NASA Aeronautics FY 2021 Congressional Budget Briefing

Robert Pearce, Associate Administrator
Aeronautics Research Mission Directorate
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NASA Aeronautics Priorities FY20/21

FY20 / FY21 Priorities

- Successfully complete the ATM Technology Demonstration Project, Advanced Composites Project, UAS Traffic Management Project, and the UAS Integration into the NAS Project and communicate the benefits to our stakeholders and the American public.
- Successfully transition from traditional air traffic management to a UTM-inspired, increasingly autonomous and collaborative air traffic management future.
- Drive U.S. leadership in Advanced Air Mobility through establishment of a community vision, development of the AAM National Campaign series and investment in priority research areas.
- Execute the LBFD Mission with rigor and discipline, including X-59 aircraft production and preparation for community response testing and flight operations.
- Establish and promote a vision for U.S. leadership in the next generation of commercial aircraft, working closely with the community to identify the highest priority technologies including appropriate applications of electrified aircraft propulsion, and fostering partnerships with industry to drive technology investment and advancement.
- Continue to integrate transdisciplinary research and fresh ideas into the ARMD portfolio through reimagining of CAS, better integrating fundamental research, and enhancing university engagements.
- Evolve NASA Aeronautics capabilities and our management policies to better integrate requirements and capability assessments into our management processes.
- Foster open communication among staff and management and enhanced engagement in ARMD day-to-day operations with an emphasis on building trust and encouraging all to assume positive intent from others.
- Evolve ARMD management structures (programmatic and mission support) to support ARMD transformation and agility.

NASA Aeronautics Strategies for Research

Safe, Efficient Growth in Global Operations

- Achieve safe, scalable, routine, high-tempo airspace access for all users

★ Captures requirements to enable diverse new aviation business models

Innovation in Commercial Supersonic Aircraft

- Achieve practical, affordable commercial supersonic air transport

Ultra-Efficient Subsonic Transports

- Realize revolutionary improvements in economics and environmental performance for subsonic transports with opportunities to transition to alternative propulsion and energy.

★ Consolidates Alternative Propulsion with Subsonic Vehicles to reflect integration focus

Safe, Quiet, and Affordable Vertical Lift Air Vehicles

- Realize extensive use of vertical lift vehicles for transportation and services including new missions and markets

★ Captures eVTOL community opportunities and requirements in new thrust

In-Time System-Wide Safety Assurance

- Predict, detect and mitigate emerging safety risks throughout aviation systems and operations

Assured Autonomy for Aviation Transformation

- Safely implement autonomy in aviation applications

Global Challenges

A New Era of Innovation Emerging for Long-Haul Aviation

NASA Aeronautics' vision and leadership underpin U.S. industry's ability to win the future

NASA is on track to enable a new era of supersonic air travel that will further connect the world and establish a new market segment for U.S. industry

- Low Boom Flight Demonstration Mission on schedule
- Industry innovation has begun – Boeing/Aerion, Lockheed, Boom, GE

NASA has established the concepts and key technologies required to enable 2030s transports

- Next step is ground and flight validation of integrated technologies by the mid-2020s
- Industry ready to cost-share partnerships – Boeing, GE, P&W, etc.

Global travel is predicted to more than double from 4 billion passengers annually today to over 8 billion annually in 20 years. This growth would support a nearly $6.8 T commercial transport market over that same timeframe.

Europe is aggressively investing to capture the technology lead from the U.S. and adding taxes/regulation to drive emissions reductions. China is seeking to capture the fastest growing market in Asia-Pacific through government funded R&D. American technology leadership at risk.

A New Era of Urban and Thin Haul Flight is Emerging

NASA Aeronautics' vision and leadership have stimulated aviation and non-aviation communities to pursue transformative aviation capabilities

NASA led the U.S. community with the UAS Traffic Management (UTM) and UAS in the NAS projects

- Integration of commercial systems is now beginning to emerge
- UTM is now the accepted concept all over the world

Advanced Air Mobility (AAM) is fast on the heels of UAS integration

- U.S. industry looking for NASA leadership now to help overcome key barriers
- Aggressive industry timeline for scalable operations creates challenging requirements

Significant Private Sector Investment – Aircraft Designs Maturing Rapidly – Competitive International Landscape – Advancing Regulatory Environment – Local/Regional Community Awareness and Interest

