National Aeronautics and Space Administration

NASA Advisory Council Aeronautics Committee Meeting

Mr. John Borghese
Chair
NASA Ames Research Center
August 30, 2018

Aeronautics Committee Membership

Mr. John Borghese

Chair,
Rockwell Collins

Dr. Eric Allison

UBER

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Georgia Institute
of Technology

Mr. Scott Drennan

Bell, Textron Inc.

Dr. Michael Francis

Aerospace Executive,
Technologist and Consultant

Dr. Greg Hyslop

The Boeing Company

Mr. Anil V. Nanduri

Intel, Drone Group

Dr. Tom I-P. Shih

Purdue University

Dr. Karen Thole

Pennsylvania State
University

Areas of Interest Explored at Current Meeting

Topics covered at the Aeronautics Committee Meeting held on August 28, 2018 at NASA Ames Research Center:

- ARMD Strategy Overview
- Urban Air Mobility (UAM) Strategy*
  - UAM Coordination and Assessment Team (UCAT)
  - Grand Challenge
- UAS Update (UAS in the NAS and UAS Traffic Management)
- Low Boom Flight Demonstrator (LBFD) Update*

* All of the topics have related findings provided by the Aeronautics Committee

NASA Aeronautics - Where Are We Today?

- Clear vision and strategy
  - Reflects visionary aviation opportunities
  - Strong community endorsement and alignment – NRC studies and ARTR, NAC, One-on-One engagement, etc.
- Strong inter-center collaborations
- Motivated and dedicated workforce
- Solid partnerships
  - OGAs, industry, academia, and international partners

- Excellent performance, producing impactful results with robust tech transfer
- Setting best practices for the Agency and the Federal Government
  - e.g., strategic planning, connecting with national economy, cost-sharing partnership and impactful tech transfer (including Fed best practice Research Transition Teams with FAA), inter-center collaboration, celebrating lessons learned through failures

Urban Air Mobility

NASA Strategy Framework

Airspace Operations Capabilities

Leverage UTM and ATM experience to enable UAM requirements for airspace management systems that enable autonomy

Advanced Technology & Methods

Develop research and technology products on key challenges (autonomy, safety, noise, adverse weather operations etc.)

Partnerships and Standards

Establish robust private partnership (PPP) model to develop and V&V critical industry standards and policy

UAM Grand Challenge

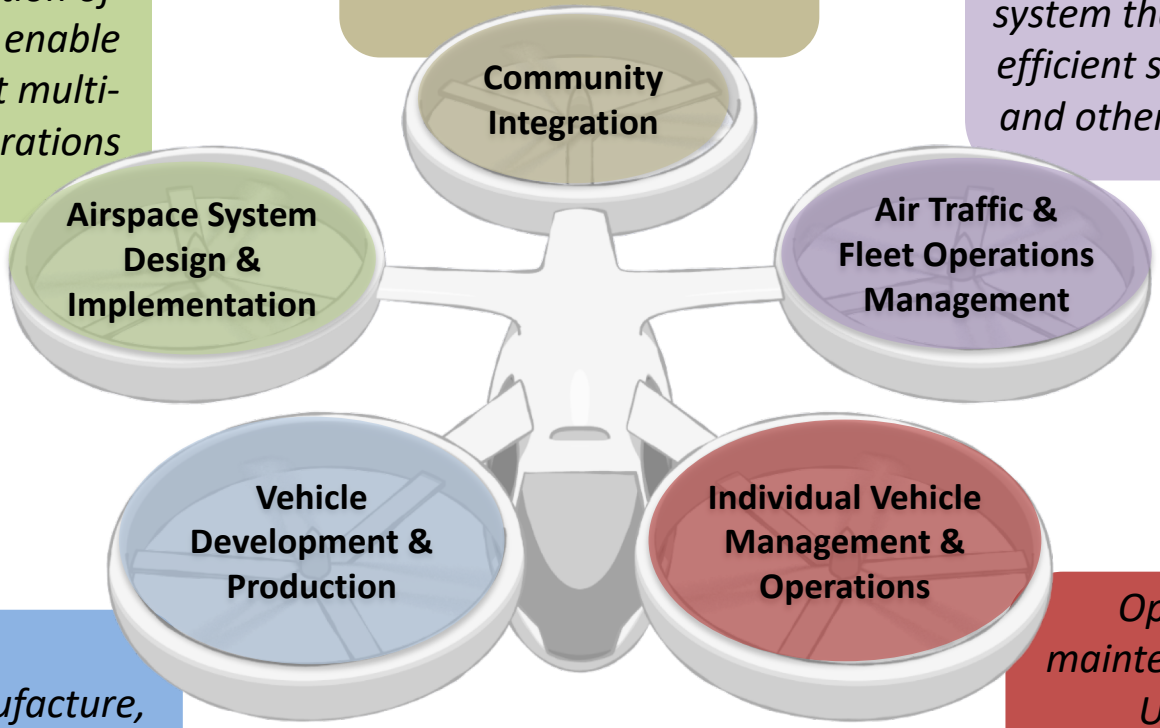
UAM community participants address ecosystem wide safety and integration barriers in a robust and relevant environment

