



EXPLORE FLIGHT

WE'RE WITH YOU WHEN YOU FLY

FAA REDAC Briefing

Dr. Edgar G Waggoner, Deputy Associate Administrator for Programs
Aeronautics Research Mission Directorate
October 20, 2021



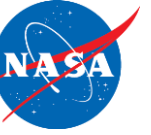
Strategy, Organization and Vision

FY 2022 President's Budget Request

Focus Topics

- Sustainable Flight National Partnership
- Low Boom Flight Demonstration Mission
- Advanced Air Mobility Mission
- Hypersonic Technology
- Energizing the U.S. Aeronautics Innovation Pipeline
- Aerosciences Evaluation and Test Capabilities

Summary



Strategy, Organization and Vision

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



Safe, Quiet, and Affordable Vertical Lift Air Vehicles



Innovation in Commercial Supersonic Aircraft



In-Time System-Wide Safety Assurance



Ultra-Efficient Subsonic Transports



Assured Autonomy for Aviation Transformation

U.S. leadership for a new era of flight

Airspace Operations and Safety Program



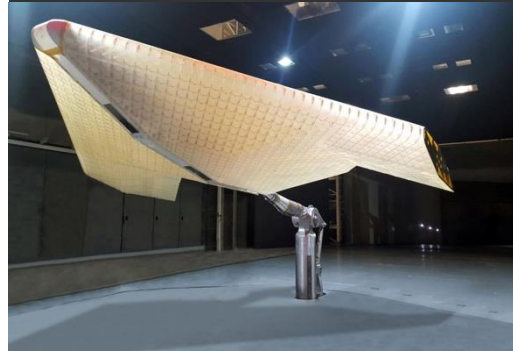
Advanced Air Vehicles Program



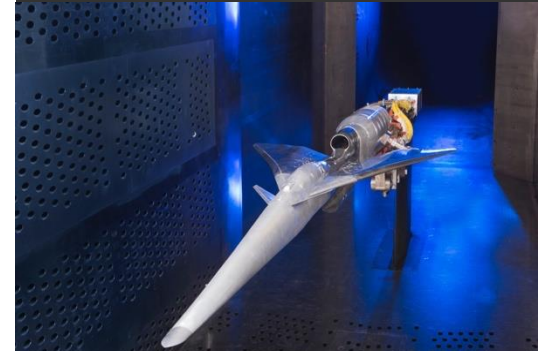
Integrated Aviation Systems Program



Transformative Aeronautics Concepts Program



Aerosciences Evaluation and Test Capabilities Portfolio



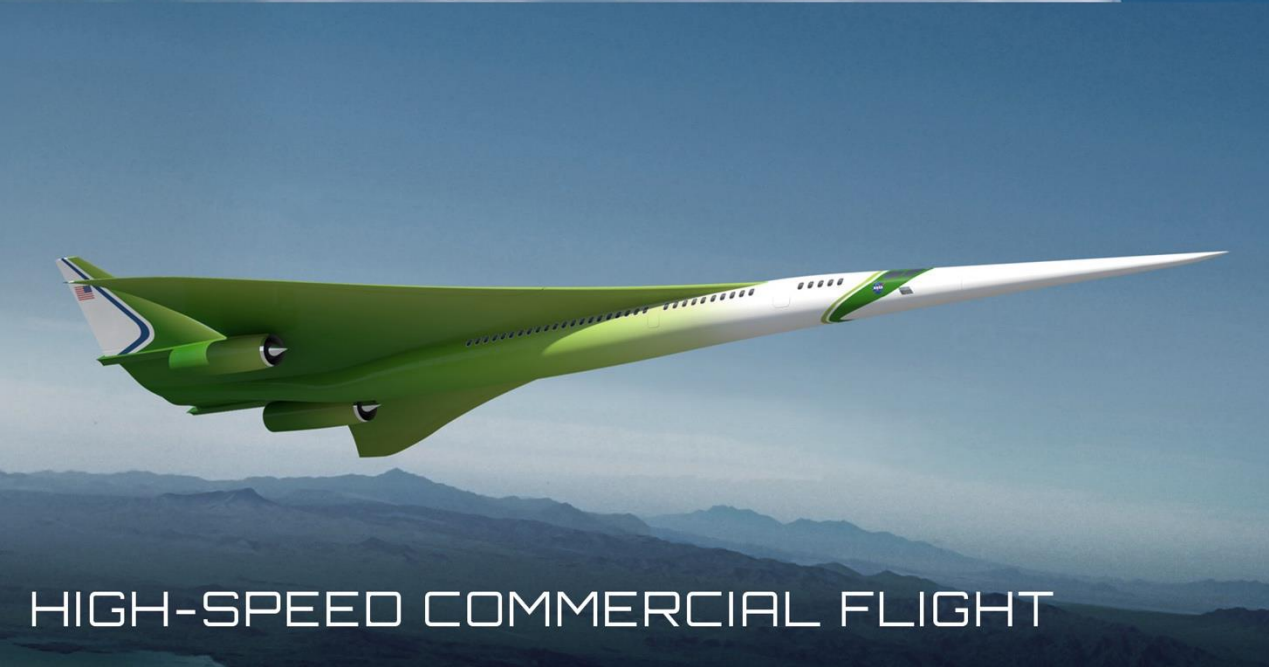
ARMD PROGRAMS



ULTRA-EFFICIENT TRANSPORT



FUTURE AIRSPACE



HIGH-SPEED COMMERCIAL FLIGHT



ADVANCED AIR MOBILITY

Four Transformations for Sustainability, Greater Mobility, and Economic Growth



FY 2022 President's Budget Request

Aeronautics FY 2022 Budget Request



\$ Millions	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026
Aeronautics	\$828.7	\$914.8	\$933.7	\$954.1	\$975.2	\$996.8
Airspace Operations and Safety	92.0	104.5	106.3	108.1	108.1	108.1
Advanced Air Vehicles	211.4	243.7	254.6	270.9	288.5	269.5
Integrated Aviation Systems	278.7	301.5	305.5	310.7	309.2	349.9
Transformative Aeronautics Concepts	129.7	148.0	150.3	147.4	152.4	152.4
Aerosciences Evaluation and Test Capabilities	116.9	117.0	117.0	117.0	117.0	117.0

