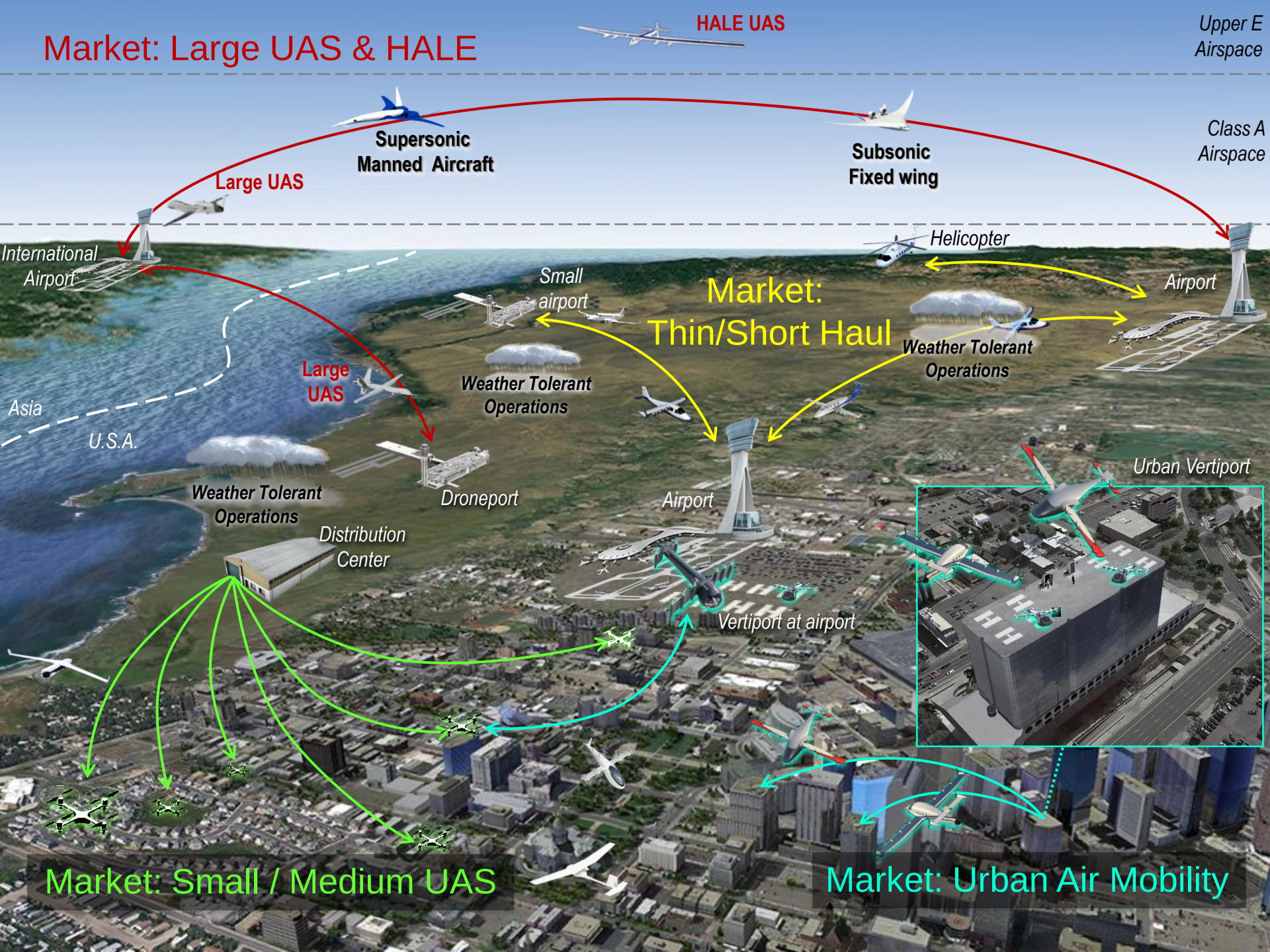
# Low Boom Flight Demonstrator Strategy

Access to Supersonic Travel

***Design and build aircraft with low-noise sonic boom signature characteristics***




***Verify aircraft low-boom acoustic signature***


Market: Large UAS & HALE
HALE UAS
Upper E Airspace
Supersonic Manned Aircraft
Subsonic Fixed wing
Class A Airspace
Large UAS
International Airport
Helicopter
Small airport
Market: Thin/Short Haul
Airport
Weather Tolerant Operations
Large UAS
Asia
U.S.A.
Weather Tolerant Operations
Droneport
Weather Tolerant Operations
Distribution Center
Airport
Urban Vertiport
Vertiport at airport
Market: Small / Medium UAS
Market: Urban Air Mobility