UAM Vision and Framework

Societal integration and acceptance of UAM operations

Design, development, and implementation of infrastructure to enable safe and efficient multi-vehicle UAM operations

Operations and management of multiple vehicles within a UAM system that enable safe and efficient sharing of airspace and other system resources



Design, manufacture, and system readiness of UAM vehicles

Operations and maintenance of a single UAM vehicle, independent of the sharing of airspace or other system resources

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

UAM Market Studies

- ARMD has funded two Urban Air Mobility market studies
- Focus of the Studies
  - Market evaluation for a range of urban areas and business models, technology requirements, legal and regulatory barriers, social acceptance issues
  - Studies included several air taxi/metro models, air ambulance, and last-mile package delivery
- Studies include many complicated assumptions (technical, regulatory, social, etc) for issues such as autonomy, batteries, weather, infrastructure, operating costs, passenger adoption rates, etc.

- Generally speaking, UAM markets were found to be viable and profitable use cases.
  - By ~2028 “air metro” could be profitable and result in ~750M flights annually
  - Air taxi models have some potential to require significant vertiport infrastructure limiting profitability
  - Air ambulance model may not be profitable, but have high impact on public good
  - By ~2030 “last mile package delivery” could be profitable and result in ~500M flights annually

Grand Challenge (GC) Mission and Goal

UAM ecosystem wide challenge for participants to execute system level safety and integration scenarios

GC Mission

Purpose for those in the organization and the public

→ Promote public confidence in UAM safety and facilitate community-wide learning while capturing the public's imagination

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GC Strategic Goal

What does the GC do for the UAM community?

→ UAM community participants address ecosystem wide safety and integration barriers in a robust and relevant environment

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Why Participate?

→ Obtain critical insights into UAM systems via realistic scenarios focused on enabling future FAA safety, certification, and operational approvals

Grand Challenge Overview

Vehicles

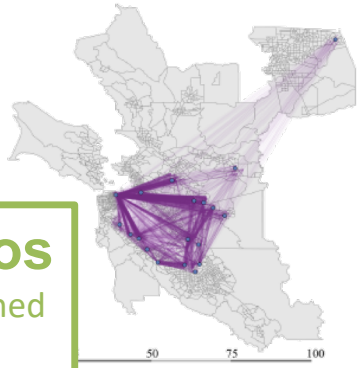
functional UAM vehicles with threshold level of demonstrated airworthiness

NASA Systems & Interfaces

ATM-X UAM ATM, "Testbed/LVC"

Airspace Management

airspace and air traffic management technologies and services (FAA ATM + UTM) built and simulated to a threshold level of UAM ATM requirements



Common Safety and Integration Scenarios

airworthiness processes, realistic UAM scenarios, and a range(s) designed in concert with the FAA to support UAM testing

Stakeholder Integration

societal integration and acceptance of UAM Operations including public acceptance, supporting infrastructure, operational integration, standards organizations, the local regulatory environment, etc.

