NASA Aeronautics
Advanced Air Vehicles Program

A Different Perspective

Barbara Esker, Deputy Director

Current Economic Benefits of Aviation

5.1% of U.S. GDP

10.6 Million
U.S. jobs

$1.6 Trillion
in U.S. economic activity annually

$59.9 Billion
of U.S. Trade Balance (exports-imports)

SOURCE: FAA Air Traffic Organization

Aviation equipment (aircraft, spacecraft, and related equipment) is largest export sector in U.S. economy accounting for over 8% of total exports.

SOURCE: U.S. International Trade Commission

Three Aviation Mega Drivers

NASA Aeronautics research strategy - addressing critical long-term needs

Traditional measures of global demand for mobility - economic development & urbanization - growing rapidly & creating transportation and competitive opportunities/challenges

- Increasingly urbanized world
- Rising global middle class driven by Asia-Pacific
- Urban transportation increasingly congested

Large/growing energy & environmental issues create enormous affordability/ sustainability challenges

- Continuing pressure to reduce noise & local air quality impacts
- Aviation industry sets challenging CO_2 reduction goals through mid-century

Revolutions in integration of automation, information, communication, energy, materials & other technologies enable opportunity for transformative aviation systems

- Networked comm/sensors, embedded artificial intelligence, & big data converging with traditional systems/technologies
- On-demand service models disrupting traditional industries

http://www.aeronautics.nasa.gov/pdf/armd-strategic-implementation-plan.pdf

NASA Aeronautics Research Programs

Aligned with Strategic Thrusts

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

MISSION PROGRAMS

Airspace Operations & Safety

AOSP

Safe, Efficient Growth in Global Operations

In-Time System-Wide Safety Assurance

Advanced Air Vehicles

AAVP

Ultra-Efficient Commercial Vehicles

Innovation in Commercial Supersonic Aircraft

Transition to Alternative Propulsion and Energy

Integrated Aviation Systems

IASP

Flight research-oriented, integrated, system-level R&T that support all six thrusts

X-planes/ test environment

SEEDLING PROGRAM

Transformative Aeronautical Concepts

TACP

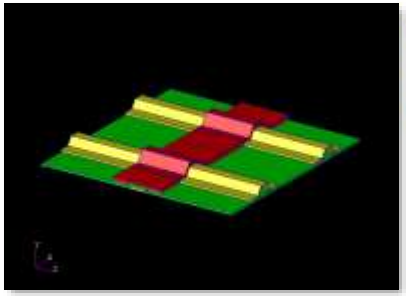
High-risk, leap-frog ideas that support all six thrusts

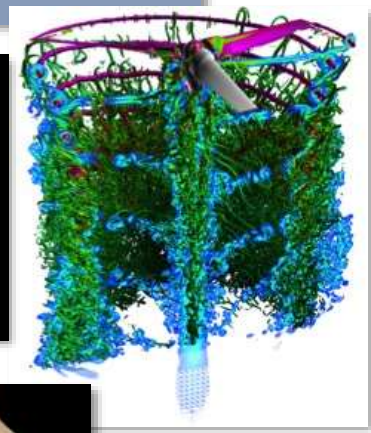
Critical cross-cutting tool development

Assured Autonomy for Aviation Transformation

Advanced Air Vehicles Program

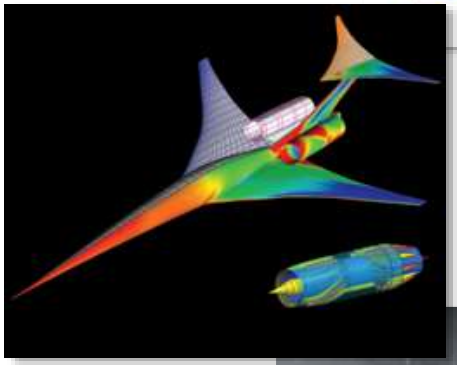
Cutting-edge research that will generate innovative concepts, technologies, capabilities & knowledge to enable revolutionary advances for a wide range of air vehicles.





