NASA Aeronautics
Airspace Operations and Safety Program

Discussion with the ARTR

John A. Cavolowsky
Director, AOSP
Akbar Sultan
Deputy Director, AOSP

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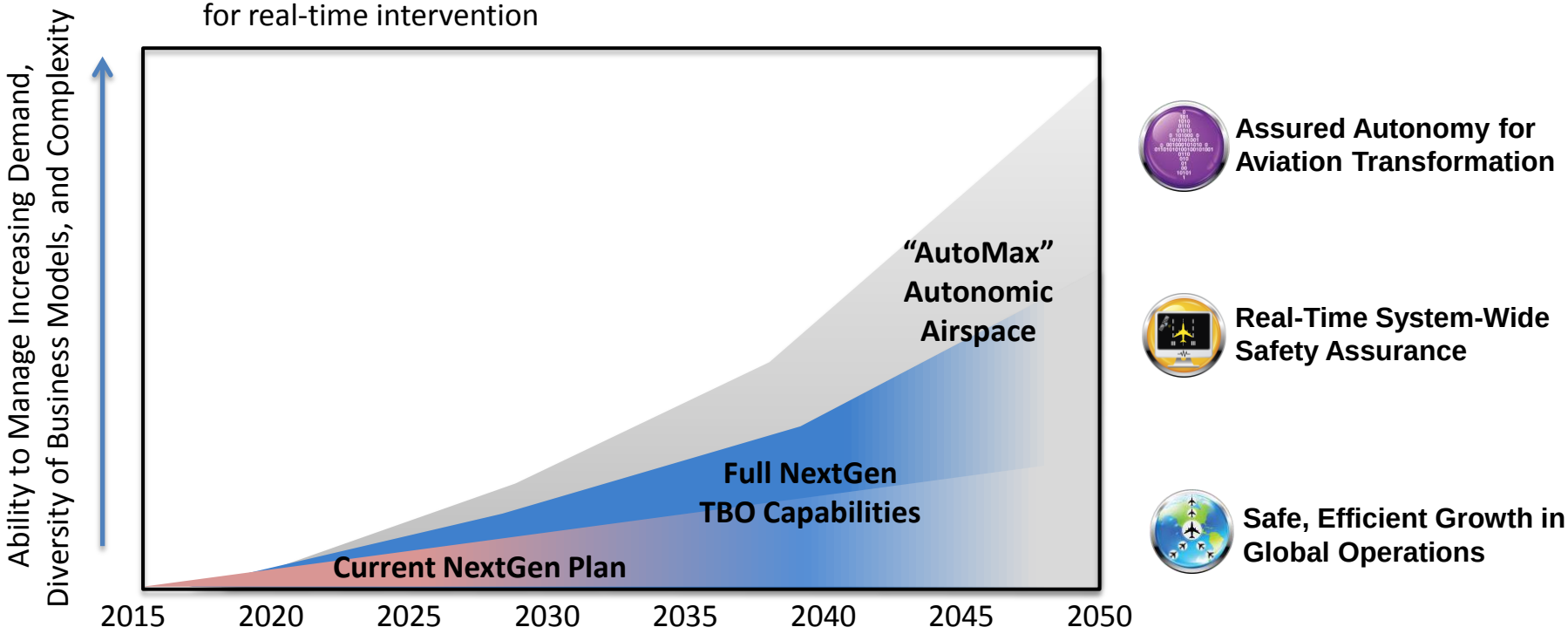
Aeronautics Strategy Supports Needed Aviation System Evolution

Thrusts 1, 5 and 6 build upon each other over time

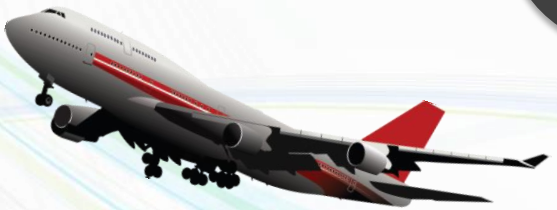
- Thrusts encompass the capabilities that are envisioned to be needed:
  - To manage increasing global demand
  - To manage increased diversity of business models, as represented initially by UAS, but ultimately including an expanded range of possibilities that more highly autonomous systems will enable, such as new modes of On-Demand Aviation
  - To manage the resulting increased complexity of operations that will be beyond human cognitive limits for real-time intervention



What is the Airspace Operations and Safety Program?

This program integrates the Airspace Systems Program and Aviation System-Safety work.