Industry Provided | NASA Provided | Ecosystem Wide Support

Committee Finding for ARMD AA – Urban Air Mobility (UAM) Grand Challenge

The Urban Air Mobility Grand Challenge is a great initiative for NASA to set the leadership beacon on UAM that inspires the industry and the next generation of workforce alike. While it is in the early stage of planning, the Committee believes that the UAM Grand Challenge needs to be articulated more clearly. The Committee also recommends that NASA's role is to study, estimate, and articulate the trade space for UAM. The Committee urges the project to work closely with universities to take advantage of the talent available. The Committee complimented NASA for the evolution of the relationship with the FAA and how this change has improved the level of collaboration.

UAS Scope / Outcome of Cohesive Strategy

Scope: Focus on what is needed to enable full integration of UAS for civil / commercial operations within the NAS by ~2025

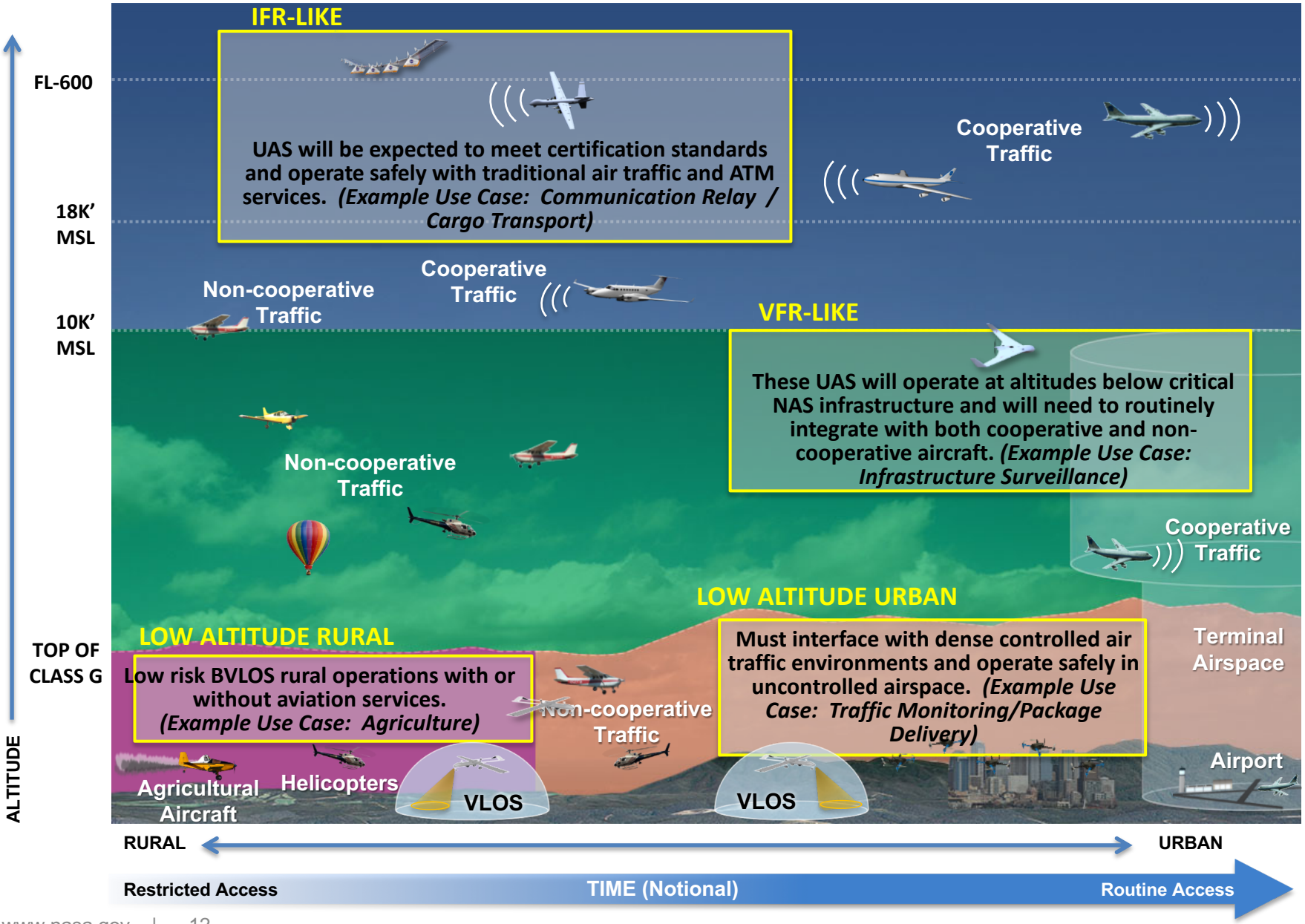
- Top level strategy that assesses stakeholder needs, FAA UAS Integration Strategy, Concept of Operations, Implementation Plans, etc.
- Leverage information from Government-wide R&D Analysis (ExCom) and FAA R&D Roadmap