FY 2022 Budget Request - Changes

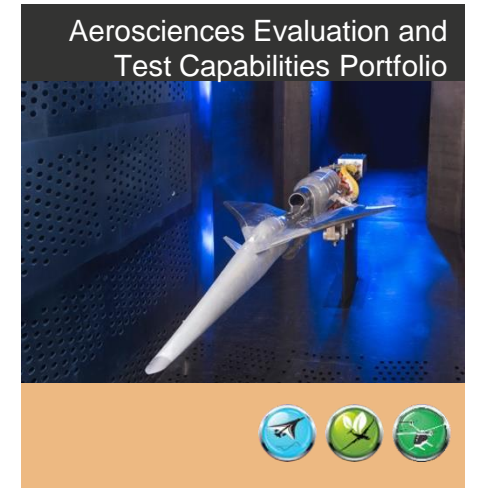
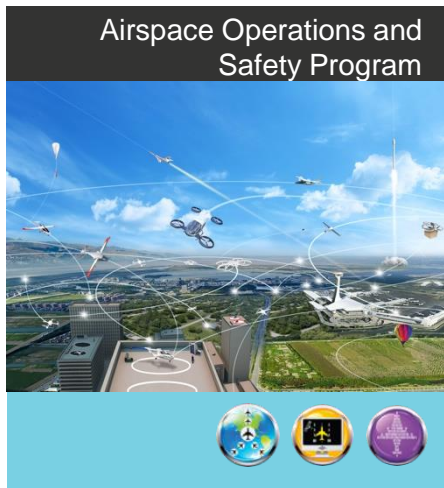


- Increased funding to accelerate and expand key components of the newly initiated Sustainable Flight National Partnership. By accelerating and expanding these activities, NASA will ensure that the technologies will be ready by the mid to late 2020s to transition into U.S. industry's next generation single-aisle transport aircraft.
 - Fund a sustainable flight demonstrator with a first flight in FY 2026
 - Ensure funding for at least two major electrified powertrain demonstrations
 - Accelerate subsonic technology development by up to two years
 - Develop technologies needed to enable use of sustainable aviation fuels
 - Enhance air traffic management automation tools that will safely and reliably put future aircraft on flight paths optimized for minimal environmental impact
 - Expand research on zero-emissions aircraft concepts and technologies through the highly successful University Leadership Initiative



Sustainable Flight National Partnership

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



Aviation Industry Pillars for a Sustainable Future



Global Aviation Industry's GOAL: 50% reduction in carbon emissions by 2050 relative to 2005 and possible net zero emissions by 2060 through these three means

TECHNOLOGY



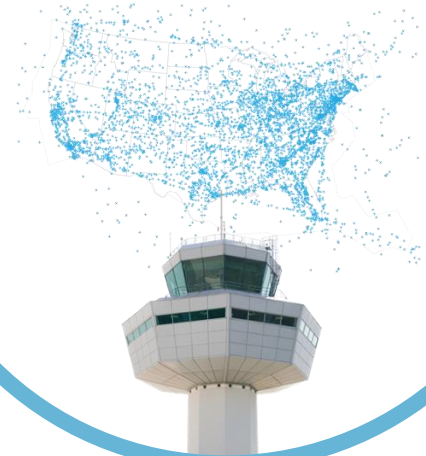
NASA = Primary Role

SUSTAINABLE
AVIATION FUEL



NASA = Supporting Role

OPERATIONS
AND INFRASTRUCTURE



NASA = Primary Role

Sustainable Flight National Partnership Benefits



Small Core Gas Turbine for
5%-10% fuel burn benefit
(HyTEC Project)

High-Rate Composites for 6x
manufacturing rate increase
(HiCAM Project)

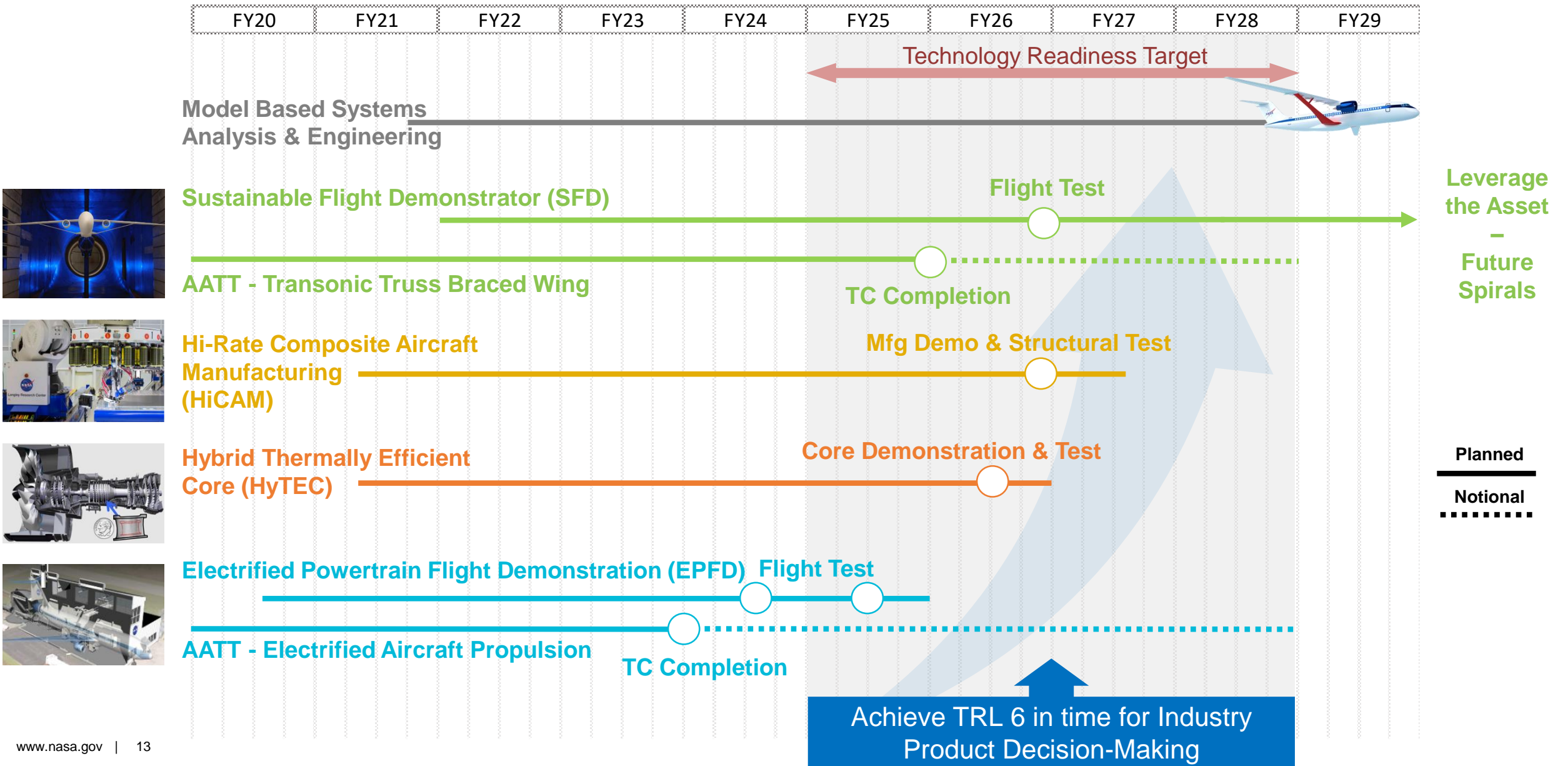
Sustainable Aviation Fuels for
reduced lifecycle carbon
emissions
(AATT Project)

