



NASA-DLR Collaboration Follow-Up

B5 – Surface Management

July 22, 2015

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

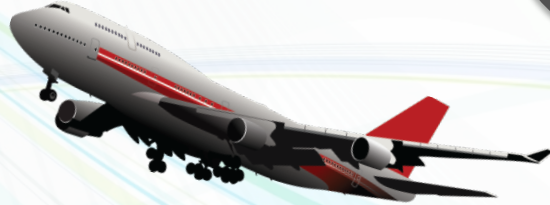
- Develop high impact aviation autonomy applications

What is the Airspace Operations and Safety Program?



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

Mission Program



**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.

Projects

- Airspace Technology Demonstrations
- SMART NAS - Testbed for Safe Trajectory-Based Operations
- Safe Autonomous System Operations

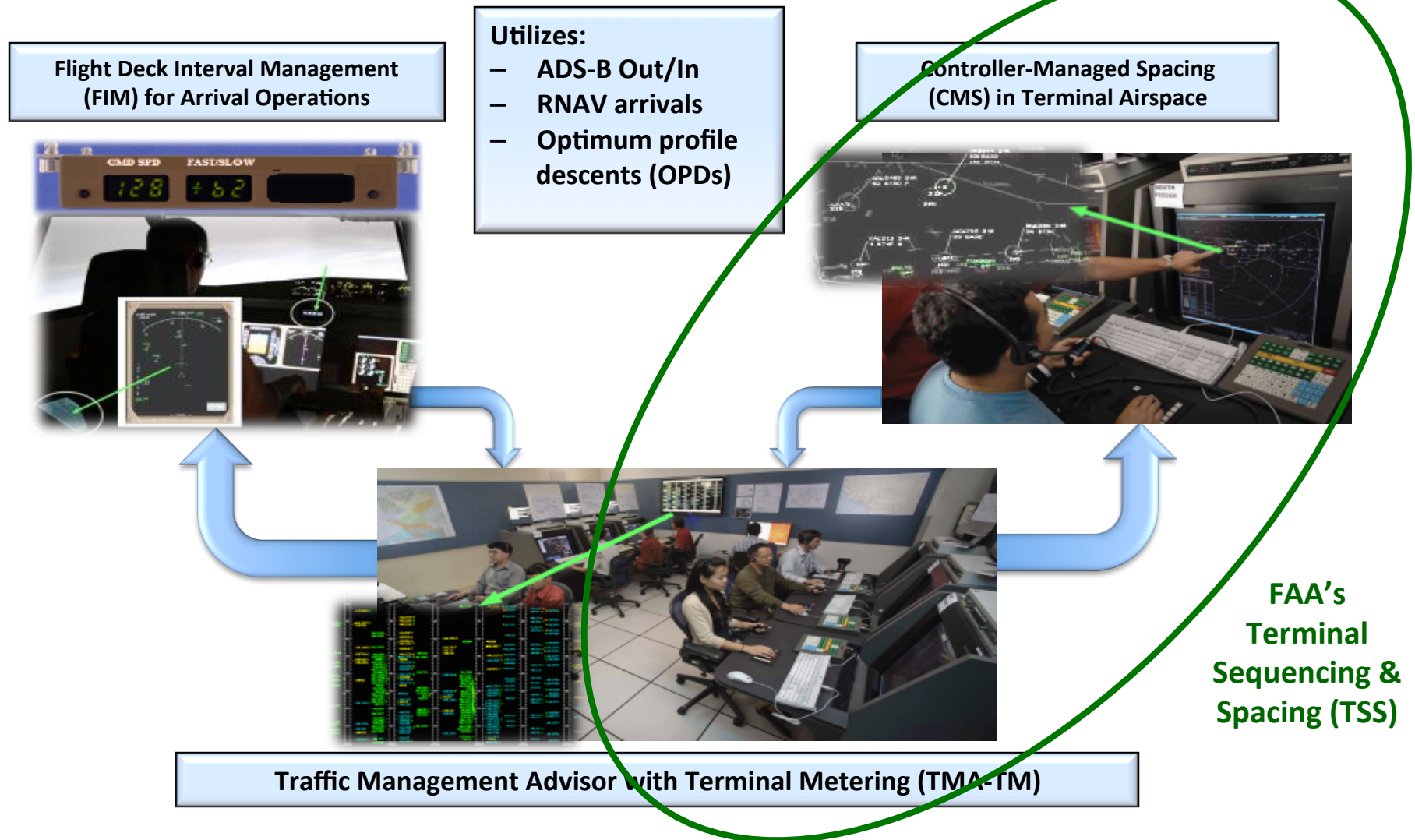


Three projects under AOSP Program

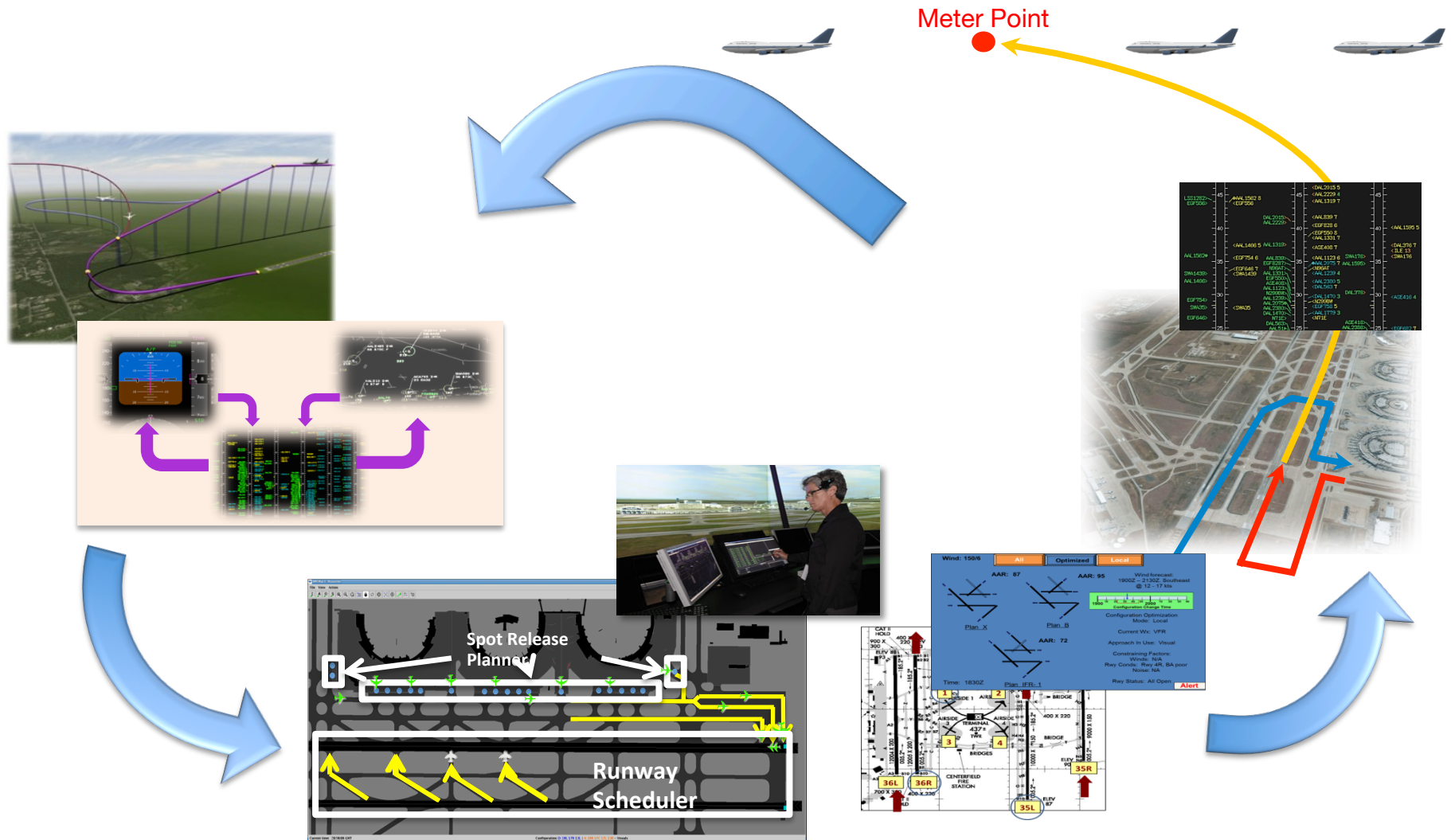


- ***Airspace Technology Demonstrations (ATD)***
- ***SMART-NAS Test Bed for Safe, Trajectory-Based Operations***
- ***Safe, Autonomous Systems Operations (SASO)***