Outcome: A Vision, Strategic Plan and Communication Strategy

- Routine UAS access within the NAS
- Concept for transitioning UAS access advancements towards the integration of highly autonomous systems and on-demand mobility

Enabling Full Integration of UAS for civil / commercial operations within the NAS by ~2025

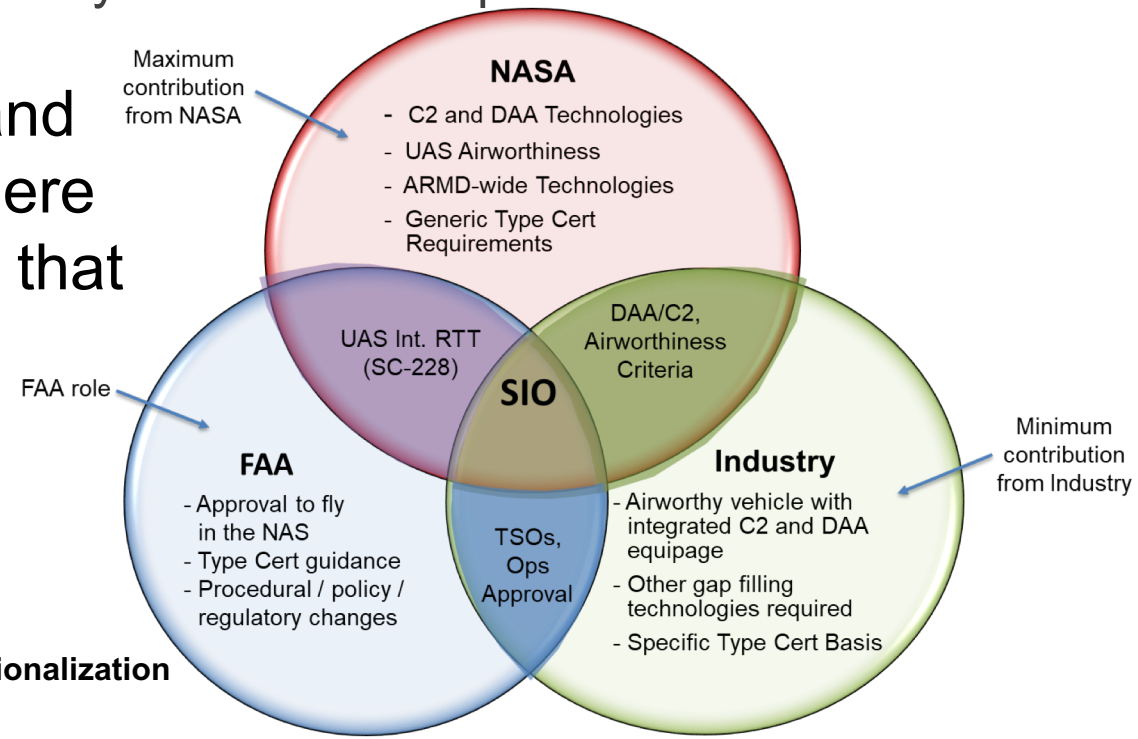
Future Civil UAS Airspace Environment



Medium/Large UAS Integration Opportunities

- NASA's Efforts supporting the development of Minimum Operational Performance Standards for the FAA has been divided into 2 Phases
  - Phase 1 – Transit to Class A Airspace, Terrestrial Com, Final MOPS FY16
  - Phase 2 – Interoperability in Class E Airspace

- We are looking at and prioritizing gaps where research is needed that NASA can support