Advanced Air Transport Project (AATT) *Conducts fundamental research to improve aircraft performance & minimize environmental impacts from subsonic air vehicles*

Revolutionary Vertical Lift Technology Project (RVLT) *Develops & validates tools, technologies & concepts to overcome key barriers, including noise, efficiency, & safety for vertical lift vehicles*

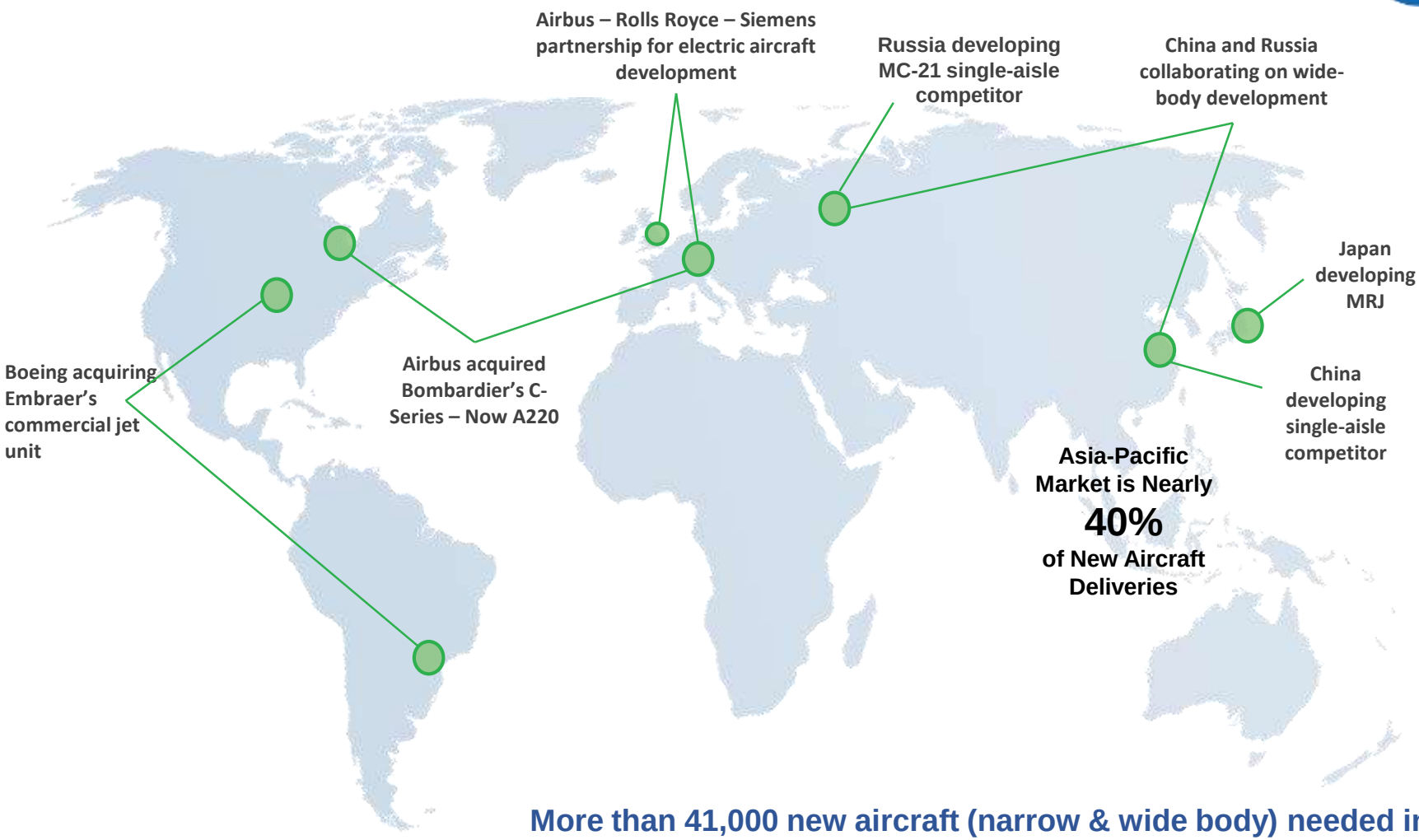


Advanced Composites Project (AC) *Conducts research to reduce the timeline for development & certification of composite structures for aviation*