Low Boom Flight Demonstration Mission

Enabling Commercial Supersonic Flight

INTEGRATED AVIATION SYSTEMS

IASP

ADVANCED AIR VEHICLES

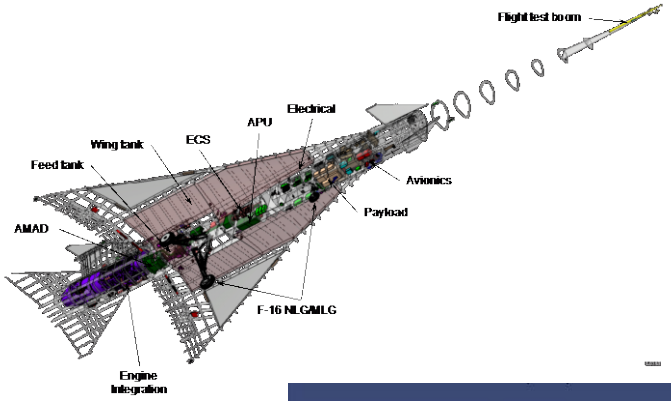
AAVP

Overcoming the Barrier to Overland Flight

Standards to Replace Current Prohibitions

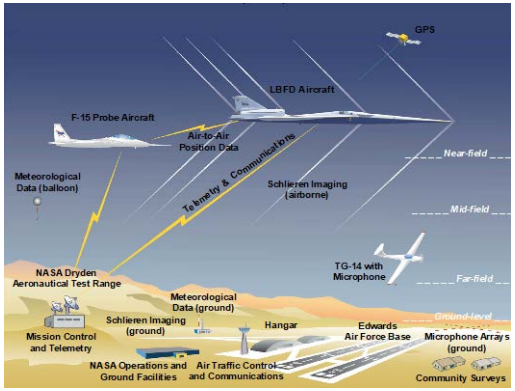
- **New Environmental Standards are needed to open the market to supersonic flight**
- **An En Route Noise Standard is the biggest challenge**
  - Requires proof of new design approaches, test procedures and response metrics
  - No relevant data exists to define limits
    - Community data from large, diverse population is a requirement
  - Standard must be accepted internationally

Low Boom Flight Demonstration Mission Phases



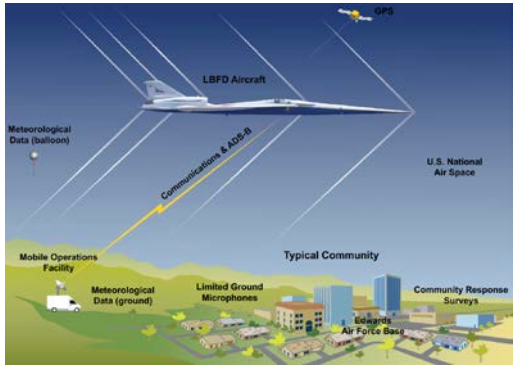
Phase 1 – X-59 Aircraft Development (FY18 - 22)

- Detailed Design
- Fabrication, Integration, Ground Test
- Checkout Flights
- Subsonic and Supersonic Envelope Expansion



Phase 2 – Acoustic Validation (FY22 - 23)

- Aircraft Operations / Facilities
- Research Measurements & Capabilities



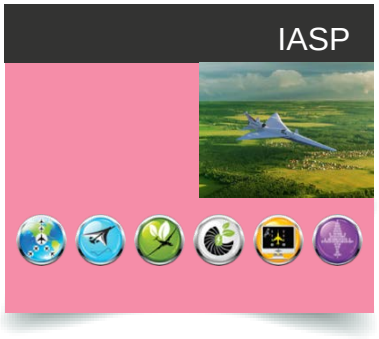
Phase 3 – Community Response (FY24 - 26)

- Initial community response overflight study
- Multiple campaigns (4 to 6) over representative communities and weather across the U.S.

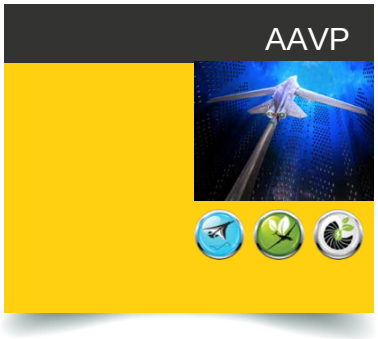
Subsonic Technology Development and Demonstration Strategy

NASA – U.S. Industry Partnership to Enable Transformational 2030's Commercial Vehicles