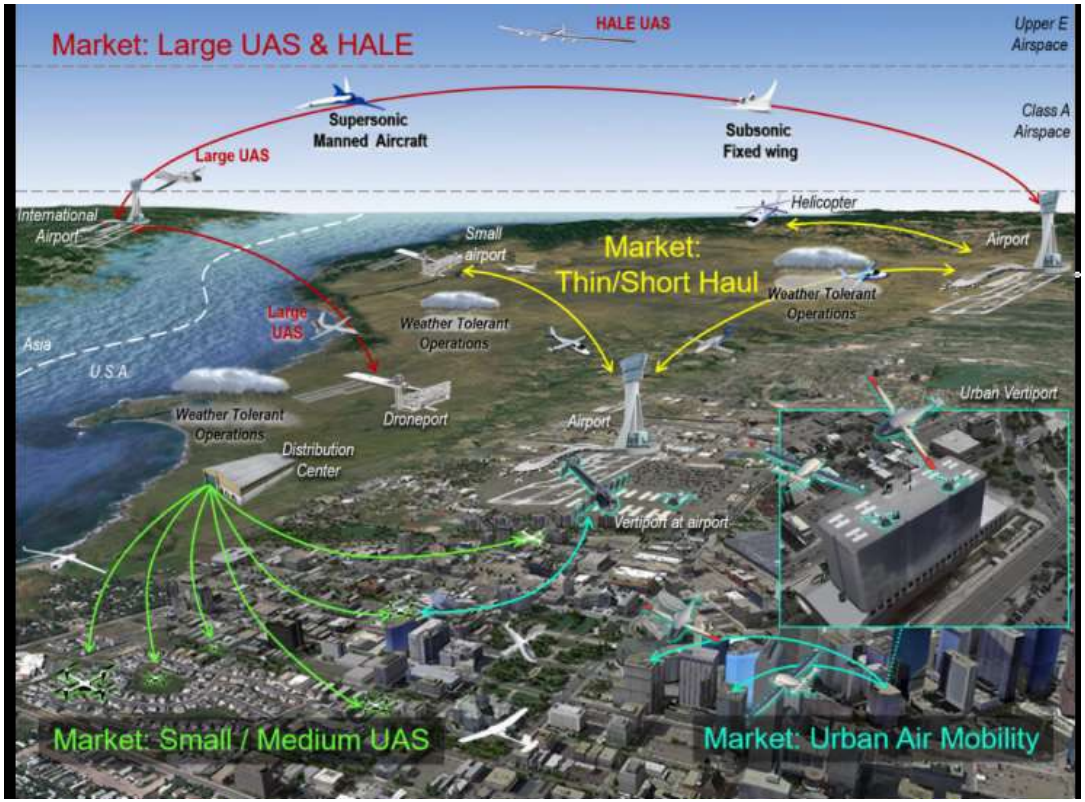


SIO: Systems Integration and Operationalization

UAS in the NAS Summary

- NASA has developed, and is executing, a Cohesive Strategy for UAS Integration
- NASA is dedicated to partnering with industry to develop robust DAA and C2 technologies in collaboration with RTCA SC-228
- NASA is moving towards a Systems Integration and Operationalization demonstration in partnership with industry
  - Industry integrates critical technologies onto a UAS, develop broad vehicle technologies, and work towards type certification
  - NASA complements industry technology development gaps in DAA, C2, and generalize the type certification efforts
  - NASA and Industry work with the FAA to ensure appropriate approvals and policies benefit the entire industry

What is UAS Traffic Management?

