

# **NASA Aeronautics Six Strategic Thrusts**





## 6 Strategic Research and Technology Thrusts



## Safe, Efficient Growth in Global Operations

 Enable full NextGen and develop technologies to substantially reduce aircraft safety risks



## **Innovation in Commercial Supersonic Aircraft**

Achieve a low-boom standard



#### **Ultra-Efficient Commercial Vehicles**

 Pioneer technologies for big leaps in efficiency and environmental performance



## **Transition to Low-Carbon Propulsion**

 Characterize drop-in alternative fuels and pioneer low-carbon propulsion technology



## Real-Time System-Wide Safety Assurance

 Develop an integrated prototype of a real-time safety monitoring and assurance system



## **Assured Autonomy for Aviation Transformation**

Develop high impact aviation autonomy applications

## **ARMD Programs with Strategic Thrusts**



#### MISSION PROGRAMS

# **Airspace Operations and Safety Program**

- Safe, Efficient Growth in Global Operations
- Real-Time System-Wide Safety Assurance
- Assured Autonomy for Aviation Transformation

# Advanced Air Vehicles Program

- Ultra-Efficient Commercial Vehicles
- Innovation in Commercial Supersonic Aircraft
- Transition to Low-Carbon Propulsion
- Assured Autonomy for Aviation Transformation

# **Integrated Aviation Systems Program**

- Flight Research-Oriented Integrated, System-Level R&T support all six thrusts
- X-Planes / Test
   Environment

#### SEEDLING PROGRAM

# **Aeronautics Concepts Program**

- High-risk, leap-frog ideas supporting all six thrusts
- Critical cross-cutting tools and technology development

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# NASA Aeronautics Ready for Flight

**NASA Aero Vision** and Strategy **Established** 



**Roadmaps** Completed

2008-2013

2014/15

2016/17

2018-2026

N+3 Subsonic & **Supersonic** Concept/Technology **Studies** 

> N+2 Environmentally **Responsible Aviation** (ERA) Project Initiated

Ground Testing of N+3 configurations and technologies



8 Integrated Tech Demos Completed, Tech transitioned to industry. HWB ready for Flight Dem/Val.

**UEST PDR LBFD PDR** Completed







Ready for X-Plane Integration & **Demonstration** 

NASA FAA NextGen Research **Transition Teams** (RTTs) Initiated









**Technology Transitions to FAA: MSP, EDA, PDRC, TSAS** 

**ATD-1 Completed** and transferred to

FAA

ATD-2.3 **Completed** & Transferred to FAA



Ready for NextGen TBO Integration & **Demonstration** 

## Ten Year Investment Plan—FY 2017 Budget Accelerates Key **Components of NASA Aeronautics Plan**



Fund the Next Major Steps to Efficient, Clean and Fast Air Transportation Mobility



























#### **New Aviation Horizons**

Start a continuing series of experimental aircraft to demonstrate and validate high impact concepts and technologies. Five major demonstrations over the next 10+ vears in the areas of Ultra-Efficiency, Hybrid-Electric Propulsion, and Low Noise Supersonic Flight

**Major New Initiative** within IASP

## **Enabling Tools & Technologies**

Major series of ground experiments to ready key technologies for fliaht

Research and ground demonstration for an advanced small engine core for very high bypass engines and as a hybrid-electric propulsion enabler

Development of next generation physicsbased models needed to design advanced configurations

Increases to AAVP and TACP

## Revolutionizing **Operational Efficiency**

Accelerate demonstration of full gate-to-gate Trajectory **Based Operations** 

Increase to AOSP

### **Fostering Advanced** Concepts & Future Workforce

Increased investment in new innovation through the NASA workforce and Universities

Leverage Non-Traditional **Technology Advances** 

Pursue challenge prizes in areas such as energy storage, high power electric motors, advanced networking and autonomy

Increase to TACP

#### **UAS**

Strong continued research leadership in enabling UAS integration into the National Airspace. Extending the UAS in the NAS project for an additional 4 years



#### **Hypersonics**

Increased investment to ensure a strong National fundamental research capability

Increases to IASP and **AAVP** 

Build off of major current developments and accomplishments

Continue to incentivize new innovation

## FY 2017 Budget



		Enacted										
\$ Millions	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026
Aeronautics	\$642.0	\$640.0	\$790.4	¢016.1	\$1,060.1	¢1 172 2	¢1 206 0	¢1 204 2	¢1 207 6	¢1 210 1	\$829.7	\$839.5
Actoliautics	3042.0	3040.0	\$750.4	3040.4	<b>31,000.1</b>	71,173.3	71,200.5	71,234.2	<b>31,307.0</b>	71,210.1	3023.7	Ç039.3
Airspace Operations and Safety	154.0		159.4	159.2	176.2	189.1	221.5	198.7	200.9	193.2	175.5	167.8
Advanced Air Vehicles	240.6		298.6	277.4	308.8	311.6	312.6	321.3	315.0	318.9	317.7	326.7
							0	022.0	0_0.0	020.0	02717	0_0.7
Integrated Aviation Systems	150.0		210.0	255.4	381.4	493.0	556.7	591.5	612.2	525.0	203.8	210.6
Transformative Aeronautics												
Concepts	97.4		122.3	154.4	193.8	179.7	196.2	182.8	179.4	181.0	132.7	134.4