Mission Program



Proposed Projects

Airspace Technology Demonstrations

SMART NAS—Testbed for Safe Trajectory-Based Operations

Safe Autonomous System Operations

Airspace Operations and Safety Program

Develops and explores fundamental concepts, algorithms, and technologies to increase throughput and efficiency of the National Airspace System safely.

Provides knowledge, concepts, and methods to the aviation community to manage increasing complexity in the design and operation of vehicles and the air transportation system.

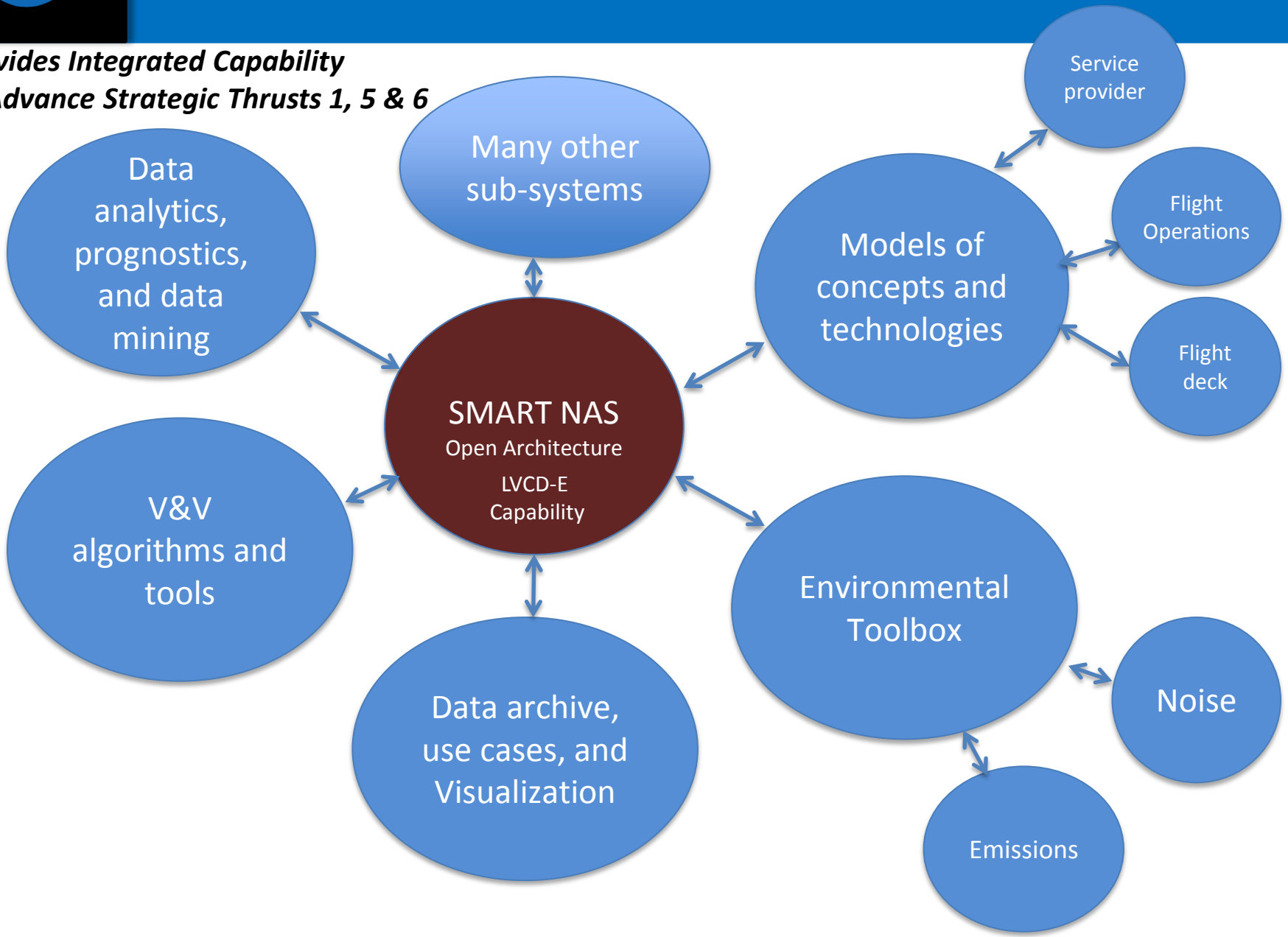
Continues Airspace Systems Program research, and the aircraft state awareness research and system wide safety research that was previously conducted within the Aviation Safety Program.