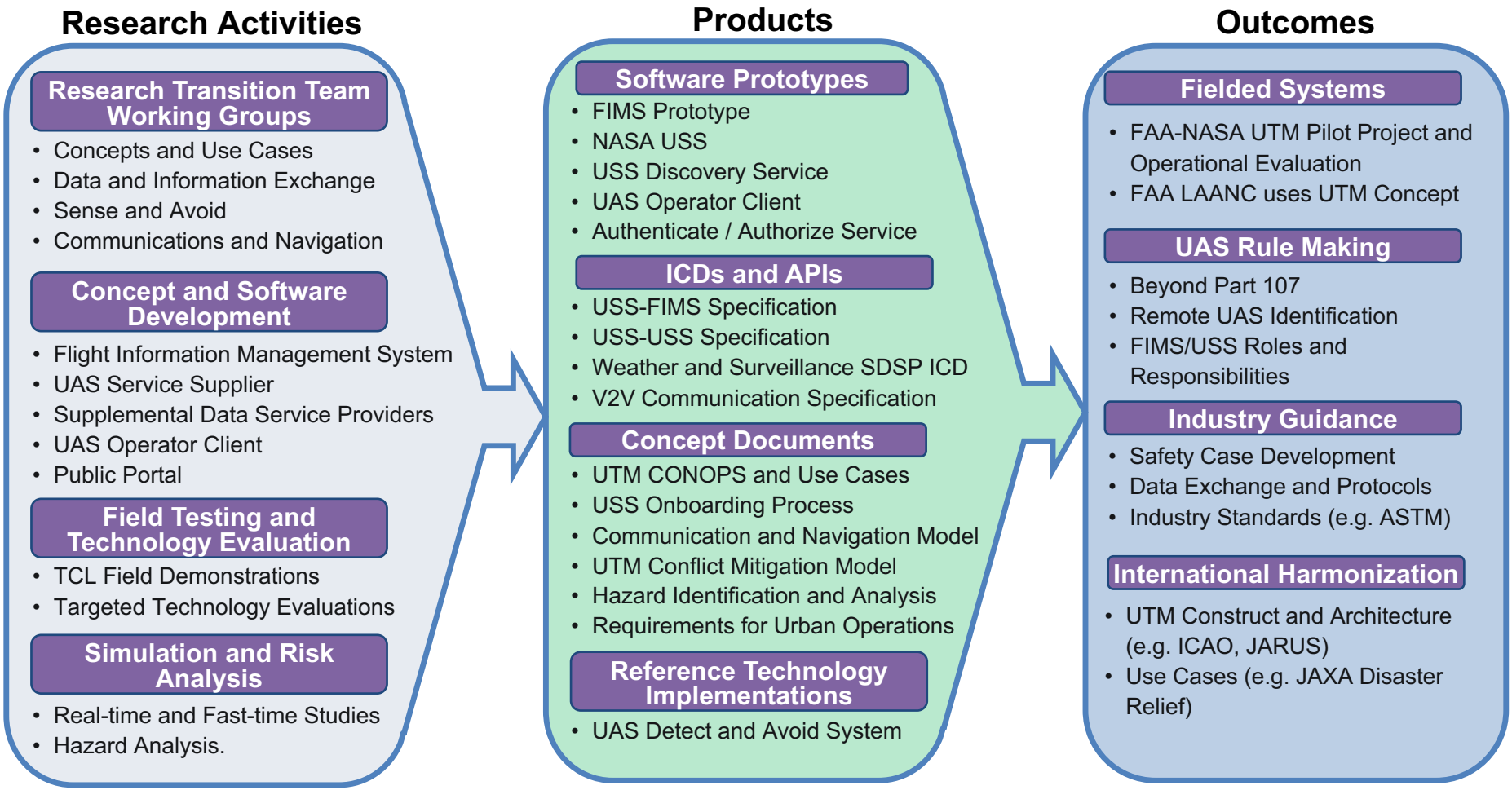


UTM is an "air traffic management" ecosystem for uncontrolled airspace

UTM utilizes industry's ability to supply services under FAA's regulatory authority where these services do not exist

UTM development will ultimately identify services, roles/responsibilities, information architecture, data exchange protocols, software functions, infrastructure, and performance requirements to enable the management of low-altitude uncontrolled UAS operations

Impact of UTM



UTM Summary

UTM Momentum: The potential high demand for UAS, a developing UTM market, an engaged UAS industry, and changing public perception are contributing to positive momentum in UTM development

TCL 1/2/3: NASA UTM research continues to address areas of need in UAS integration and transfers these results to industry and FAA.