Aeronautics budget includes paid-for 10-year mandatory funding from the Administration's 21st Century Clean Transportation Plan. See appendix for additional detail.

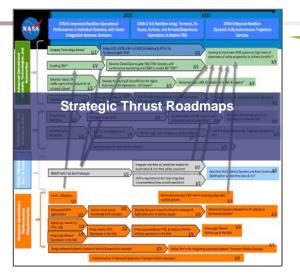
Mandatory Budget Authority						
\$ Millions	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	Outyears
21st Century Clean Transportation Plan	100	200	400	500	600	1900
Airspace Operations and Safety	18	20	35	45	75	170
Advanced Air Vehicles	30	41	79	80	65	305
Integrated Aviation Systems	37	84	196	300	370	1170
Transformative Aeronautics Concepts	15	55	90	75	90	255
Low Boom Flight Demonstrator	56					
Integrated Aviation Systems	56					

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# NASA Aeronautics Strategic Portfolio Model



SIP Outcomes **Drives Top-Down Planning** 



Roadmaps Provide Guidance for Project / Center Innovation and **Planning** 



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#### Real-Time System-Wide Safety Assurance

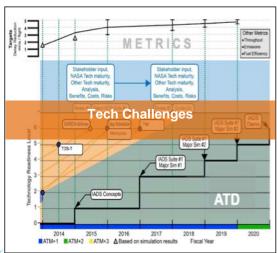
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#### Assured Autonomy for Aviation Transformation

Develop high impact aviation autonomy applications

Partnerships & Performance Create a Feedback Loop





# NASA Efficient Vehicle – Subsonic Transport: Research Strategy, 2015-2035+



NASA strategy supports each of the three Community Outcomes (2015-2025, 2025-2035, 2035+)

COMMUNITY

2015

Meet the economic and environmental demands and on a defined path to fleet-level carbon neutral growth

2025

Revolutionary improvements in community noise and energy efficiency to achieve fleet-level carbon neutral growth relative to 2005

2035

Transforming capabilities in community noise and energy efficiency enabling a 50 percent reduction in fleet-level carbon output relative to 2005

NASA Strategy Prove practicality of revolutionary and transformational aircraft concepts and technology *via large-scale integrated demonstrations* 

Execute early-stage exploration and development of gamechanging concepts and technology to overcome the technical challenges of efficient, quiet flight

Develop and validate enabling tools, methods, and processes

June 14, 2016

# NASA Low Carbon Propulsion: Research Strategy, 2015-2035+



COMMUNITY 51

Introduction of Low-carbon Fuels for Conventional Engines and Exploration of Alternative Propulsion Systems Initial Introduction of Alternative Propulsion Systems

Introduction of
Alternative Propulsion
Systems
to Aircraft of All Sizes

2035

**Explore and demonstrate combustor concepts** that exploit future alternative fuels

2025

Aviation
Alternative
Fuels
(drop-in)

Characterize the performance and emissions of an increasing spectrum of alternative jet fuels in advanced combustors

NASA Strategies Advance scientific understanding relating fuels to combustion to emissions to atmospheric impact

Explore and demonstrate vehicle integration synergies enabled by hybrid electric propulsion

Alternative Energy/Power Architectures

Increasingly electric aircraft propulsion with minimal change to aircraft outer mold lines

Gain experience through integration and demonstration on progressively larger platforms

June 14, 2016

## **Summary – A New Era for NASA Aeronautics**



Investing In Our Future - Investments in NASA's cutting edge aeronautics research today are investments in a cleaner, safer, quieter and faster tomorrow for American aviation:

- A future where Americans are working in stable, well-paying jobs.
- A future where we fly on aircraft that consume half as much fuel and generate only one quarter of current emissions.
- A future where flight is fueled by greener energy sources.
- A future where our air transportation system is able to absorb nearly four billion more passengers over the next 20 years without compromising the safety of our skies.
- A future where our airports are better neighbors because aircraft noise is contained well within the airport boundary.
- A future where people can travel to most cities in the world in six hours or less in an airplane that can fly faster than the speed of sound on bio-fuels.