ATD-1: Improve arrival operations efficiency while increasing arrival throughput using integrated aircraft-based and ground-based automation technologies



Integrated Arrival/Departure/Surface Operations (IADS): Simultaneously increase arrivals, departures, and surface operations efficiency while increasing overall throughput





Future steps beyond current NASA DLR collaboration agreement B5 (1)



- Comparison of ConOps between Europe and US
 - A-CDM vs. S-CDM
 - Harmonizing strategic and tactical scheduling
 - IADS (Integrated Arrival/Departure/Surface)
- Improve surface optimization solutions in real-time
- Expand modeling fidelity, such as gate turn-around and off-nominal situations (e.g., de-icing)

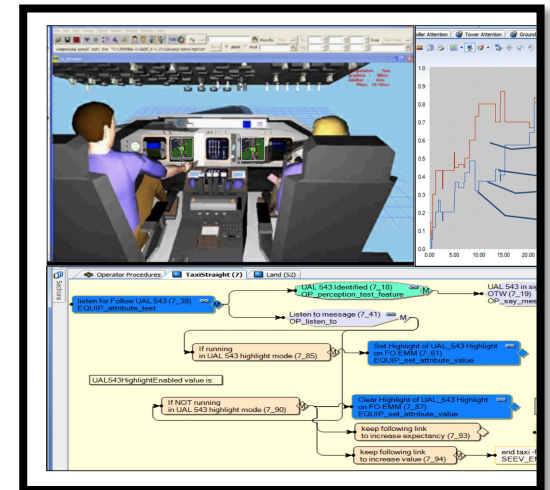
- Further refinement of 4DT Concept
 - Specific focus areas:
 - Operator Interfaces (Pilot, ATC, ramp);
 - Roles and Responsibilities;
 - Robustness and Resilience



Flightdeck Simulations



ATC Simulations



Human Performance Modeling

Future steps beyond current NASA DLR collaboration agreement B5 (3)

- Integrated HITL Pilot-ATC simulation of advanced (4DT) Surface Traffic Management Systems with Advanced flight deck systems (manual / auto-taxi)



We must work ATC concepts and flight deck concepts together in parallel
otherwise vulnerable to risk of:

- developing ATC / scheduling concepts to which pilots cannot comply
- Developing pilot concepts that don't meet the precision requirements of the scheduler
 - Developing pilot and ATC systems that are based on different assumptions



Future steps beyond current NASA DLR collaboration agreement B5 (4)



New areas for collaboration:

- Human-Automation Teaming
- Autonomous Airports
- Unmanned Aircraft Systems (UAS)

- Design and evaluation of human-automation architectures
 - What will be the role for the human controller if the scheduling, taxi clearances, and conformance monitoring is automated (monitor? set priorities and constraints? handle exceptions?)
 - Implication of automation design choices on operator performance (workload, situation awareness, complacency, error /failure recovery)
- Design principles and guidelines to support effective human-automation teaming
- Metrics and measures to evaluate effective human-automation teaming



Autonomous Airports

- Computer-based ATC agents that can:
 - monitor and plan traffic movement,
 - issue taxi and runway clearances,
 - communicate with the pilots (Cheng, V., 2015)
- Auto-Taxi

Research Issues:

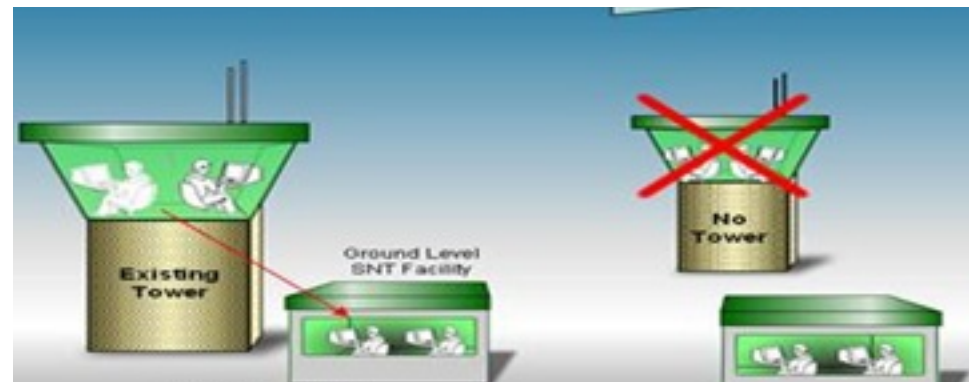
Technology Development

- Surveillance,
- Taxi plan generation,
- Communication

Robustness/Resilience

- Off-nominals,
- communication lags,
- system failures

FAA, 2010





Unmanned Aircraft Systems (UAS)