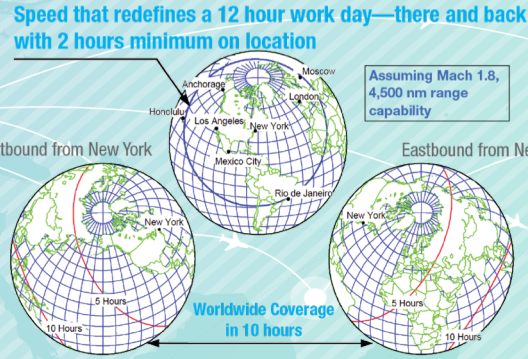
UTM Pilot Program: A collaborative FAA/NASA effort to transition technology to a pre-implementation stage and demonstrate role of the ANSP in UTM Operations

UTM Impact: The UTM project has driven industry development and momentum to expand the UAS market. The NASA and partner research products are being fielded in pilot programs and NASA research continues to inform UAS rulemaking and industry standardization bodies. UTM has become internationally recognized and NASA's service-based model has been used as the basis for UTM development world-wide

Next Steps: Planning is underway for next year's TCL 4 (urban operations)

INNOVATION IN COMMERCIAL SUPERSONIC FLIGHT

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



- Global demand for air travel is growing, which places a demand on speed
- Supersonic aircraft will be excellent export products that can be capitalized on by the U.S. to support a positive balance of trade
- New supersonic products lead to more high-quality jobs in the U.S.
  - Large potential market predicted: - business aircraft followed by larger commercial aircraft
  - Technology leadership established through initial products will lead to development of larger, more capable airliners

The government plays a central role in developing the data needed for the regulation change that is essential to enabling this new market

BARRIERS TO COMMERCIAL SUPERSONIC FLIGHT

Sonic Boom Noise and Overland Flight Prohibitions

NASA's Low-Boom Flight Demonstration is specifically planned to generate key data to validate design approaches and support development of certification standards based on acceptable sound levels

Proposed Products -2020s

- 1st supersonic flight: 1947
- Planned introduction of supersonic commercial transports in 1970s brought the problem of sonic boom noise to public attention
- Community overflight tests in the U.S. and elsewhere showed sonic boom noise to be unacceptable

- Supersonic overflight restrictions followed
  - US: FAA Regulation (FAR) prohibits supersonic flight over US
  - Worldwide: ICAO Assemble Resolution – "No unacceptable situation for the public due to sonic boom"
- Restriction dramatically limited market potential for supersonic commercial flight
- The creation of a market for supersonic commercial aircraft requires eliminating sonic boom as a barrier to overland flight