INTEGRATED AVIATION SYSTEMS

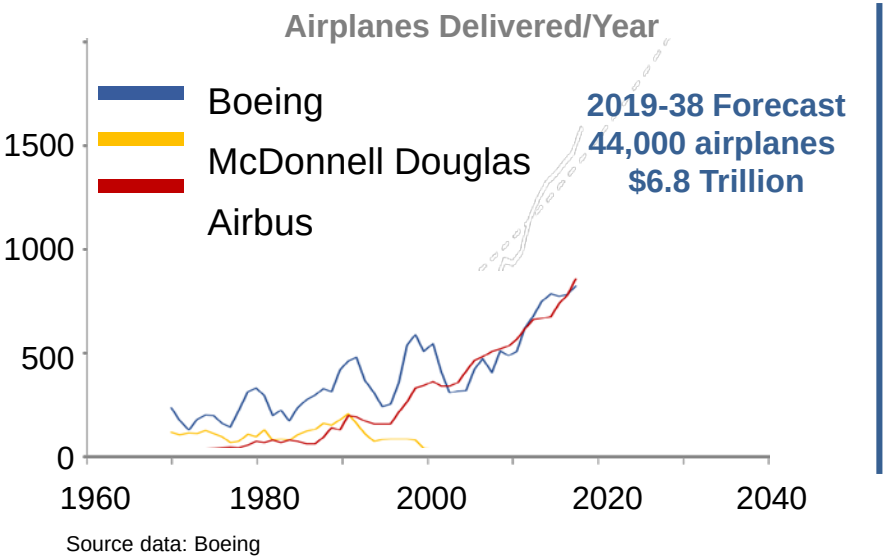


ADVANCED AIR VEHICLES

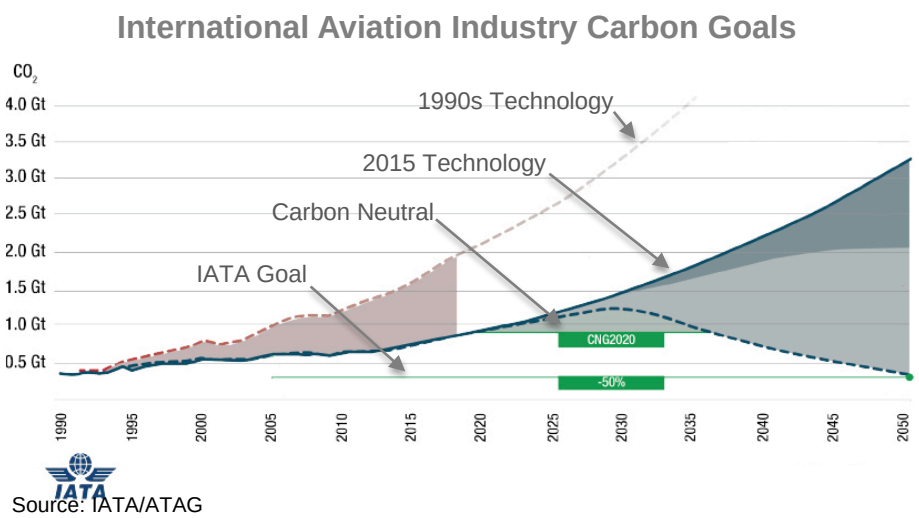


Subsonic Transport Airplane Market

Global competition and environmental pressure expanding



Source data: Boeing



Source: IATA/ATAG

- European manufacturers reaching parity
- New competitors in key Asia-Pacific growth market
- U.S. leadership at risk

- Market-based measures in place
- New ICAO CO_2 and nvPM standards starting in 2020
- Social pressure growing, e.g., flight shaming
- U.S. industry must meet global standards

Ultra-efficient subsonic transport technologies address both needs and offer operating cost benefits to airlines

Four Key Subsonic Transport Technologies

Create new "S" curve for the next 50 years of subsonic transports

Electrified Aircraft Propulsion

- Improved efficiency/emissions
- Mild hybrid systems promising for early 2030s

Small Core Gas Turbine

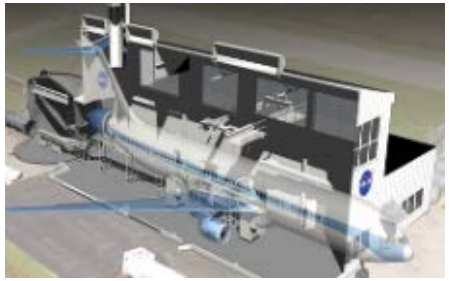
- Increased gas turbine efficiency
- Facilitates airframe integration – conventional or EAP

Transonic Truss-Braced Wing

- Increased aerodynamic and structural efficiency
- Propulsion system integration and high rate production

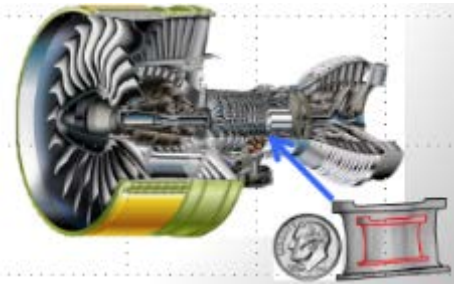
High Rate Composites

- Critical to U.S. competitiveness via reduced delivery time
- Reduced time/cost to market with increased performance