Commercial Supersonics Technology Project (CST) *Develops tools & explores concepts for potential advanced capabilities & configurations for low boom supersonic aircraft.*

Hypersonic Technology Project (HT) *Develops tools & technologies in the area of hypersonic flight*

Commercial Transport Market on the Move



More than 41,000 new aircraft (narrow & wide body) needed in the next 15 years (market value of $6.1 trillion)

- 78% for narrow body including Regional Jet

Regional Jet demand to peak in 2025 as current fleets are retired

- Over 5,000 new RJs needed just for the North America market in the next 20 years, 2X more than the next largest market, Europe

Urban Air Mobility Emerging

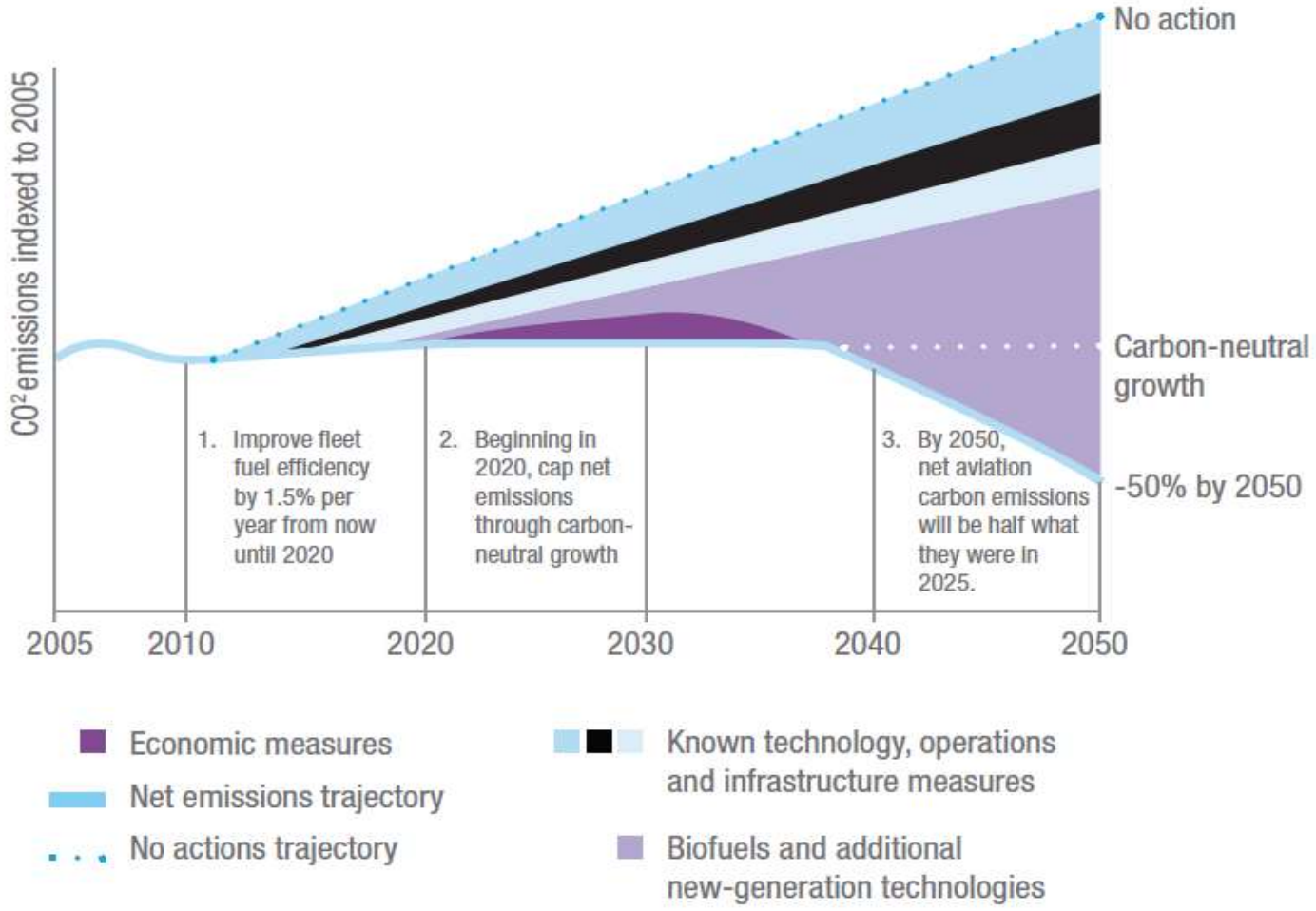
Large projected market–McKinsey analysis of demand by 2030 in 15 major U.S. cities:

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

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

Environmental Footprint - Major Aviation Community "Driver"

Reduce carbon footprint by 50% by 2050…



…. in the face of increasing demand, and while reducing development, manufacturing and operational costs of aircraft & meeting noise and LTO NO_x regulations.

Image Credit: IATA

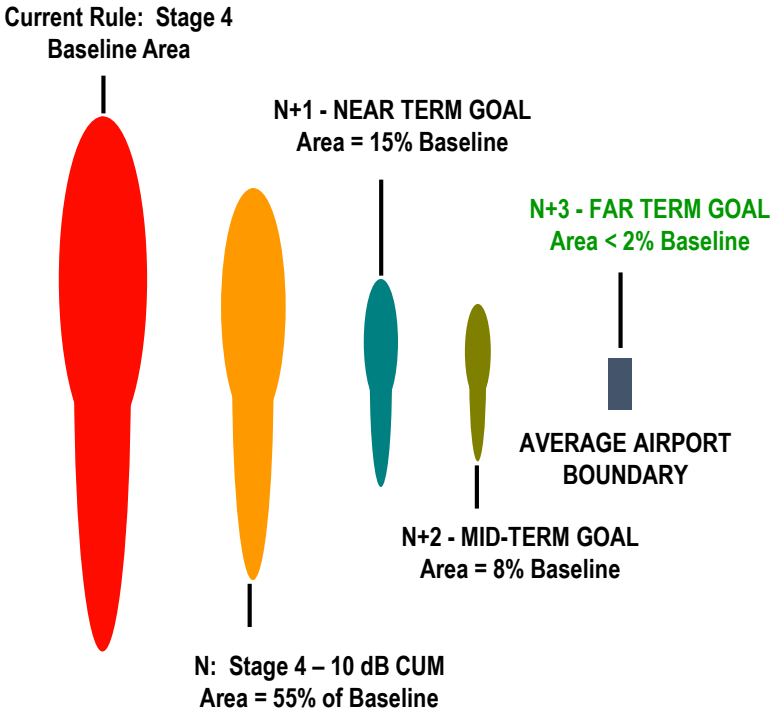
Noise Challenge to Global Growth in Aviation