Electrified Aircraft Propulsion for
~5% fuel burn and maintenance
benefit
(EPFD Project)

Integrated Trajectory Optimization
for 1%-2% reduction in fuel
required and minimization of
contrail formation
(ATM-X Project)

Transonic Truss-Braced Wing
for 5%-10% fuel burn benefit
(AATT Project)

Subsonic Transports: Integrated Technology Development



Sustainable Flight Demonstrator

Demonstrate integrated technologies in flight



FY22	FY23	FY24	FY25	FY26	FY27
Preliminary & detailed design					
			Build		
					Test

Scope

- Develop and fly an integrated multi-technology flight demonstrator with U.S. industry to mature technologies that enable the next-generation single-aisle aircraft in the 2030s.

Benefit

- Validate promising technologies, retire technical risks, and mature to TRL 6 key synergistic commercial transport vehicle technologies. Combined, these technologies could support efficiency and environmental performance goals for the 2030s.

Approach

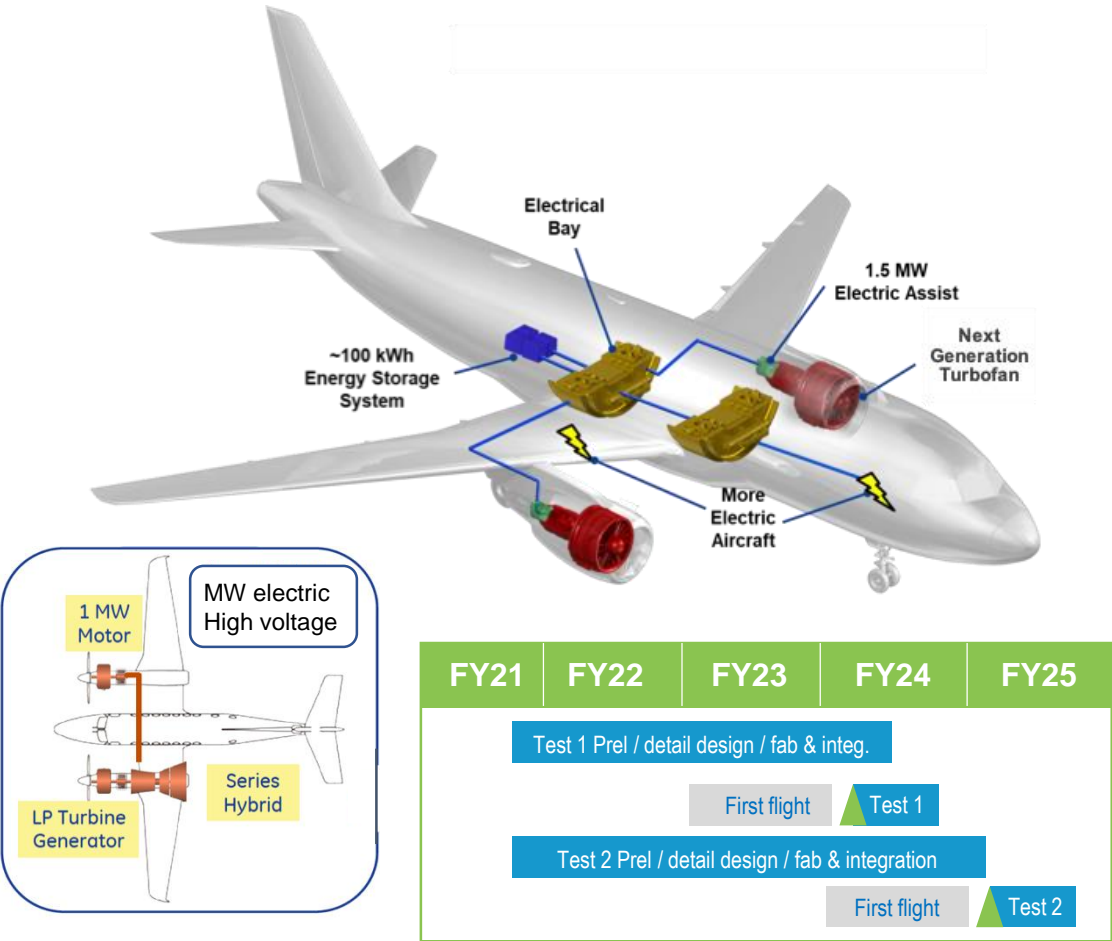
- Currently in pre-formulation
- Request for information in November 2020
- December 2020 industry day to discuss ideas

Risk Reduction Contract Awards 2021, Design/Build Contract Award 2022

Electrified Powertrain Flight Demonstration



Demonstrate integrated electrified powertrains in flight using industry platforms



Scope

- Demonstrate practical vehicle-level integration of megawatt-class electrified aircraft propulsion systems, leveraging advanced airframe systems to reinvigorate the regional and emerging smaller aircraft markets and strengthen the single aisle aircraft market.
- Assess gaps in regulations/standards to support future Electrified Aircraft Propulsion (EAP) certification requirements.