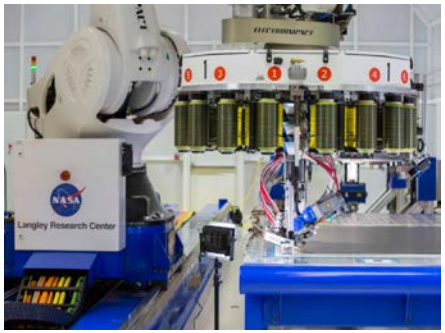


Electrified Aircraft Propulsion

synergistic



Small Core Gas Turbine



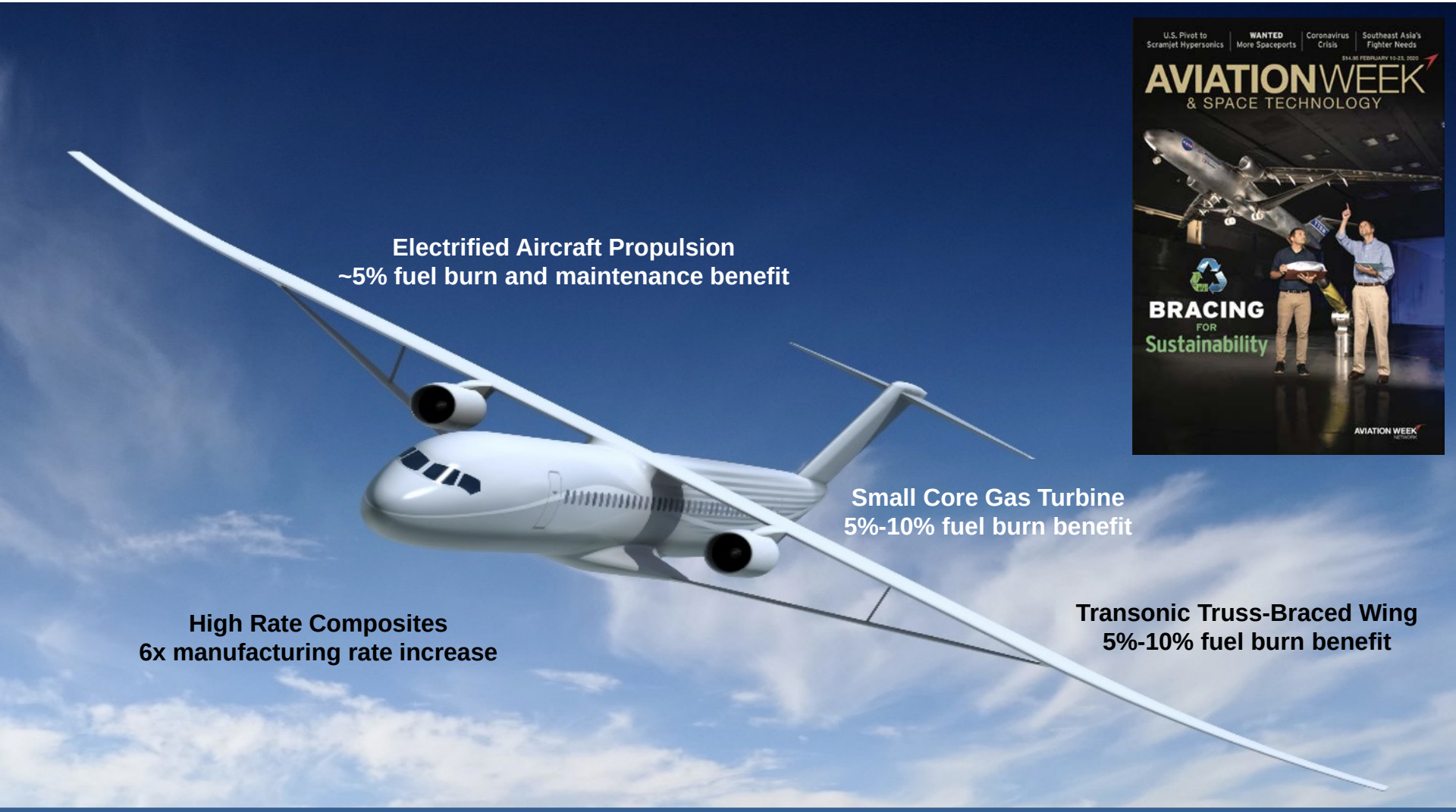
High Rate Composites

synergistic

Transonic Truss-Braced Wing

Advance key technologies to TRL 6 by 2025-28 to create early 2030s market opportunities for U.S. industry

Transonic Truss-Braced Wing Unifying Construct



Ensure U.S. industry is the first to establish the new “S Curve” for the next 50 years of transports