Containing Objectionable Noise Within Airport

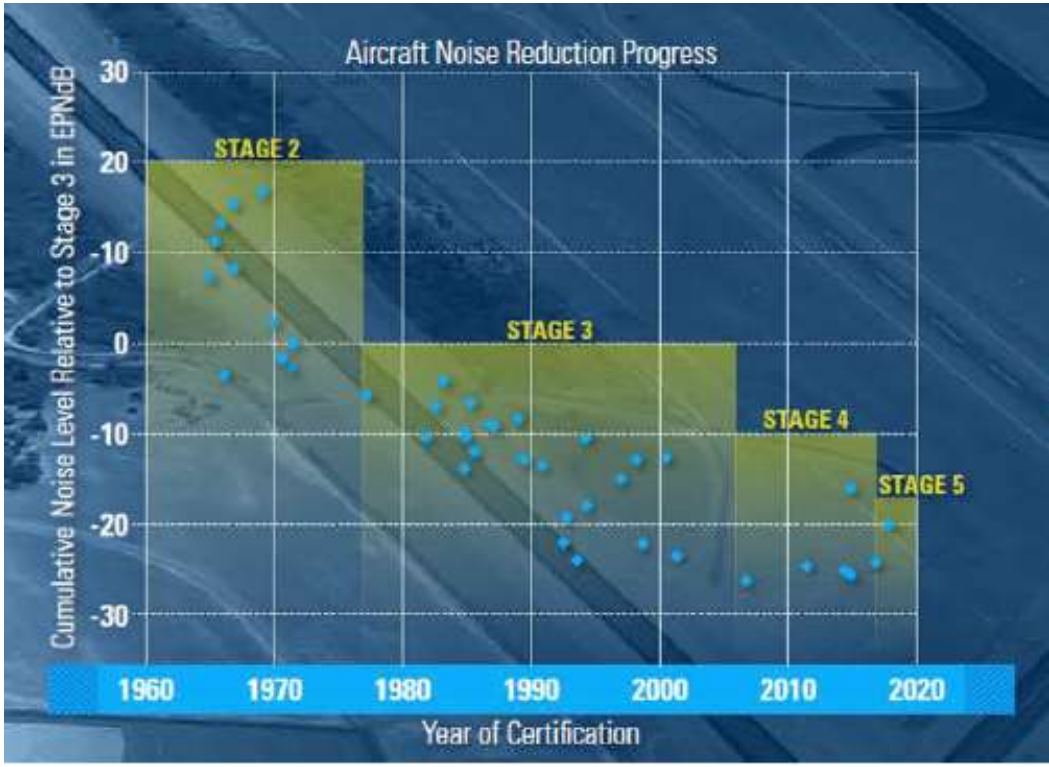
- FAA current (Stage 5) noise certification standards for airplanes certificated in the US went into effect January 2018 - an increase in stringency of 7 EPNdB (cum) relative to Stage 4 levels
- By 2030, noise regulations expected to be much stricter than current Stage 5. At least 1 and possibly 2 new stages for regulations may be expected

"Despite advances in noise reduction technologies, aviation noise is still the greatest constraint to capacity/growth at airports."

Sandy Lancaster, DFW Environmental Program Manager @ Acoustics Technical Working Group Meeting, April 10, 2018



Change in Noise "Footprint" Area for a Single Event Landing & Takeoff



Innovation in Commercial Supersonic Flight

WHY? **Commercial supersonic flight represents a potentially large new market for aircraft manufacturers and operators world-wide**

Government plays a central role in developing data needed for the regulation change - essential to enabling this new market

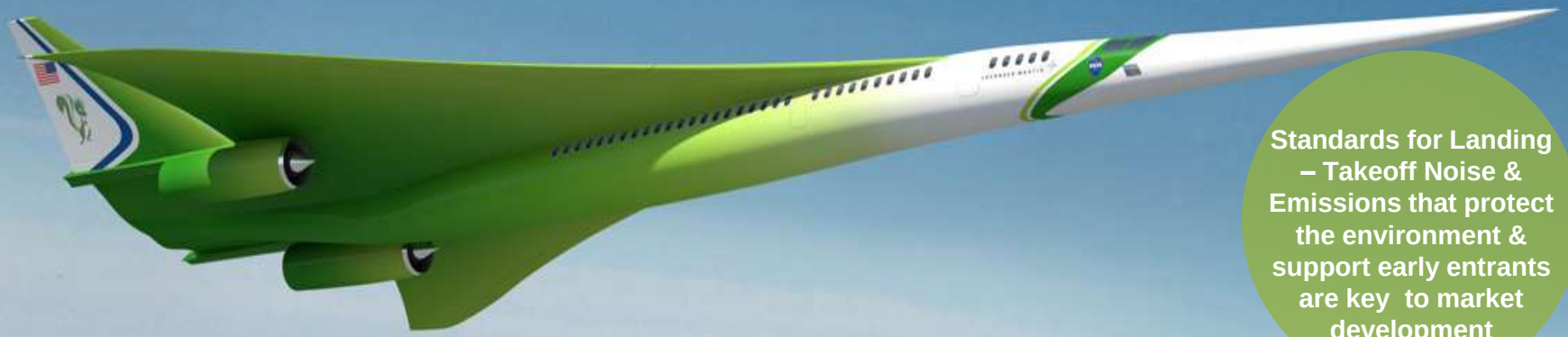
- **Air travel global demand growing - places a demand on speed.**
- **Supersonic aircraft manufacturing - opportunity for new market segment with significant export opportunity & high-tech job growth.**
  - **Large potential market predicted; business aircraft then larger commercial aircraft**
  - **Technology leadership through initial products leading to development of larger, more capable airliners**
- **Technologies reducing the environmental impact of supersonic aircraft may also benefit subsonic aircraft.**