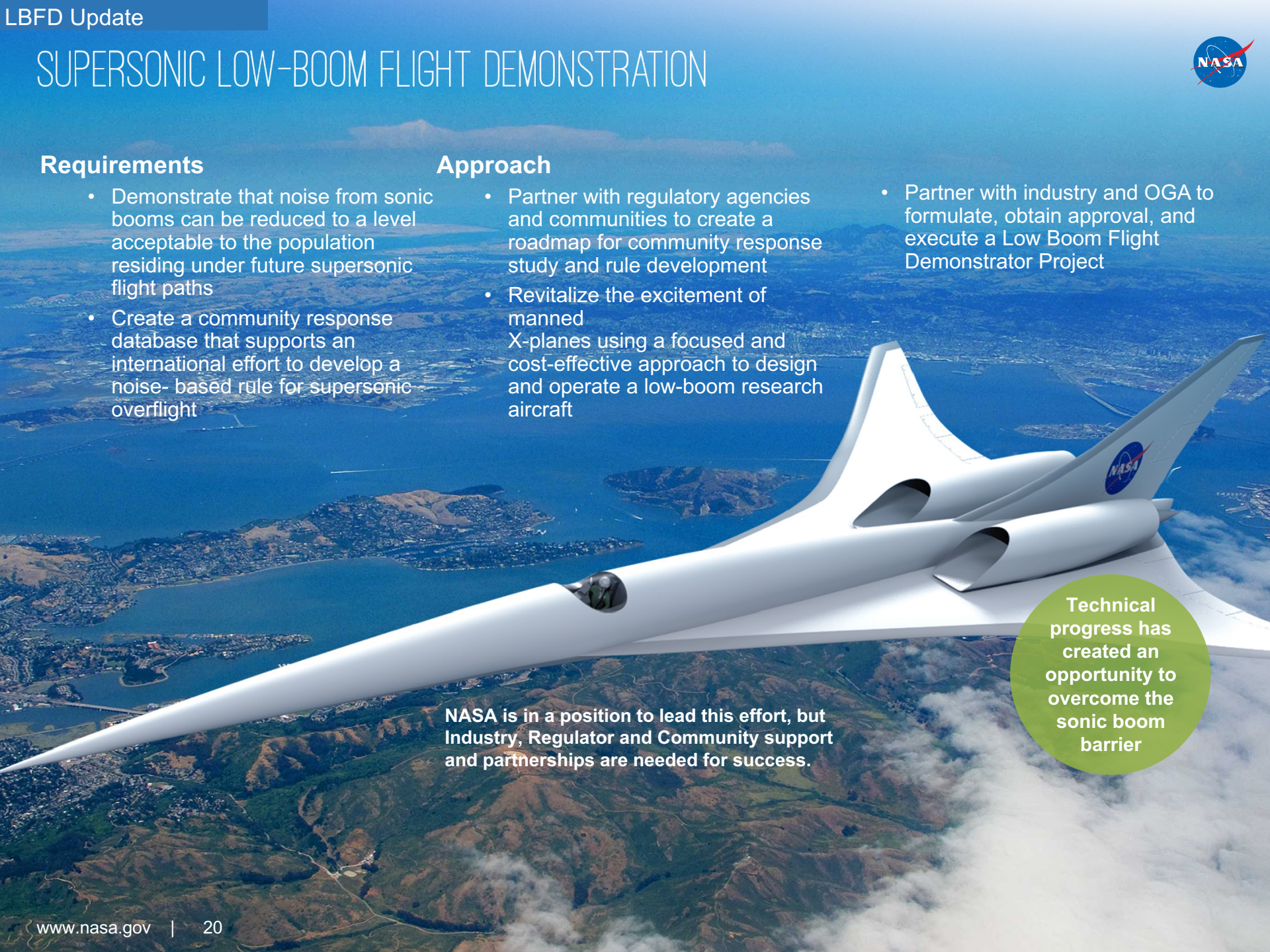
SUPERSONIC LOW-BOOM FLIGHT DEMONSTRATION

Requirements

- Demonstrate that noise from sonic booms can be reduced to a level acceptable to the population residing under future supersonic flight paths
- Create a community response database that supports an international effort to develop a noise- based rule for supersonic overflight

Approach

- Partner with regulatory agencies and communities to create a roadmap for community response study and rule development
- Revitalize the excitement of manned X-planes using a focused and cost-effective approach to design and operate a low-boom research aircraft
- Partner with industry and OGA to formulate, obtain approval, and execute a Low Boom Flight Demonstrator Project



NASA is in a position to lead this effort, but Industry, Regulator and Community support and partnerships are needed for success.

Technical progress has created an opportunity to overcome the sonic boom barrier

LOW-BOOM FLIGHT DEMONSTRATION

Committee Finding for ARMD AA – Low Boom Flight Demonstrator (LBFD)

The Committee endorses the Low Boom Flight Demonstrator project and congratulates NASA for developing clear project objectives and an adequate yet aggressive schedule. The Committee observed that the risk mitigation strategy has been well-developed and the goals of the project are clearly articulated. The Committee believes that the demonstrator will reinvigorate the public view of the role of Aeronautics within NASA and encourages the project to involve schools to take advantage of this opportunity to inspire the next generation.

BACK-UP

Acronyms

- ATD – Airspace Technology Demonstration
- ANSP - Air Navigation Service Provider
- BVLOS – Beyond Visual Line of Sight
- DAA - Detect-and-Avoid
- FAA – Federal Aviation Agency
- HALE – High Altitude Long Endurance
- ICAO - International Civil Aviation Organization
- IFR - Instrument flight rules
- OGA – Other Government Agencies
- NAC – NASA Advisory Council
- NAS – National Airspace System
- NRC – National Research Council
- TCL – Technical Challenge Level
- UAM – Urban Air Mobility
- UAS - Unmanned Aircraft Systems
- UCAT – UAM Coordination and Assessment Team
- UTM – Unmanned Aircraft Systems (UAS) Traffic Management
- V & V – Verification and Validation
- VFR – Visual flight rules
- VLOS - Visual Line of Sight
- VTOL – Vertical take-off and landing