# Emerging Aviation Markets

Global Race to Achieve Leadership

## Urban Air Mobility Example

Ehang - China

E-Volo - Germany

Joby - US

**And many other U.S. and international competitors have the same vision and are capable of innovative vehicle design, development and flight demonstration**

The race to capture the market will be won based on…

- Ability to safety certify innovative aviation technologies and configurations
- Achieving equitable community noise standards
- Enabling safe airspace access at high densities
- Achieving safe vertiport infrastructure standards

But most demonstrations and early market growth are overseas – all four key issues easier to manage in many other countries. The U.S. must lead or risk falling behind.

**NASA is adjusting its portfolio to address the issues, support FAA and industry to accelerate U.S. competitive posture, and do it through a technically sound, sustainable and scalable approach**

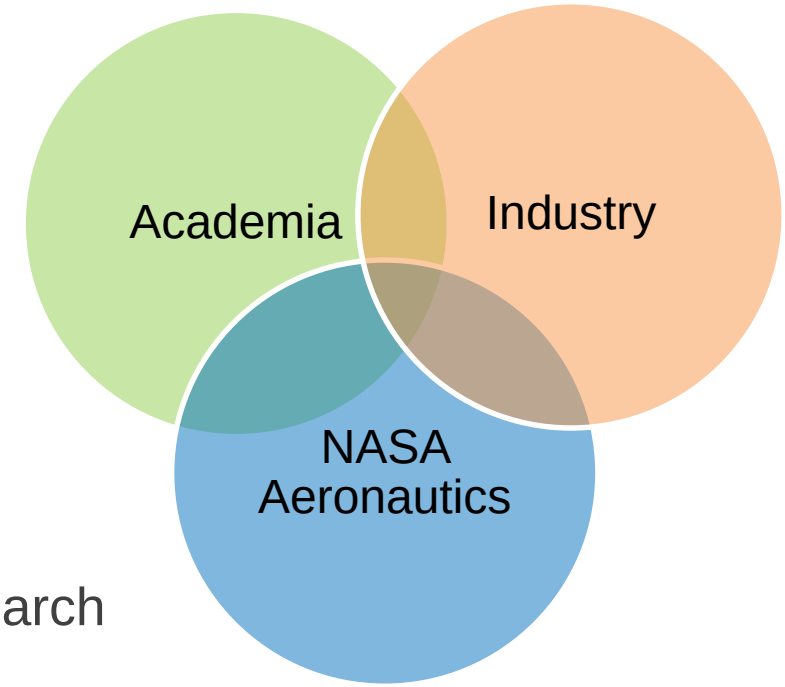
NASA and Industry are already working to respond to these challenges and the deliver the desired outcomes

Need universities to join in this response

Seeking ULI proposals that will continue to keep U.S. aviation a leader in 2040 and beyond

# University Leadership in Aeronautics Innovation

Annual NASA ULI Solicitations




- Further the global competitiveness of U.S. aviation industry
- University initiation and leadership
- Integrate diverse participants from the U.S. innovative community
- Students learn through aeronautics research
- NASA investments and Investigator commitments - signals to attract industry investment
- Accelerating progress of technology from the laboratory to the market
- NASA accepts the high risk-high payoff nature of proposed research

# Current Teams in University Leadership Initiative

- ***Thrust 1:*** "Hyper-Spectral Communications, Networking & ATM as Foundation for Safe and Efficient Future Flight: Transcending Aviation Operational Limitations with Diverse and Secure Multi-Band, Multi-Mode, and mmWave Wireless Links," **PI: David Matolak, University of South Carolina** (NASA POC: Alan Downey, GRC)