Urban Air Mobility Mission

AOSP

TACP

AAVP

IASP

Advanced Air Mobility Community Outcome

Vehicle Development and Operations

Airspace Design and Operations

Community Integration

AAM Community Outcome

Deliver a validated

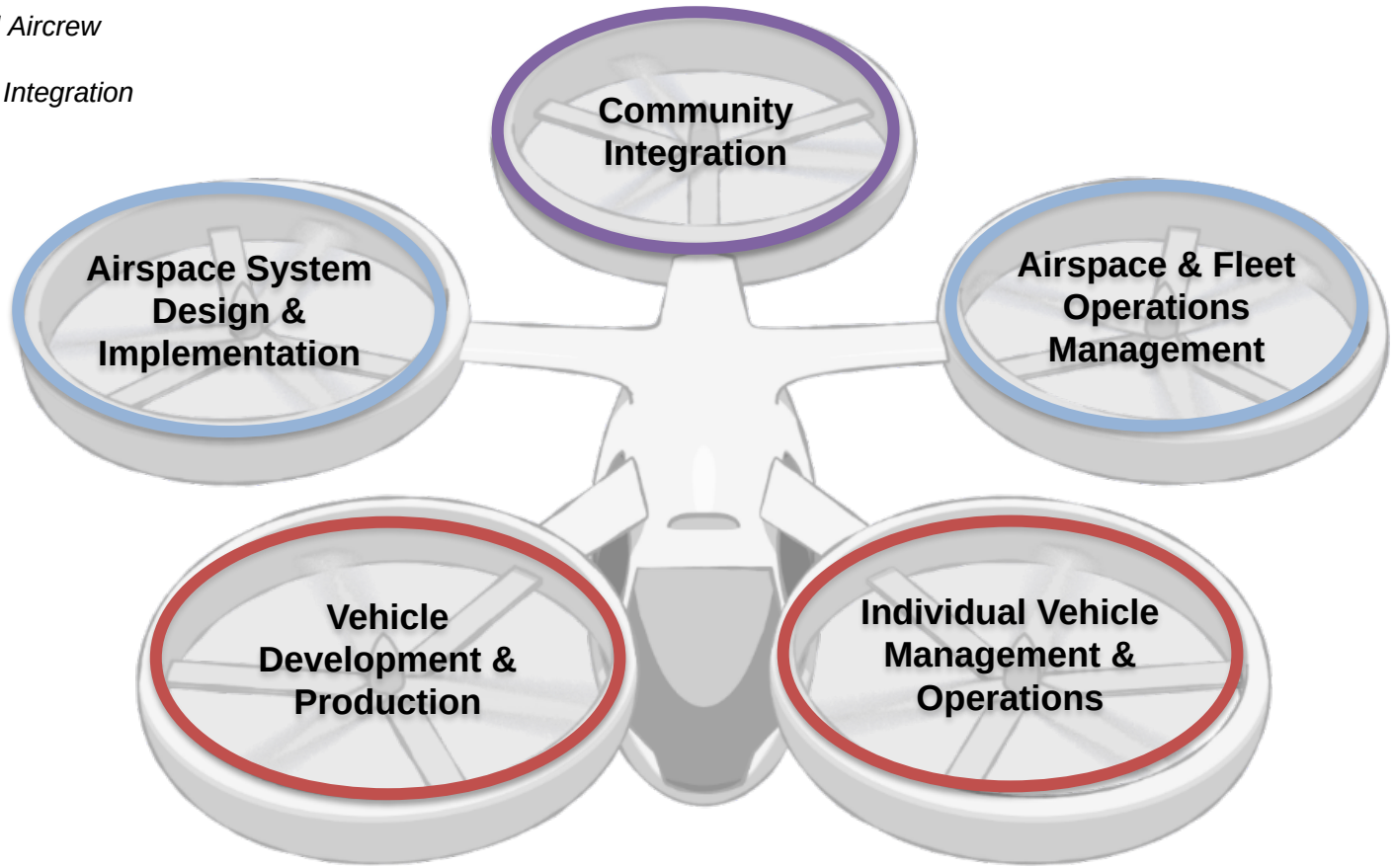
1) system concept and
2) corresponding set of requirements

for a safe and scalable UAM transportation system.

Achieving a “system of requirements” will require *enabling activities* such as 1) the UAM Grand Challenge Series, 2) a robust Partnership Strategy, and 3) NASA ARMD Portfolio Execution