Benefit

- Accelerate U.S. industry readiness to transition to Electrified Aircraft Propulsion (EAP)-based commercial transport aircraft.
- Enable new standards that are needed for EAP-based aircraft certification.

Approach

- Engage with U.S. industry to integrate and demonstrate megawatt-class EAP machines in flight.
- Engage with the FAA, SAE, ASTM, etc. to contribute data that inform EAP standards and regulations.

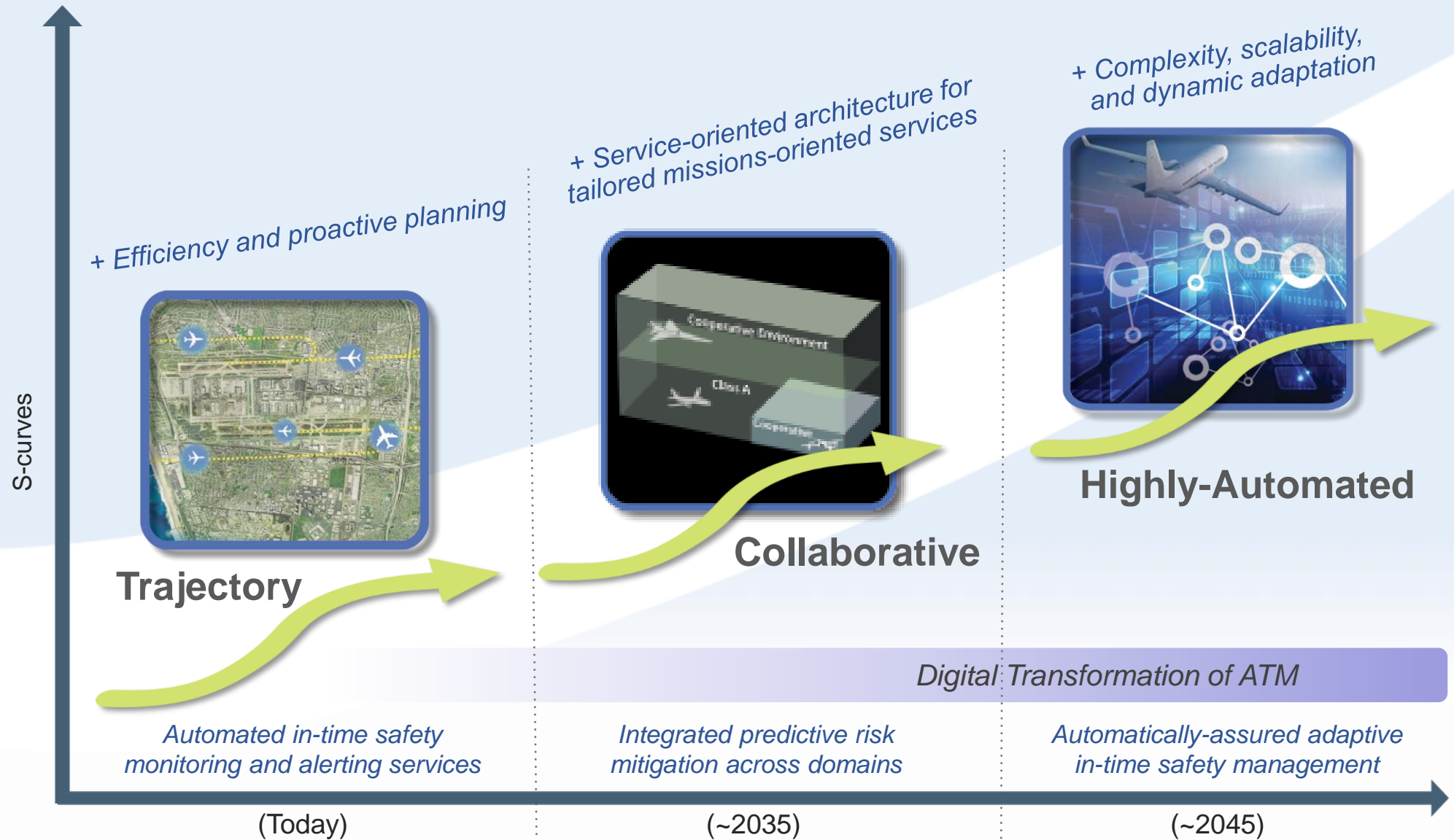
SOLICITATION RESPONSES SUBMITTED TO NASA IN MAY 2021

NASA's Vision for Sustainable Aviation Operations



- Integrated trajectories optimized for environmental benefit
- Advanced flight deck capabilities to operate on those trajectories
- Tailored services that support safe integration of all diverse operations

Evolution of Airspace Operations and Safety



Low Boom Flight Demonstration Mission

Enabling Commercial Supersonic Flight



High-Speed Commercial Flight

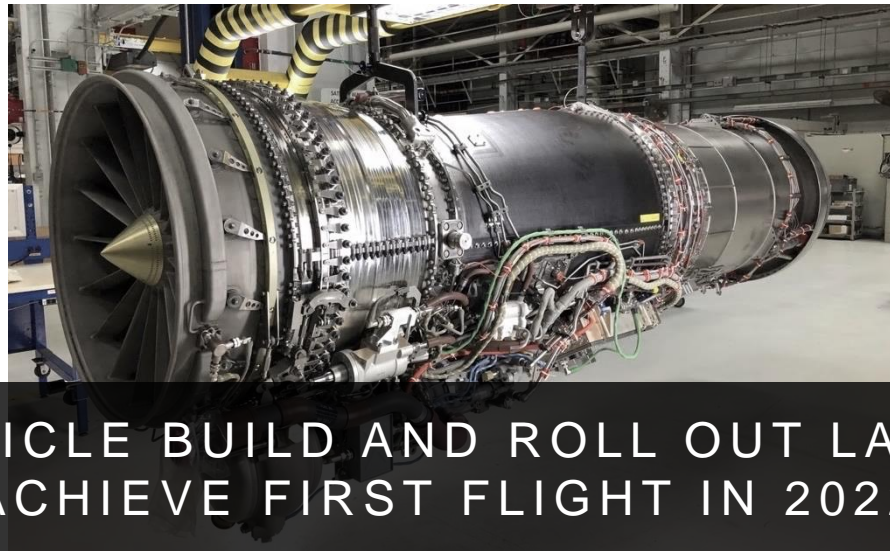
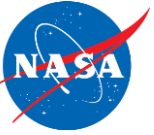
Sustainable transformation of the speed of air travel



Addressing the unique barriers to sustainable, environmentally responsible high-speed flight

Generate key data to support development of en route certification standards based on acceptable sound levels

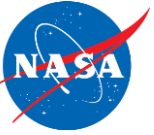
Recent Scenes of X-59 Construction Progress



Components of NASA's first piloted supersonic X-plane in a generation are under construction by our contract partner Lockheed Martin.

