NASA ARMD Seedling Technical Seminar
Measurement Technology

ARMD Strategic Implementation Plan

NASA's Aeronautical Research Role

Address Research Needs within Three Overarching Areas Affecting Future Aviation

- Mega Driver 1: Global Growth in Demand for High Speed Mobility
- Mega Driver 2: Global Climate Change, Sustainability, and Energy Transition
- Mega Driver 3: Technology Convergence

ARMD's Aeronautical Research Taxonomy

Strategic Thrusts

ARMD Research is Organized into Six Strategic Thrusts

- Strategic Thrust 1: Safe, Efficient Growth in Global Operation
- Strategic Thrust 2: Innovation in Commercial Supersonic Aircraft
- Strategic Thrust 3 Ultra-Efficient Commercial Vehicles
- Strategic Thrust 4: Transition to Low-Carbon Propulsion
- Strategic Thrust 5: Real-Time System Wide Safety Assurance
- Strategic Thrust 6: Assured Autonomy for Aviation Transformation

Outcomes

Outcomes are Defined for Each of Three Time Periods

Near-Term: 2015-2025 | Mid-Term: 2025-2035 | Far-Term: Beyond 2035

Research Themes

Long-term Research Areas That Will Enable the Outcomes

- Most Outcomes encompass multiple Research Themes

Technical Challenges

Specific Measurable Research Commitments within the Research Themes

- Most Research Themes encompass several Technical Challenges

How are the vision's research thrusts used?

All of the new programs address more than one, or all, of the research thrusts.

MISSION PROGRAMS

Airspace Operations and Safety Program

AOSP

Safe, Efficient Growth in Global Operations

Real-Time System-Wide Safety Assurance

Assured Autonomy for Aviation Transformation

Advanced Air Vehicles Program

AAVP

Ultra-Efficient Commercial Vehicles

Innovation in Commercial Supersonic Aircraft

Transition to Low-Carbon Propulsion

Assured Autonomy for Aviation Transformation

Integrated Aviation Systems Program

IASP

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

X-planes/ test environment

SEEDLING PROGRAM

Transformative Aeronautics Concepts Program

TACP

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

Critical cross-cutting tool development and advancement of critical aeronautics technologies

What is the Transformative Aeronautics Concept Program?

While mission programs focus on solving challenges, this program focuses on cultivating opportunities.

Seedling Program

Transformative Aeronautics Concept Program

Cultivates multi-disciplinary, revolutionary concepts to enable aviation transformation and harnesses convergence in aeronautics and non-aeronautics technologies to create new opportunities in aviation

Knocks down technical barriers and infuses internally and externally originated concepts into all six strategic thrusts identified by ARMD, creating innovation for tomorrow in the aviation system.

Provides flexibility for innovators to explore technology feasibility and provide the knowledge base for radical transformation.

Solicits and encourages revolutionary concepts

Creates the environment for researchers to become immersed in trying out new ideas

Performs ground and small-scale flight tests

Drives rapid turnover into new concepts

Projects

Leading Edge Aeronautics Research for NASA (LEARN)

Transformational Tools & Technologies

Convergent Aeronautics Solutions

NASA Aeronautics Research Six Strategic 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

Strategic Thrust 1: Safe, Efficient Growth in Global Operations

	2015	2025	2035
Outcomes	Improved NextGen Operational Performance in Individual Domains, with Some Integration Between Domains (ATM+1)	Full NextGen Integrated Terminal, En Route, Surface, and Arrivals/ Departures Operations to Realize Trajectory-based Operations (ATM+2)	Beyond NextGen Dynamic Fully Autonomous Trajectory Services (ATM+3)
Research Themes	**Advanced Operational Concepts, Technologies, and Automation** Research and development of operational efficiency incorporating proactive safety risk management in operational domains **Safety Management for Emergent Risks** Research and development of prognostic safety risk management solutions and concepts for emergent risks **Integrated Modeling, Simulation, and Testing** Development, validation, and application of advanced modeling, simulation, and testing capabilities to assess integrated, end-to-end NextGen trajectory based operations functionality, as well as seamless UAS operations and other future aviation system concepts and architectures **Airspace Operations Performance Requirements** Advanced research to develop performance requirements, functional allocation definitions, and other critical data for integrated, end-to-end NextGen trajectory-based operations functionality, as well as seamless UAS operations and other future aviation system concepts and architectures		