Airspace Operations and Safety Program Strategic Thrust Alignment

- Safe, Efficient Growth in Global Operations
  - Continue Airspace Technology Demonstrations for full NextGen capabilities in close partnership with FAA and the operator community
  - Continue development of SMART-NAS Testbed Capability to advance Full Trajectory Based Operations
- Real-Time System-Wide Safety Assurance
  - Real-Time System-Wide Safety research will be integrated into SMART-NAS development with network-enabled operations
  - Support assured safety of growing systems complexity with Human-Machine Integration, Prognostics, Data Mining, and V&V
- Assured Autonomy for Aviation Transformation
  - Continue exploratory research of “Beyond NextGen” Autonomic Airspace Architectures
  - Utilize NRC Autonomy Study and ICAST findings to initiate prioritized Autonomy-Focused Fundamental Research
  - Continue UTM development and plan future Autonomy Demonstrations

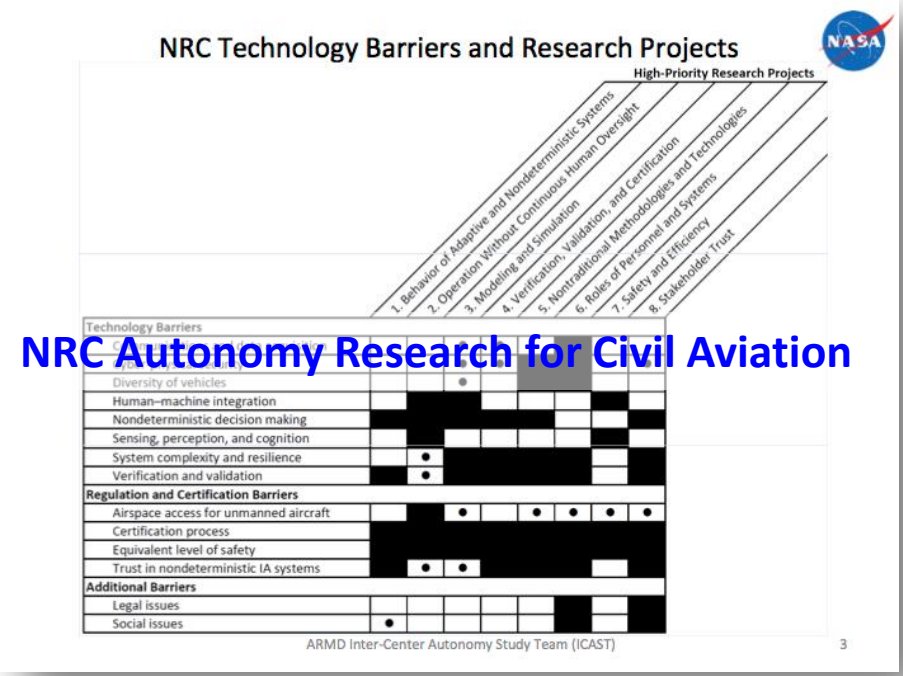
SMART-NAS Test Bed Capability

Provides Integrated Capability
to Advance Strategic Thrusts 1, 5 & 6

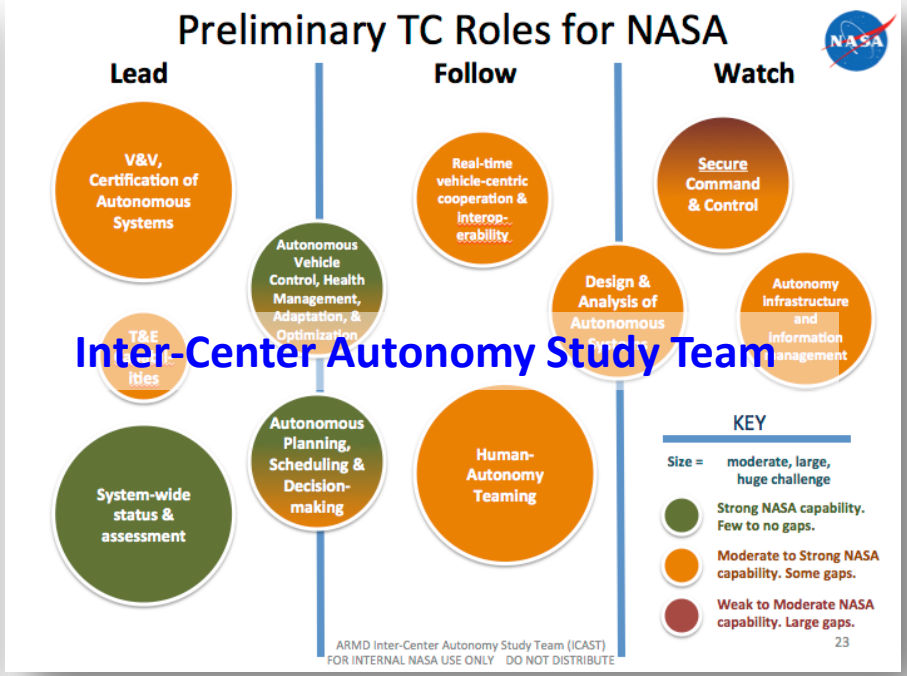


AOSP
Autonomy Research Needs

Studies have developed key technology barriers / challenges



NRC Autonomy Research for Civil Aviation



Inter-Center Autonomy Study Team

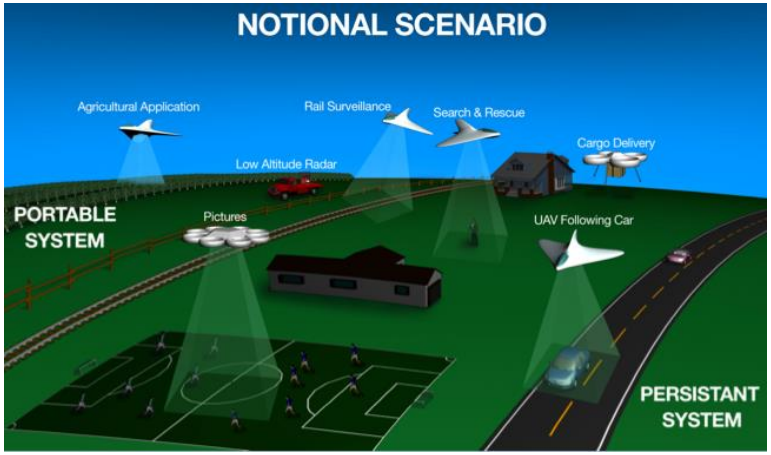
ARMD Planning

- **Augment fundamental research** in high impact areas where NASA ARMD has strong capability
- **Pursue an augmented UTM** as an integrated demonstration aligned to high impact areas and ARMD capabilities - V&V, T&E, System-Wide Status & Assessment, and Autonomous Planning, Scheduling & Decision-Making

AOSP
Autonomy Near-Term Challenge: UAS Traffic Management (UTM)

***Goals*:**

- Safely enable low altitude operations of UAS with other users within five years by developing technologies and procedures, and demonstrating an initial operating capability.
- Develop autonomous concepts, technologies, and procedures, and demonstrate a prototype operational capability to accommodate expected large increases in future demand for access to low-altitude airspace.