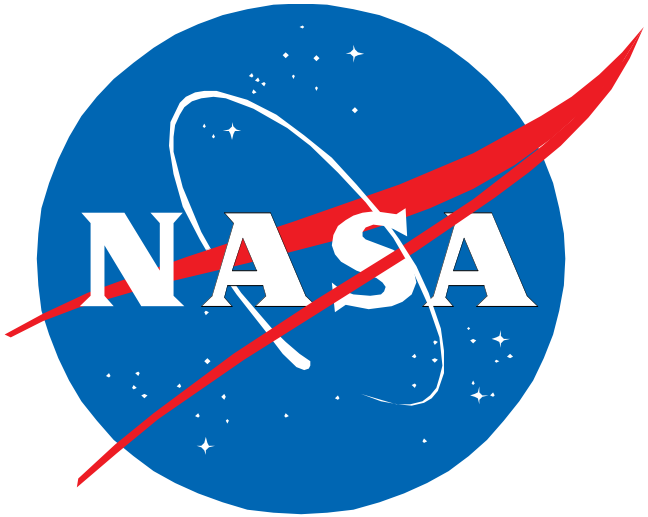
- ***Thrust 2:*** "Adaptive Aerostructures for Revolutionary Civil Supersonic Transportation," **PI: Dimitris Lagoudas, Texas A&M University** (NASA POC: Larry Cliatt, AFRC)

- ***Thrust 3:*** "Advanced Aerodynamic Design Center for Ultra-Efficient Commercial Vehicles," **PI: James Coder, University of Tennessee, Knoxville** (NASA POC: William Milholen, LaRC)

- ***Thrust 4:*** "Electric Propulsion: Challenges and Opportunities," **PI: Mike Benzakein, Ohio State University** (NASA POC: Ray Beach, GRC)

- ***Thrust 5:*** "Information Fusion for Real-Time National Air Transportation System Prognostics under Uncertainty," **PI: Yongming Liu, Arizona State University** (NASA POC: Kai Goebel, ARC)

| Agenda | | |
|---|---|---|
| Monday 25 June | 930-1000 | Introduction from NASA (Dr. John Cavolowsky, Director, Transformative Aeronautics Concepts Program) |
| | 1000-1100 | Adaptive Aerostructures for Revolutionary Civil Supersonic Transportation (Dr. Dimitris Lagoudas, Texas *A&M* Univ.) |
| | 1115-1215 | Hyper-Spectral Comm, Networking & ATM as Foundation for Safe, Efficient Future Flight (Dr. David Matolak, Univ. of So. Carolina) |
| | 1215-1300 | Lunch Break |
| | 1300-1400 | Panel Discussion - John Langford (President, Aurora Flight Sciences), Scott Drennan (Director, Innovation, Bell), Eric Ringer (Director, Aviation Technology, Skyward) will talk about aviation challenges that industry faces that could serve as future proposal ideas for university led teams |
| | 1400-1500 | Information Fusion for Real-Time National Air Transportation System Prognostics under Uncertainty (Dr. Yongming Liu, Arizona State Univ.) |
| | 1515-1615 | Electric Propulsion: Challenges and Opportunities (Dr. Mike Benzakein, Ohio State Univ.) |
| | 1615-1715 | Advanced Aerodynamic Design Center for Ultra-Efficient Commercial Vehicles (Dr. James Coder, Univ. Of Tennessee, Knoxville) |
| | 1730-1800 | Future ULI discussion and networking |
| | 1830-1930 | Informal ULI networking in the hotel lobby |
| | | |
| Tuesday, 26 June | 1830-2000 | Informal ULI networking at the NASA booth during the Opening Reception in the Exhibit Hall |


NASA

# Backups

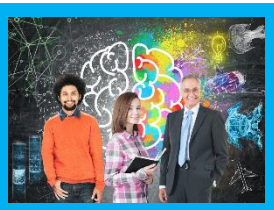
# University Leadership Initiative Strategic Goals

1. Achieve Aeronautics Strategy Outcomes with NASA-Complementary Research


2. Transition Research to Stakeholders


Strategic Goals


4. Promote Diversity in Aeronautics



3. Provide Opportunities for Students to Participate in Aeronautics Research