COMPLETE VEHICLE BUILD AND ROLL OUT LATER THIS YEAR
ACHIEVE FIRST FLIGHT IN 2022

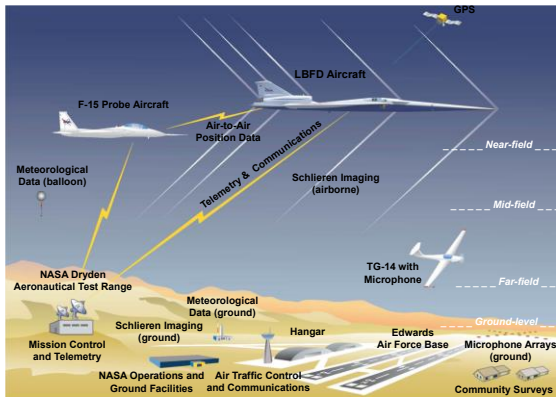
Low-Boom Flight Demonstration Mission Overview



Phase 1 – Aircraft Development

In progress (FY18-23)

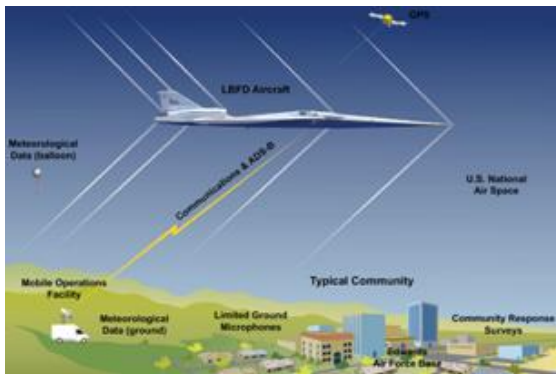
- Design, fabricate a quiet supersonic research aircraft
- Prove performance in test range flights
- Prove safety for flights in normal airspace



Phase 2 – Acoustic Validation

Preparation in progress (FY18-23), Execution FY23-24

- Prove the acoustic characteristics match design targets
- Detailed in flight and ground measurements in test range



Phase 3 – Community Response Testing

Preparation in progress (FY19-23), Execution FY24-27

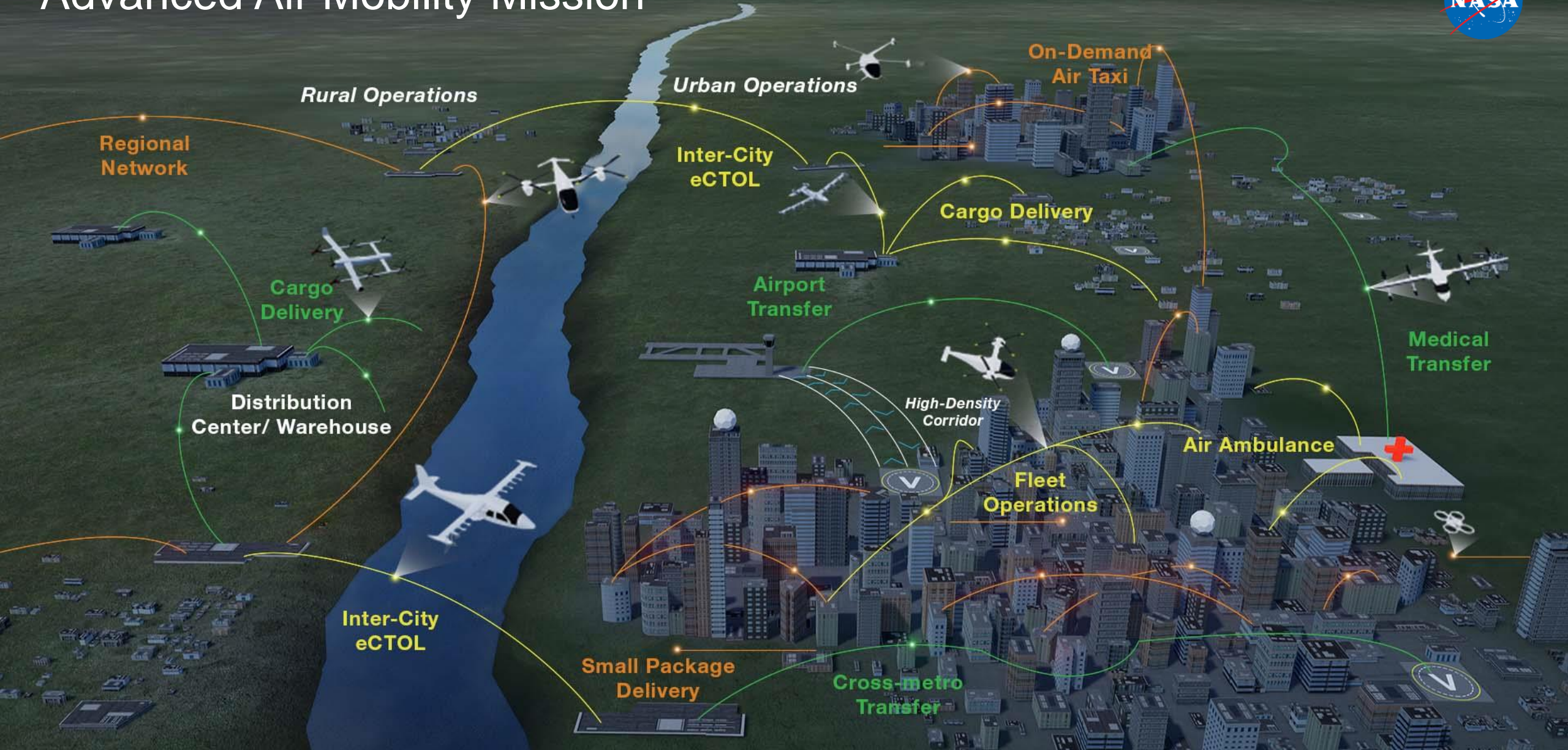
- Conduct community tests
 - Select communities
 - Outreach and engagement (including STEM)
 - Obtain necessary approval
 - Plan surveys and recruit participants
 - Collect ground measurements