***Approach*:**

- Collaborative, cost-sharing partnerships
  - Partners develop vehicles, NASA develops UTM, jointly test UTM with diverse vehicles and missions
  - Partners and stakeholders demonstrate proactive collaboration
- NASA led tests will collect system performance data on trajectory conformance, UTM support, contingency management procedures, separation minima, and other considerations common to users of low altitude airspace
- Spiral development of UTM builds that increase capability incrementally
  - Build 1 is the foundation for all subsequent builds (1. Geo-fencing and airspace design; 2. Methods for establishing and maintaining UTM airspace (e.g. Open and close airspace decision based on the weather/wind forecast); 3. Separation/collision avoidance procedures and techniques for UAS within UTM airspace; 4. Basic scheduling of vehicle trajectories; and, 5. Terrain/man-made objects database to verify obstruction-free initial trajectory)

UTM is a near-term opportunity that aligns to several Autonomy “Lead” areas, such as V&V, T&E, System-Wide Status & Assessment, and Autonomous Planning, Scheduling & Decision-Making

Next Steps

FY 2015 Next Steps

- Begin implementation of Safe Autonomous System, Operations (SASO) project, including UTM
- Refine technical challenges and roadmaps based on NRC Autonomy Report and internal autonomy planning (ICAST)
- Refine potential future Autonomy focused demonstration candidates
  - All demonstrations are to be planned with strong (cost-shared) partner involvement, and evolving autonomy/autonomous/autonomicity operations
  - Progress towards autonomy: Demonstrations are initiated with targeted autonomy but will build toward fully autonomous capability (initial 2018, interim 2020+, final 2025+)
  - Example Candidates
    - Networked, Technologies for Reduced Crew Operations for cargo operator
    - Cloud-based/Networked aircraft operations
    - Disaster management with UAS and Portable UTM system
    - Enable all low-altitude operations supported by a Persistent UTM system
    - Low-altitude airspace for Personal Aerial Systems (PAS) and UAS supported by UTM