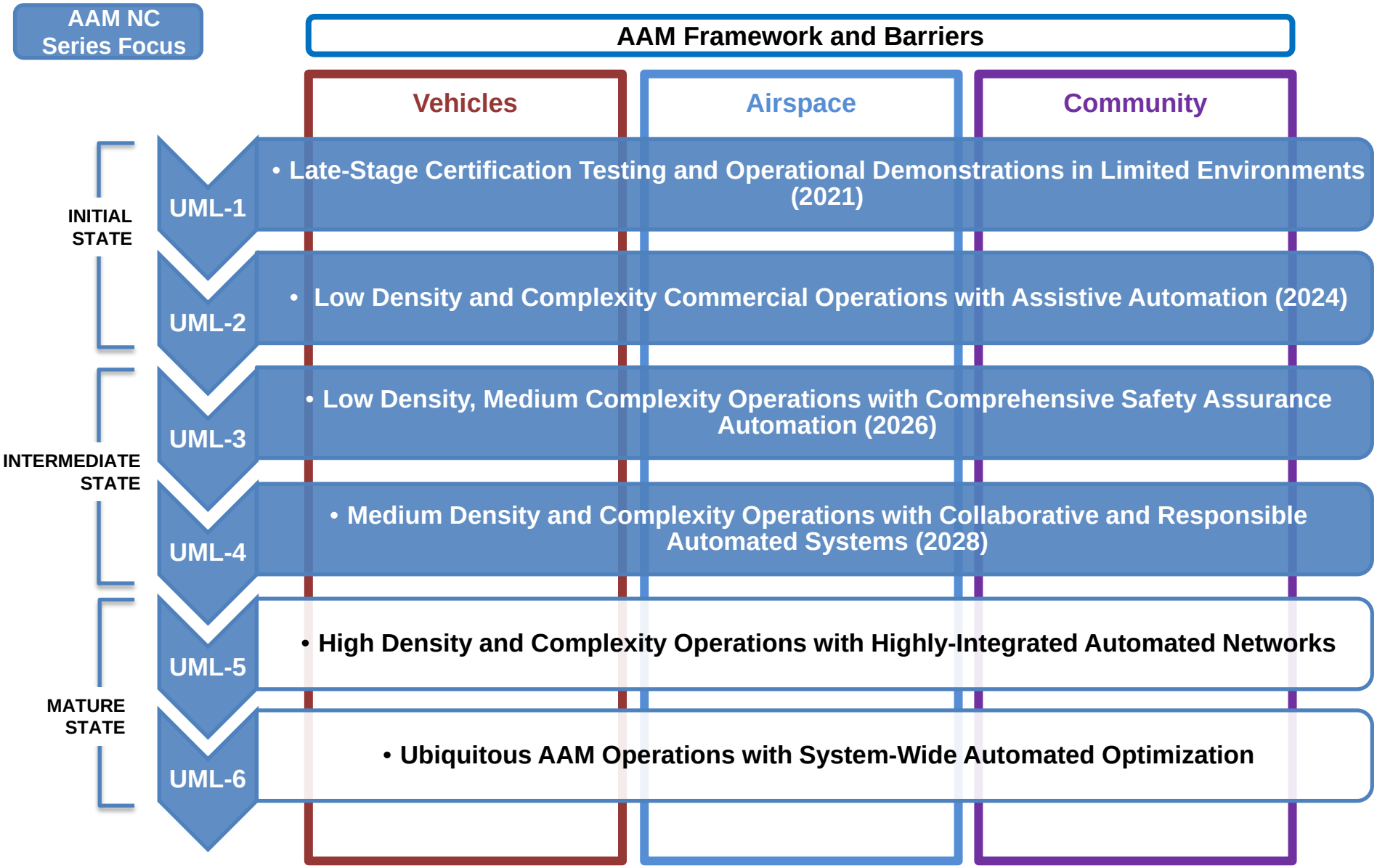
UAM Vision and Framework

Vehicle and Aircrew
Airspace
Community Integration

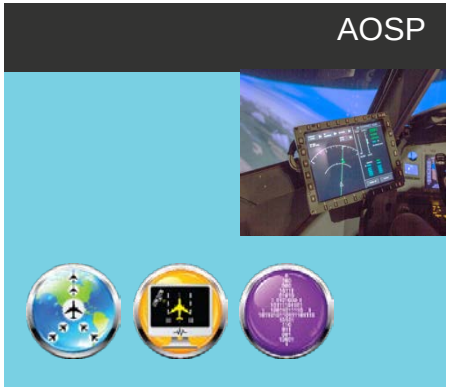


Urban Air Mobility (UAM) Vision
Revolutionize mobility in and around metropolitan areas by enabling a safe, efficient, convenient, affordable, and accessible air transportation system for passengers and cargo