**Systematic
Approach Leading
to Community
Testing**

Advanced Air Mobility Mission



Advanced Air Mobility Mission



Safe, sustainable, affordable, and accessible aviation for transformational local and intraregional missions

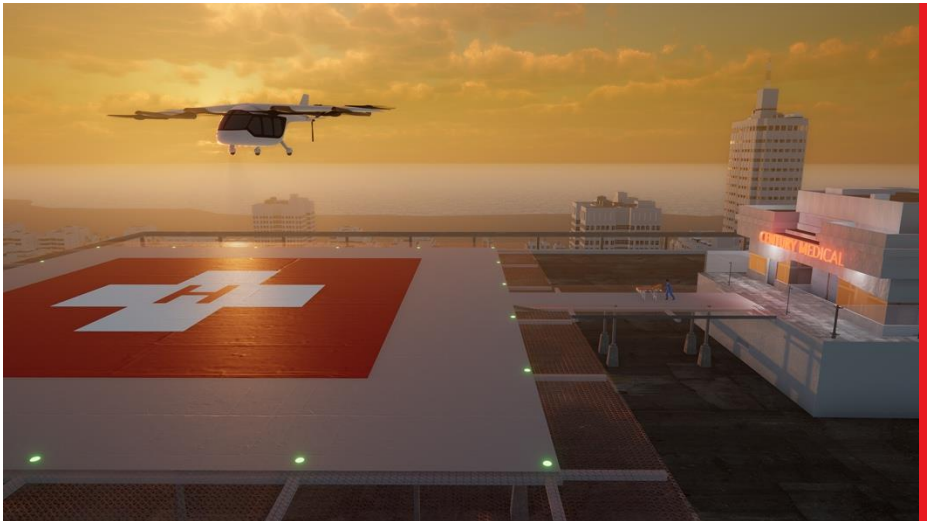
Advanced Air Mobility is Emerging



CARGO
TRANSPORT



PUBLIC GOOD



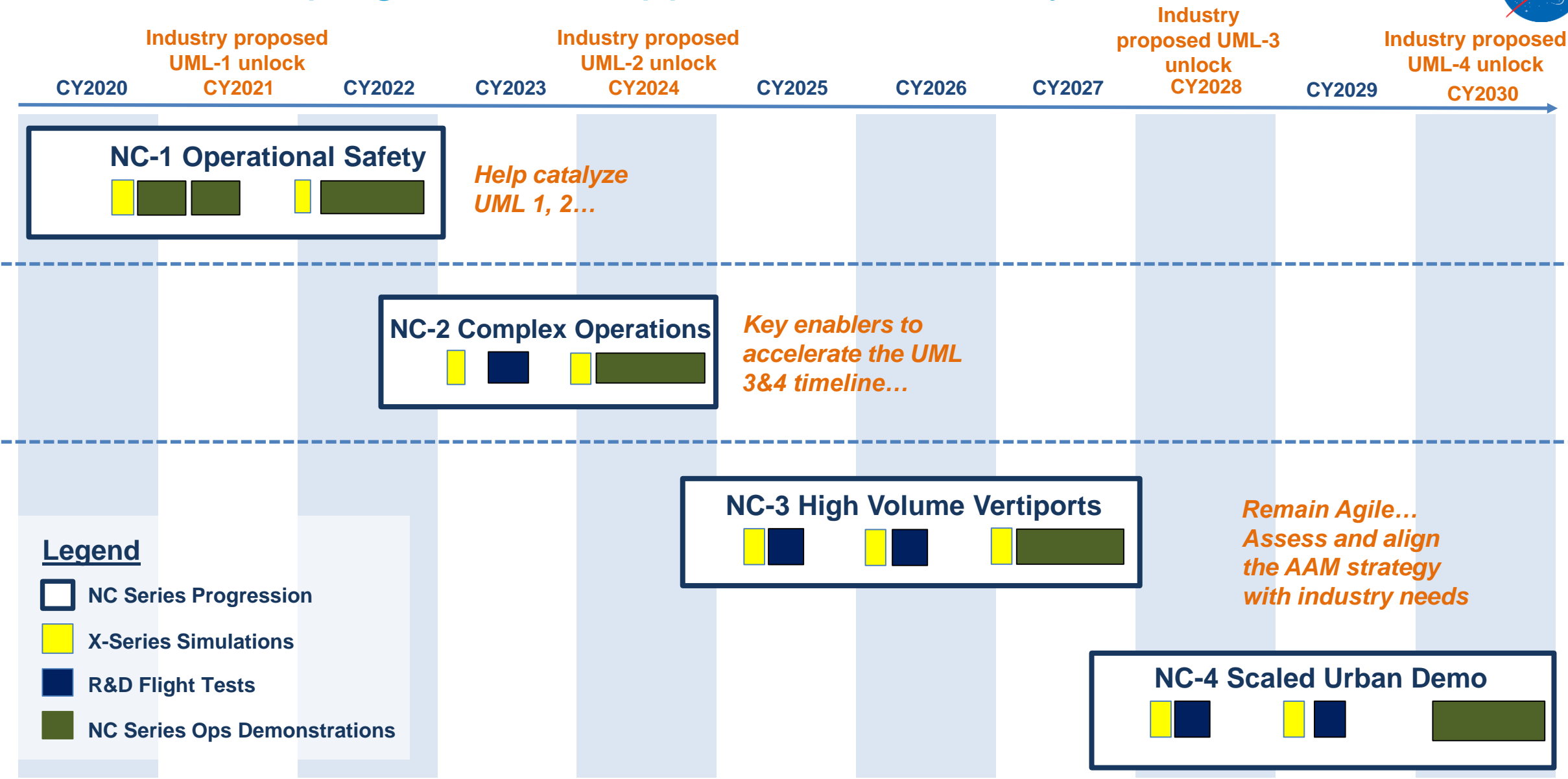
CONSUMER/
ENTERPRISE
GOODS AND
SERVICES



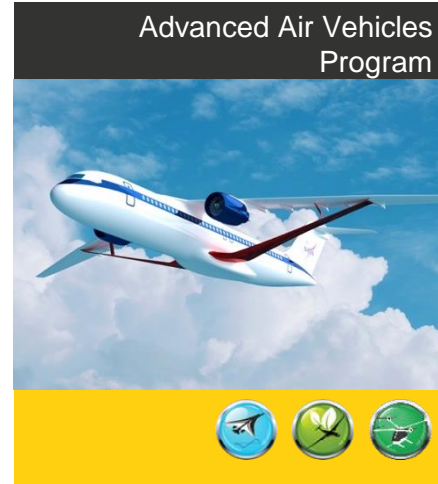
PASSENGER
TRANSPORT



National Campaign Series support of the Industry Timeline



Hypersonic Technology



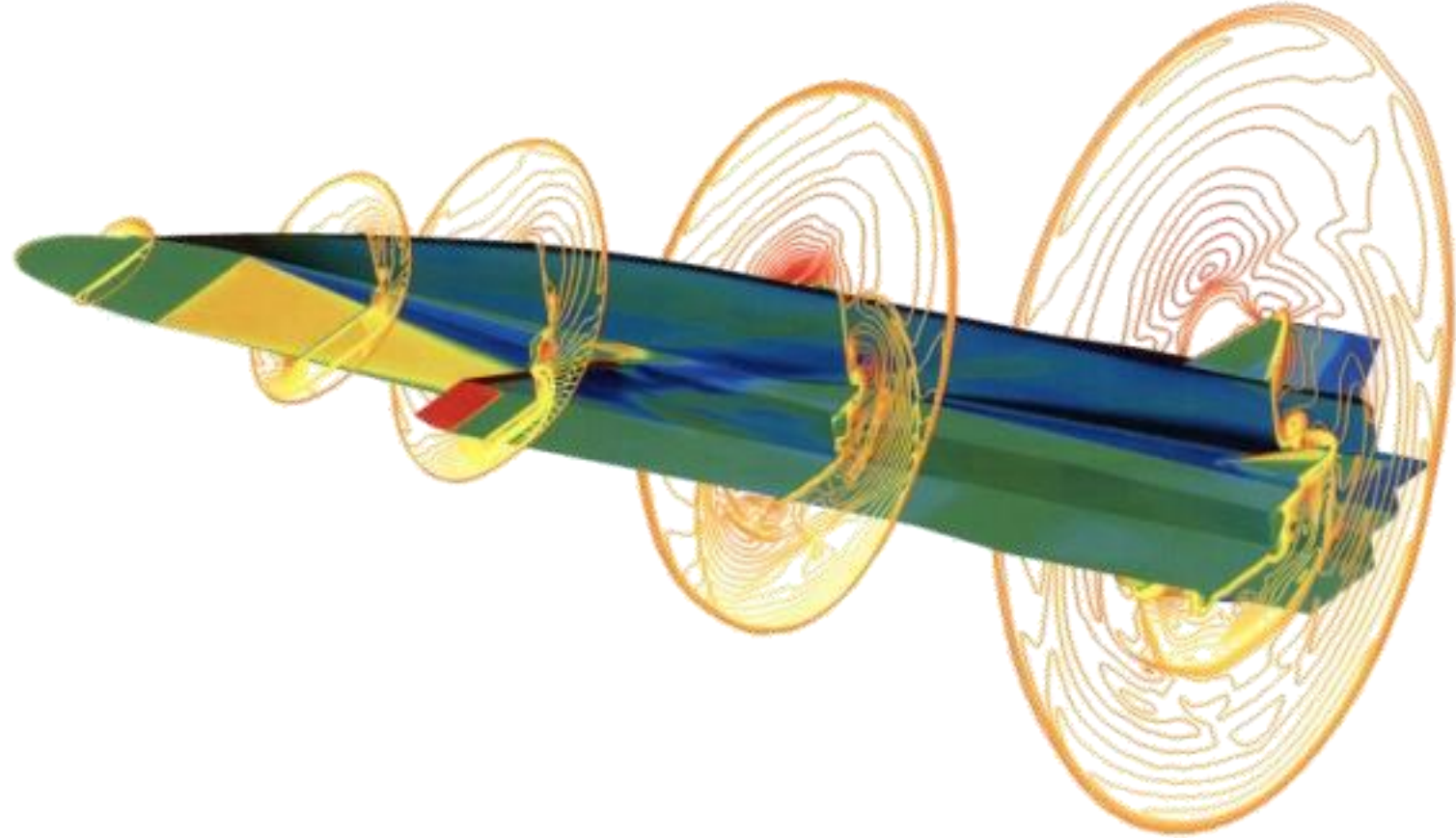
Hypersonic Technology Project



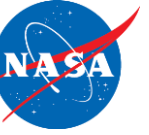
Fundamental Research on
Dual-Use Applications



Industry Engagement on Future
Commercial Hypersonic Vision



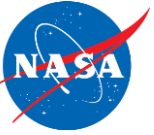
Strong Department of Defense Partnership



Energizing the U.S. Aeronautics Innovation Pipeline



ARMD's Agile Innovation Ecosystem



NASA Leadership for the Aviation Community – Exploration, Invention and Innovation

University Leadership Initiative Engaging the University Community



4 rounds of solicitations
\$126M of awards

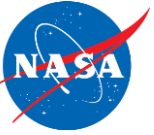
Seeking & awarding proposals
addressing all Strategic Thrusts

- 19 awards with 59 universities
- 6 HBCUs and 9 MSIs
- 333 proposals submitted
- 245 different proposing Principal Investigators
- 2468 team members
- 1602 different people
- 20–50 students per team



NASA's University Leadership Initiative represents a new type of interaction between ARMD and the university community, where universities take the lead, build their own teams, and set their own research path.