The Vision for Commercial Supersonic Flight

Emerging potential market has generated renewed interest in civil supersonic aircraft

- Evidenced by the appearance of several commercial programs even with existing restrictions on overland flight and other challenges

Overland Flight Restrictions based on unacceptable sonic boom noise are viewed as the main barrier to this vision



Standards for Landing – Takeoff Noise & Emissions that protect the environment & support early entrants are key to market development

The vision of the Supersonics Community is a future where fast air travel is available for a broad spectrum of the traveling public.

- Future supersonic aircraft will not only be able to fly overland without creating an “unacceptable situation” but compared to Concorde and SST will be efficient, affordable and environmentally responsible

Credit: Lockheed Martin

Potential Urban Air Mobility (UAM) Missions

Passenger Carrying


e.g. AIR MEDICAL TRANSPORT


e.g. INTRA-METRO AIR SHUTTLE


e.g. UBIQUITOUS INTRA-METRO TAXI

Non-Passenger Carrying


e.g. PUBLIC SERVICE VEHICLES


e.g. SMALL PACKAGE DELIVERY


e.g. UAS MULTI-PACKAGE DELIVERY

Urban Air Mobility Market Studies

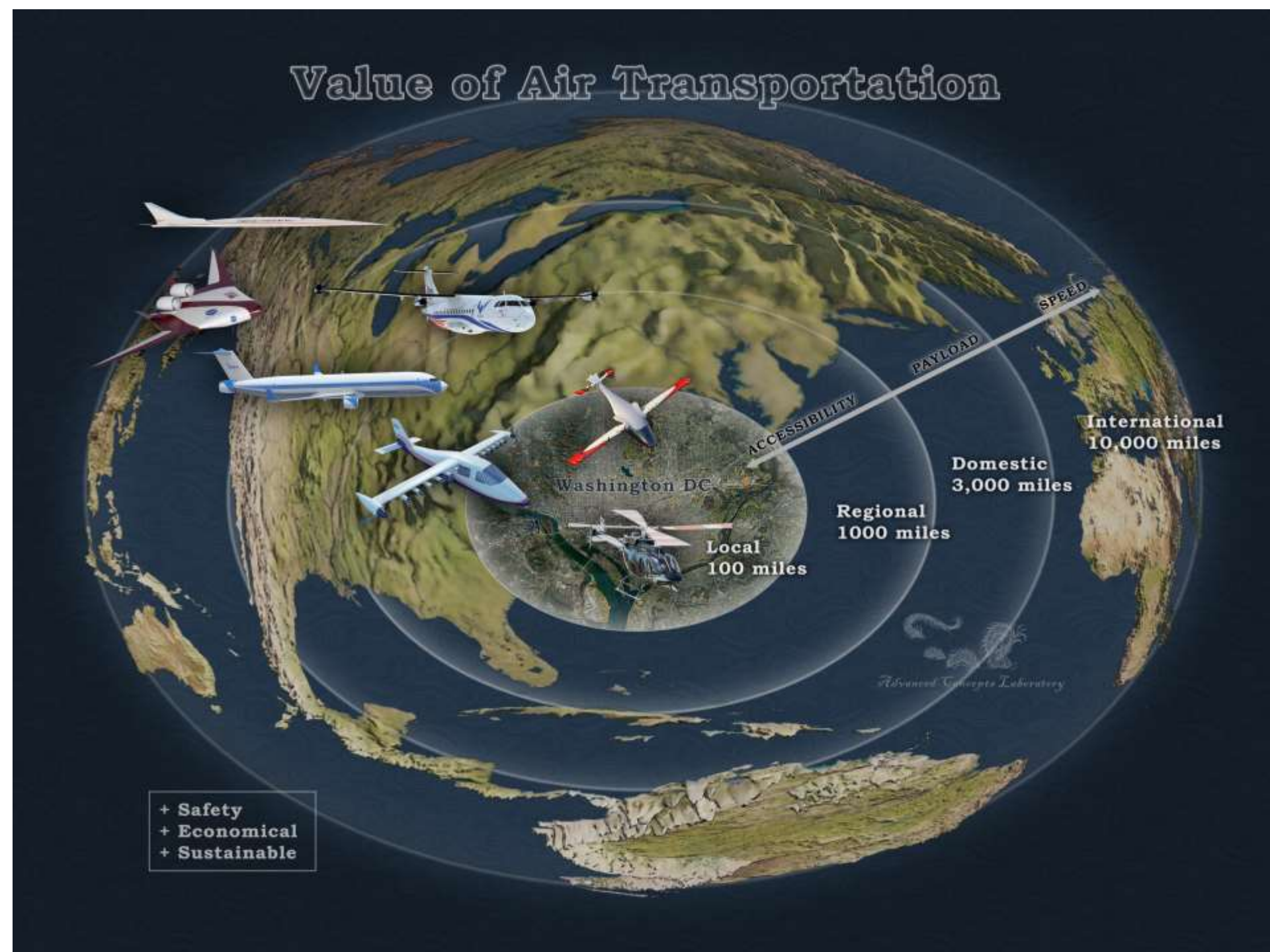
Two market studies

- Several air taxi/metro models, air ambulance, & last-mile package delivery potential markets
- Considerations for different urban areas, legal/regulatory barriers, & social acceptance issues

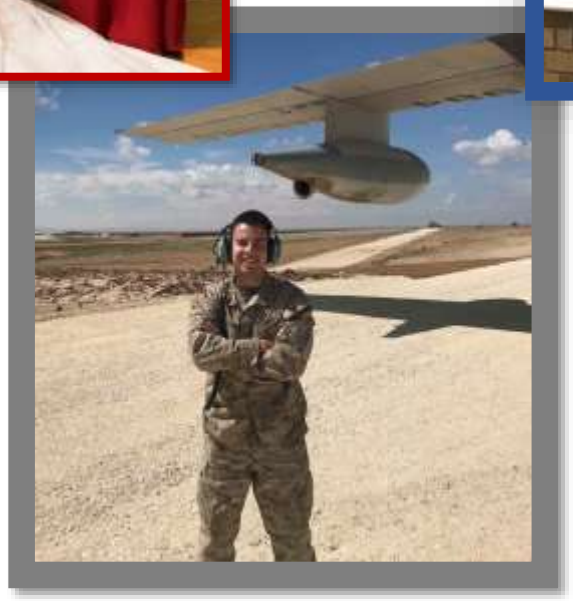
Large variability in specific predictions based on differences in assumptions

- By ~2028 a highly-automated “air metro” could be profitable
- By ~2030 result in ~750M annual passenger trips 15 metro areas or ~137k pax trips/day/area (key assumptions embedded) potential
- More conservative assumptions - $2.5B passenger transport market with ~8.2k pax trips/day/area
- Air ambulance model may not be profitable, but high impact on public good
- By ~2030 “last mile package delivery” could be profitable & result in ~500M deliveries annually

UAM - economically viable use cases if many challenges are overcome


Value of Air Transportation
SPEED
PAYLOAD
ACCESSIBILITY
Washington DC
Local
100 miles
Regional
1000 miles
Domestic
3,000 miles
International
10,000 miles
+ Safety
+ Economical
+ Sustainable

The Real “Why”



Thank you