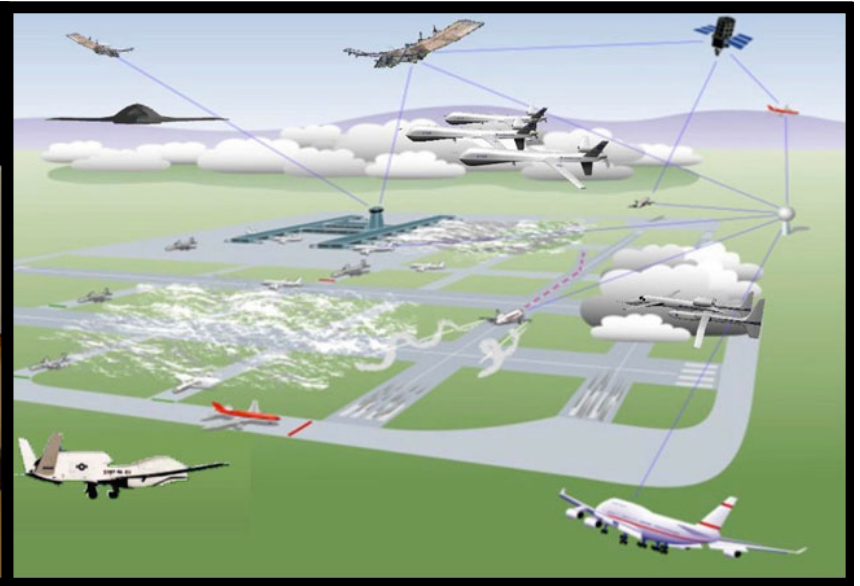
- Ground stations for maneuvering UAS on the surface
- Adapt flight deck displays to support ground-based pilots



HCSL. NASA ARC



Raytheon Company



Johnson, C., (2012) NASA Dryden



Backup Slides

Integrated System Capability ATM Generations



ATM +1

Domain-Focused Enhanced System

Improved individual domains (e.g., surface traffic flow) with some initial integration between domains

Provides improved efficiency in each domain at the earliest possible date, supporting airline cost savings and reduction of environmental impact

Majority of current ASP research is supporting ATM +1

ATM +2

Integrated Airspace System

Integration of terminal and en route, integrated surface and arrivals/departures, and system modeling enable predictive capabilities

Provides system efficiency, predictability and reliability gains to further improve airline and ATM network operations and support traffic growth, including UAS

Some current research supports ATM +2

ATM +3

System-wide Autonomous Optimized Airspace

Dynamic, fully autonomous trajectory services enabling rapid adaption to meet user demand or respond to system perturbations (e.g., weather)