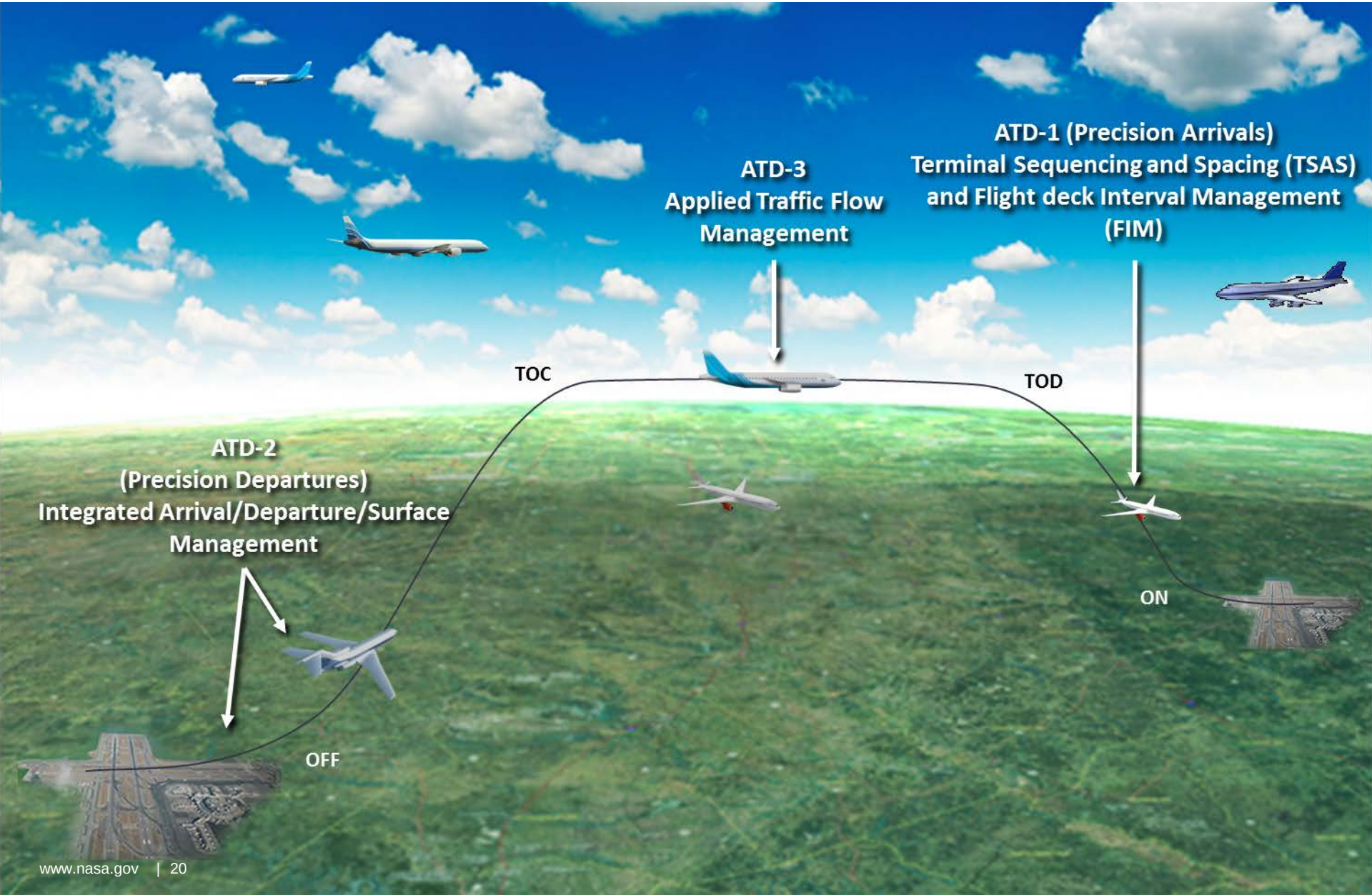
AAM Maturity Levels (UML) with Industry Timeline



Future Air Traffic Management



NASA's Contribution to the FAA NextGen Transformation



UTM Technical Capability Levels (TCL) Progression

- Beginning with a UAS Traffic Management (UTM) convention in 2015, NASA has completed a series of UTM technical capability demonstrations highlighted by flight tests in Reno, NV and Corpus Christi, TX.

TCL1

Remote Population

Low Traffic Density

Multiple VLOS Operations

Validation of cloud-based service oriented architecture

Completed 2015

TCL 2

Sparse Population

Low-Mod Traffic Density

Multiple BVLOS Operations

Operators, and established federated 3rd party service model information sharing

Completed 2017

TCL 3

Moderate Population

Suburban Applications

Mixed Operations

Vehicle to Vehicle Communication

UAS Service Supplier (USS) data exchange

Completed 2018

TCL 4

Dense Population

Urban Applications

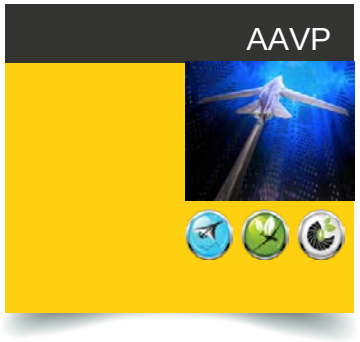
Operational concept, technologies, and data exchanges for operations near large structures and in highly populated areas