Questions

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

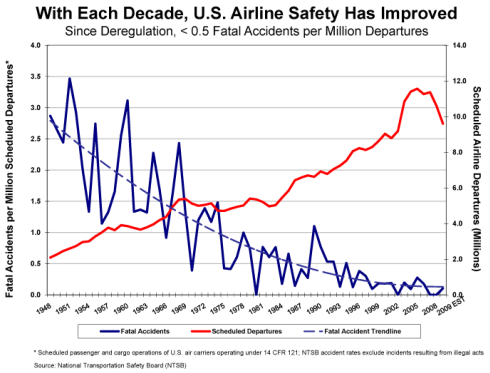
Assured Autonomy for Aviation Transformation

- Develop high impact aviation autonomy applications

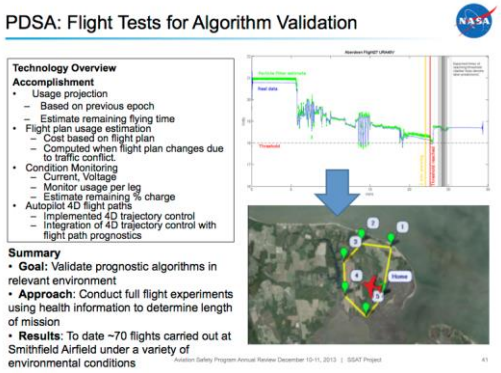
Real-Time System-Wide Safety Assurance

- Pioneering Methods and Integration for Real-Time System-Wide Safety Monitoring and Assurance

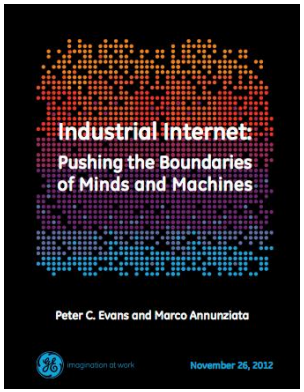
Achieve a New Level of Safety Performance and Enhance Safety Management Agility/Flexibility to Accommodate Greater Aviation System Creativity and Innovation

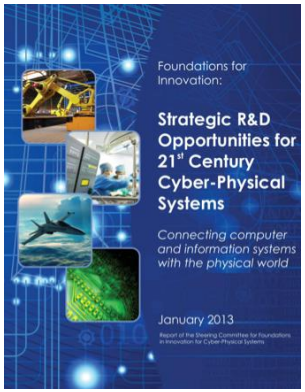


Build off of Technical Progress in Key Technical Challenge Areas



Leverage Industry & Government Vision and Investment in Cyber Physical Systems and the Industrial Internet





AOSP
Real-Time System-Wide Safety Assurance
Status and Next Steps

- Real-Time System-Wide Safety Assurance (RTSWSA) builds off of the successful research that has been performed in the AvSP System-Wide Assurance Technologies (SSAT) Project:
  - Discovery of Precursors to Safety Incidents
  - Prognostic Algorithm Design for Safety Assurance
  - Assurance of Flight Critical Systems
  - Assuring Safe Human-Systems Integration
- Initially, RTSWSA efforts will be more highly integrated in the forward looking SMART-NAS (full NextGen) project within the Airspace Operations and Safety Program (AOSP)
  - SMART-NAS provides a full Trajectory-Based Operations shadow mode simulation environment that creates a true system-wide environment for the development, test, and validation of system-wide safety assurance tools
  - Examine ***system-wide safety implications*** of new concepts, technologies, operations, and autonomy architectures and address design and operational ***mitigations of safety risks*** through live, virtual, and constructive simulation environment
- Ultimately, RTSWSA will be an enabler for future autonomic architectures envisioned by the SASO project within AOSP
  - Autonomic Systems have self-management properties designed-in – for aviation that will require RTSWSA capability
- Next Steps in FY15
  - Integration of SSAT efforts in SMART-NAS
  - Development of RTSWSA Measures, Metrics and Research Roadmaps to guide FY16 and outyear investment