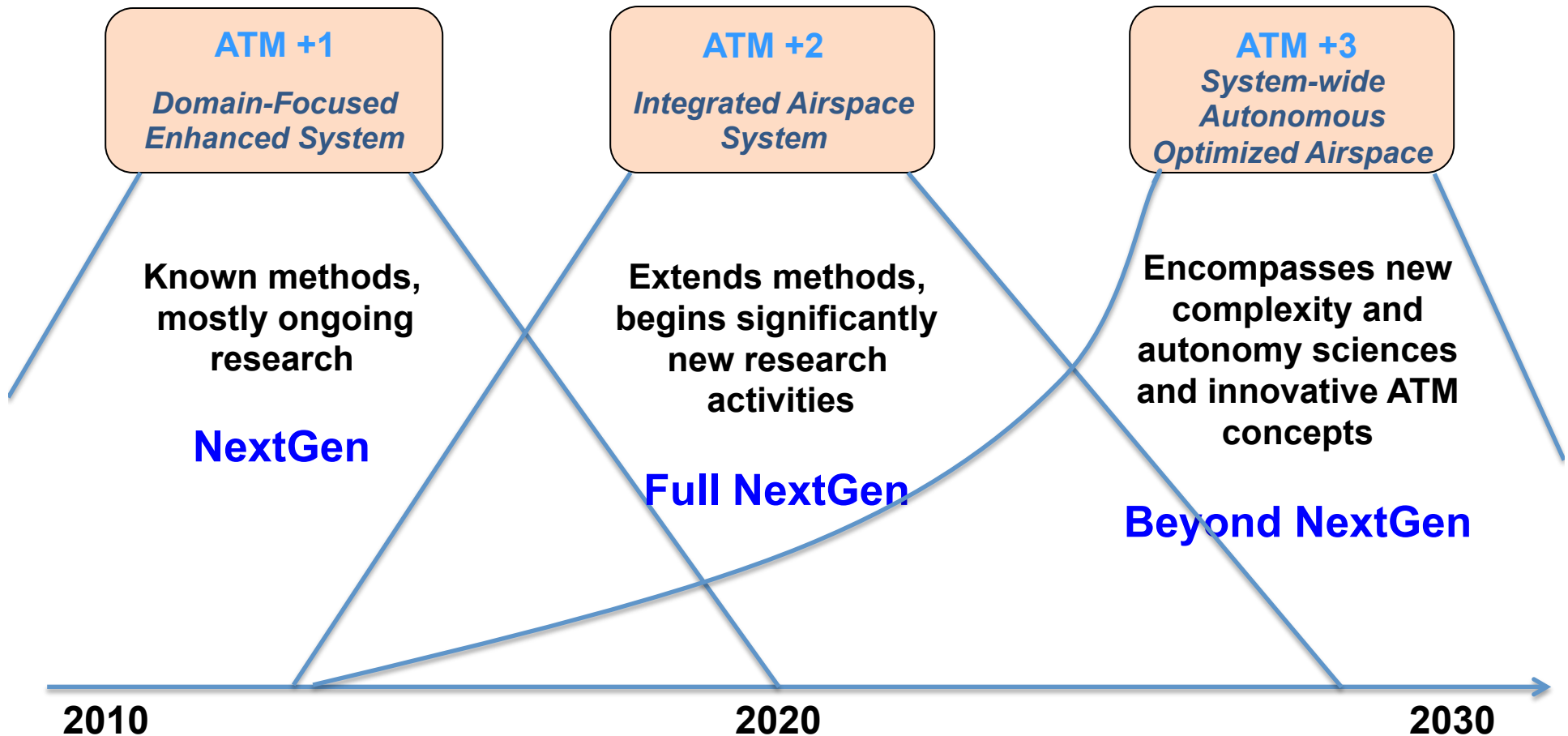
Provides a flexible, scalable, and resilient system to meet significant traffic growth and support changing operators' business-network models

This is beyond NextGen capabilities and requires the development of new concepts

Required to achieve projected 3X+ growth in traffic demand, including UAS*

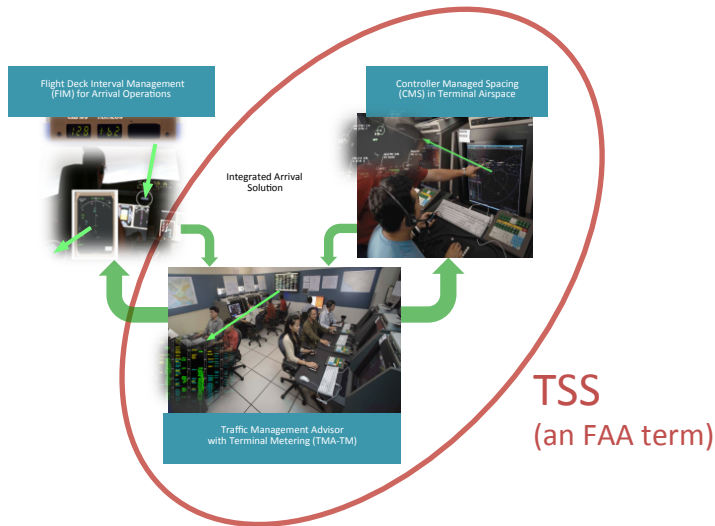
* Demand based on JPDO IPSA analysis of FAA Terminal Area Forecast and RTCA SC-203 OSED for UAS

ATM Generations Timeline





ATD-1 Delivers to NextGen



- ATD-1 transferred Terminal Sequencing and Spacing (TSS) technologies to the FAA in 2013
- TSS enables use of underutilized modern avionics and Performance-Based Navigation or PBN procedures

- Estimated benefit to airlines operating at 35 benchmark airports ranges from \$100-200M/year
- FAA is planning for Initial Operating Capability in 2018

This is an unprecedented contribution of NASA technology to NextGen

IADS Benefits Roadmap