Completed 2019

Next Challenge: A More Highly Complex and Dynamic Airspace

Hypersonic Technology

ADVANCED AIR VEHICLES

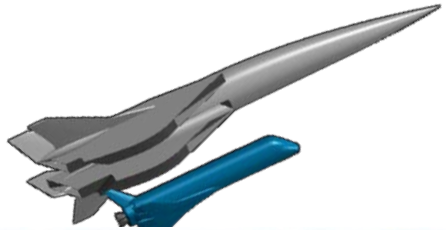


NASA Hypersonic Research

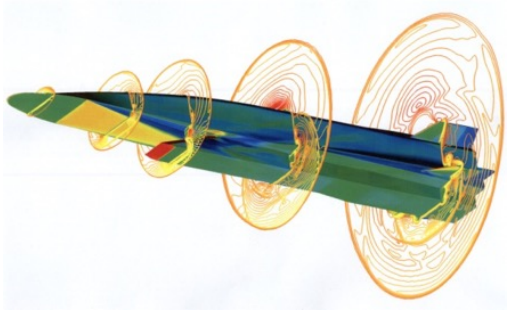
NASA's Hypersonic Technology Project supports the Nation by addressing key fundamental challenges for hypersonics

- Historically, NASA provided some of the key knowledge and technologies that paved the way for recent hypersonic programs

- In order to enable civilian applications and expanded defense missions we need reusability

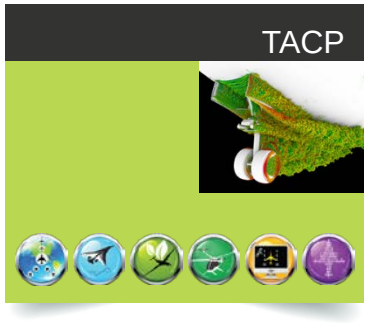


- Experience with recent flight projects has helped illuminate where shortfalls in design capabilities exist



There is significant international competition to develop hypersonic capabilities and NASA plays a key role in laying the groundwork for taking the next steps.

Energizing the U.S. Aeronautics Innovation Pipeline



ULI is Already Having a Broad Impact

- University teams proposing innovative ideas to solve complex, multi-disciplinary, aeronautics problems
- Integrating diverse participants from the broader community
- Educating students by engaging them in aeronautics research

33	*Universities*
75	*Faculty*
150+	*Students*
8	*Majors represented*

Aerosciences Evaluation and Test Capabilities

Aerosciences Evaluation and Test Capabilities Portfolio

- In FY 2020, Aeronautics began to manage Aerosciences Evaluation and Test Capabilities (AETC) Portfolio to support ground testing across all Agency mission directorates.

Portfolio Objectives

- **Strategically** manage a critical portion of aerosciences ground test capabilities in support of Agency testing requirements
- Ensure the **availability and ease of access** of a **minimum critical suite of aeroscience ground test assets** that are necessary to meet the long-term needs of the Agency

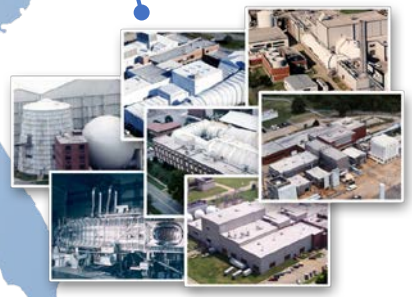
NASA Glenn Research Center (GRC)
Cleveland, OH

NASA Ames Research Center (ARC)
Moffett Field, CA

Portfolio Scope

- Aerosciences ground test facilities deemed critical to Agency (i.e. the Portfolio)
- Operations, maintenance, new capability, test technology and CFD-experimental integration advancements investments

NASA Langley Research Center (LaRC)
Hampton, VA



Summary

Supporting a New Era in the U.S. Aviation Industry

- U.S. industry needs to develop significantly more efficient aircraft by the mid 2030s to remain competitive in the global marketplace – these new aircraft will use advanced technologies and systems pioneered by NASA.
- U.S. industry will develop new AAM vehicles to move people and packages through urban environments by the late 2020s – NASA will provide critical leadership to enable safe, scalable and low-impact deployment in the national airspace.
- With the FY 2021 Budget Request, NASA Aeronautics:
  - Will develop and demonstrate key enabling technologies in close partnership with the U.S. aviation industry to transform subsonic airliners market
    - Demonstrates electrified aircraft propulsion via flight testing, first flight in FY 2023
  - Will develop and demonstrate key enabling technologies in full partnership with the Advanced Air Mobility community to ensure the U.S. leadership in opening a scalable, safe, efficient, and environmentally acceptable market – This new capability will reduce ground-based traffic congestion, improve local air quality, and transform urban areas
  - Will deliver scientifically acquired data of community response to low sonic boom to the international and U.S. standards and rule making organizations (e.g., ICAO, FAA) to usher in renewed supersonic flight for the flying public
  - Will take the next steps beyond NextGen with the aviation community to advance research for a more flexible and dynamic airspace management system that supports traditional and new users with high levels of safety and efficiency