Strategic Thrust 2: Innovation in Commercial Supersonic Aircraft

	2015	2025	2035
Outcomes	Supersonic Overland Certification Standard Based on Acceptable Sonic Boom Noise	Introduction of Affordable, Low-boom, Low-noise, and Low-emission Supersonic Transports	*(Outcomes beyond 2035 will depend on market needs and technology solutions)*
Research Themes	**Understanding and Measuring Community Response to Sonic Booms** Research, development, and application of validated methodologies for a field study of community response to enable development of overland sonic boom standards **Integrated Design Solutions for Revolutionary High-speed Aircraft** Research and development of validated analysis tools and technologies that enable the low-sonic-boom design of supersonic aircraft **Minimizing the Airport Community Noise Impact of High-speed Aircraft** Research and development of validated analysis tools and technologies to enable low-airport-noise propulsion system designs for supersonic aircraft **Increasing Cruise Efficiency and Reducing or Eliminating the Impact of High-altitude Emissions** Research and development of airframe and engine analysis tools and technologies to maximize the efficiency and minimize the emissions of supersonic aircraft		

Strategic Thrust 3: Ultra-Efficient Commercial Vehicles – Subsonic Transport

	2015	2025	2035
Outcomes	New Transport-class Aircraft that Achieve N+1 Levels of Efficiency	Technology and Potentially New Configuration Concepts that Achieve N+2 and N+3 Levels of Efficiency and Environmental Performance	Technology and Configuration Concepts, Including Low-carbon Propulsion, that Stretch Beyond N+3 Levels of Efficiency and Environmental Performance
Research Themes	**Advanced Ultra-efficient Airframes** Research and development of tools and technologies to enable new airframe configurations with high levels of aerodynamic performance, lower structural weight, and innovative approaches to noise reduction **Advanced Ultra-efficient Propulsion** Research and development of tools and technologies to reduce turbofan-thrust-specific fuel consumption, propulsion noise, and emissions **Advanced Airframe-engine Integration** Research and development of innovative approaches and the supporting tools and technologies to reduce perceived noise and aircraft fuel burn through integrated airframe-engine concepts		

Strategic Thrust 4: Transition to Low-Carbon Propulsion

	2015	2025	2035
Outcomes	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
Research Themes	**Characterization and Integration of Alternative Fuels** Characterization of alternative fuels, combustor concepts, and their integration requirements **Scalable Alternative Propulsion Systems** Technical study of alternative propulsion system architectures and research on key physical attributes and technology enablers to demonstrate fundamental feasibility		

Strategic Thrust 5: Real-Time System-Wide Safety Assurance

	2015	2025	2035
Outcomes	Introduction of Advanced Safety Assurance Tools	An Integrated Safety Assurance System Enabling Continuous System-wide Safety Monitoring	Automated Safety Assurance Integrated with Real-time Operations Enabling a Self-protecting Aviation System

Research Themes

System-wide Data Analysis for Understanding Safety Events
Technical approaches for integrating sensitive data from heterogeneous sources to build base models of nominal and off-nominal system performance and improve accuracy of detection and prediction tools

Improved Performance of Detection, Analysis, and Prognostic Tools
Increased speed and scaling of tools to enable rapid detection of safety threats in large, heterogeneous data sets as they arise

Integrated Threat Prognosis, Alerting, and Guidance
Architecture for integration of scaled, automated methods for threat alerting, prognosis and guidance to improve mitigation strategies; simulation tools for real-time operational evaluation

Techniques for Real-time Safety Assurance
Advances in verification techniques to be applied during operation of systems to monitor performance, efficiently analyze risks, and rapidly provide potential solutions

Real-time System-wide Safety Assurance Demonstration
Integrated demonstration of a real-time system-wide safety assurance prototype system

Strategic Thrust 6: Assured Autonomy for Aviation Transformation

	2015	2025	2035
Outcomes	Initial Autonomy Applications	Human-machine Teaming in Key Applications	Ability to Fully Certify and Trust Autonomous Systems for NAS Operations

Research Themes

UAS Integration
Airspace integration procedures and performance standards to enable UAS integration in the air transportation system

Validation, Verification, Testing, and Evaluation
Application of assurance technologies to validate performance of autonomous systems in a variety of known (i.e., conceivable) operational scenarios; extension of traditional verification and validation techniques to ensure trust and confidence in the performance of machine learning, and sense-making autonomy functions capable of adapting to conditions of the unknown unknown type

Design and Analysis of Autonomous Systems
Development of core automation for supporting specific autonomy operational needs in functional areas such as navigation, communication, surveillance, and robotics, and design of architectures for integration of technologies into an autonomous system

Autonomous Planning, Scheduling, and Decision Making
Development and application of advanced cognitive computing architectures and sensory technologies for reasoning and decision making, and capabilities for engaging unknown unknowns in the operational environment as part of human-machine cognitive systems

Vehicle Control, Health Management, Adaptation, and Multivehicle Cooperationand Interoperability
Application of autonomy to assist human-in-vehicle operations and expanding vehicle health management capabilities