Net Zero Aviation Emissions Innovation



NASA Distributed Propulsion Concept

- Turbo-Electric with superconducting electric drivetrain
- Over 70% reduction in energy use



Examples
of current
Research at
Low TRL



University of Illinois, Urbana-Champaign (NASA ULI) fully electric concept

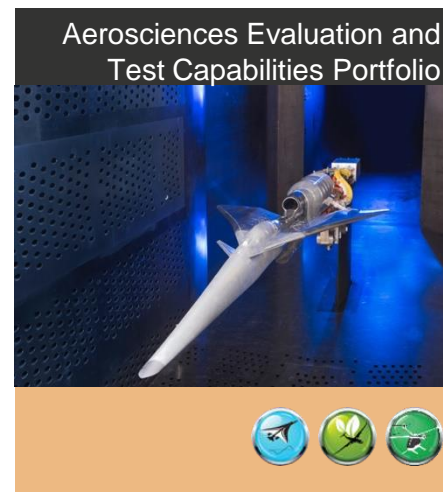
- Hydrogen fuel cell, superconducting electric drivetrain
- Zero carbon emissions

Foster radical aviation technology advancement – new energy sources, aircraft architectures – necessary for large aircraft with extremely low or zero emissions

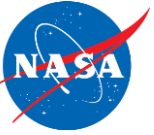
Low TRL concepts can be further conceptualized, researched, developed, ground and flight tested and advanced for late 2030s / early 2040s

Recent University Leadership Initiative solicitation (March 2021) included net-zero emissions topics

Aerosciences Evaluation and Test Capabilities



Aerosciences Evaluation and Test Capabilities (AETC) Portfolio

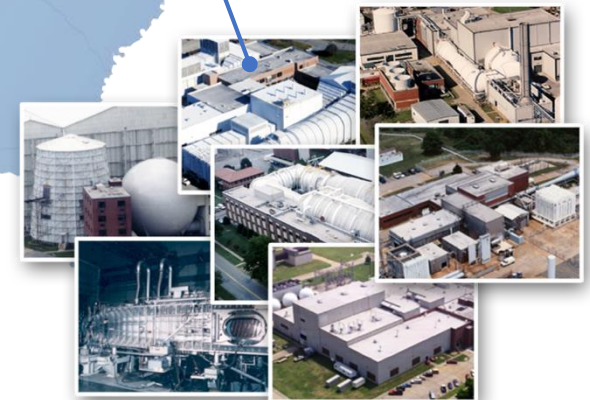


NASA Ames Research Center (ARC)
Moffett Field, CA



NASA Glenn Research Center (GRC)
Cleveland, OH

NASA Langley Research Center (LaRC)
Hampton, VA



Portfolio Objectives

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

Portfolio Scope

- Aerosciences ground test facilities deemed critical to Agency
- Investments in operations, maintenance, new capability and test technology, data systems and security, and CFD-experimental integration investments



Summary

Summary



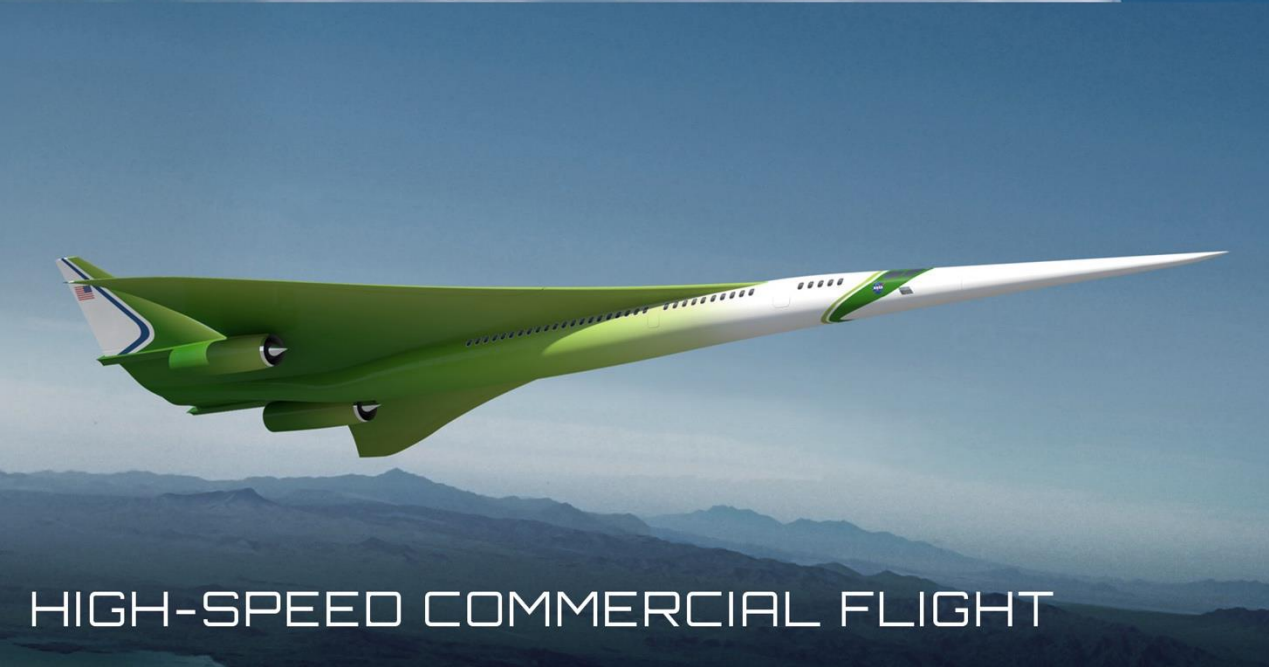
- NASA is leading transformation across the aviation sector, including next generation large civil aircraft, quiet supersonic flight, advanced air mobility and the next evolution of air traffic management.
- NASA Aeronautics is partnering with industry, academia and other agencies through the Sustainable Flight National Partnership to accomplish the aviation community's aggressive climate change agenda through dramatic efficiency gains.
- We have accelerated our plans to demonstrate high-risk, high-payoff technology advancements that will be critical for U.S. aerospace manufacturers to bring to market innovative, cost-effective and sustainable products and services demanded by airlines and customers.
- This budget will enable technology maturity at the pace required for continued U.S. competitiveness in global markets.
- NASA Aeronautics continues building on decades of contributions to aviation to persistently and consistently improve environmental sustainability, global mobility, and economic growth.



ULTRA-EFFICIENT TRANSPORT



FUTURE AIRSPACE



HIGH-SPEED COMMERCIAL FLIGHT



ADVANCED AIR MOBILITY

Four Transformations for Sustainability, Greater Mobility, and Economic Growth



Back Up