Research underway to provide more information during operations when its needed

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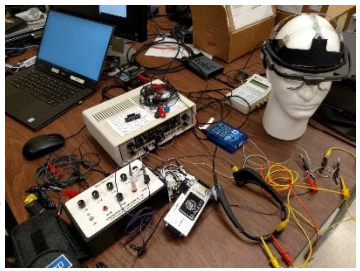
Technologies for Airplane State Awarenes (TASA) – Sim Activities

- **AFDC-3A/B – Eval of SVS w/ Unusual Attitudes (SE200)**
  - Langley Research Flight Deck - Regional Jet Pilots
  - B-787 @BFS-Miami – International Pilots - Summer 2017
    - Only Level-D sim used for training to be integrated with SVS
    - Via Boeing SAA

- **SHARP-2 – Evaluation of Prototype CSM System (SE211)**
  - Langley Research Flight Deck – In Progress
  - Collaboration with industry, academia for big data and machine



- **T-tail RJ Simulation Development (SE209)**
  - Baseline aero validation (qualitative) – CRJ-700 @AA-CLT
  - Assessment via Boeing expertise
  - *Preliminary* ID of key modeling parameters

- **Stall Recovery Guidance Study - Ames VMS (SE207)**
  - Pitch/Roll/Thrust Guidance
  - High-fidelity stall modeling
- **Stall Motion-Cueing-Ames VMS-Summer 2017 (SE209)**

ATM Accomplishments

NASA successfully closed out ATM Tech Demonstration 1 (ATD-1). ATD-1 focused on the ability to achieve very efficient arrival operations during congested times at the nation's busiest airports.

FAA plans to deploy the Terminal Sequencing and Spacing Operational Test and Evaluation in April/May 2018, with Initial Operating Capability (IOC) in 2019.

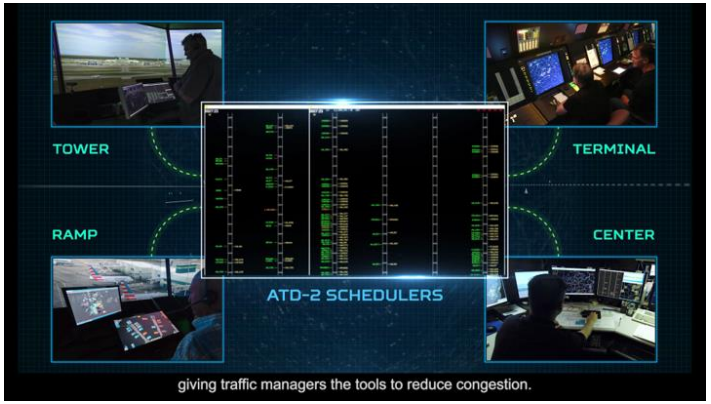
Flight Deck Interval Management FAA Final Investment Decision planned for FY2020, with FY 2020-2021 implementation start.

Terminal Sequencing and Spacing

ATD-1 demonstrated ground and airborne automation that is able to achieve efficient arrivals *utilizing Performance Based Navigation (PBN)* over 90% of the time, which is 2 to 3 times better than current operations. The final flight trials of the Flight-deck Interval Management (FIM) component was successfully completed in FY2017, demonstrating for the first time ever the ability of *multiple* aircraft *(three aircraft)* to self-*space* through complex airspace into an efficient arrival stream.

ATM Accomplishments

NASA has begun operational evaluation of ATD-2 technologies that improve predictability and efficiency through advanced scheduling and information sharing. The ATD-2 scheduling tools help traffic managers coordinate operations at the ramp, tower, terminal, and center control facilities.

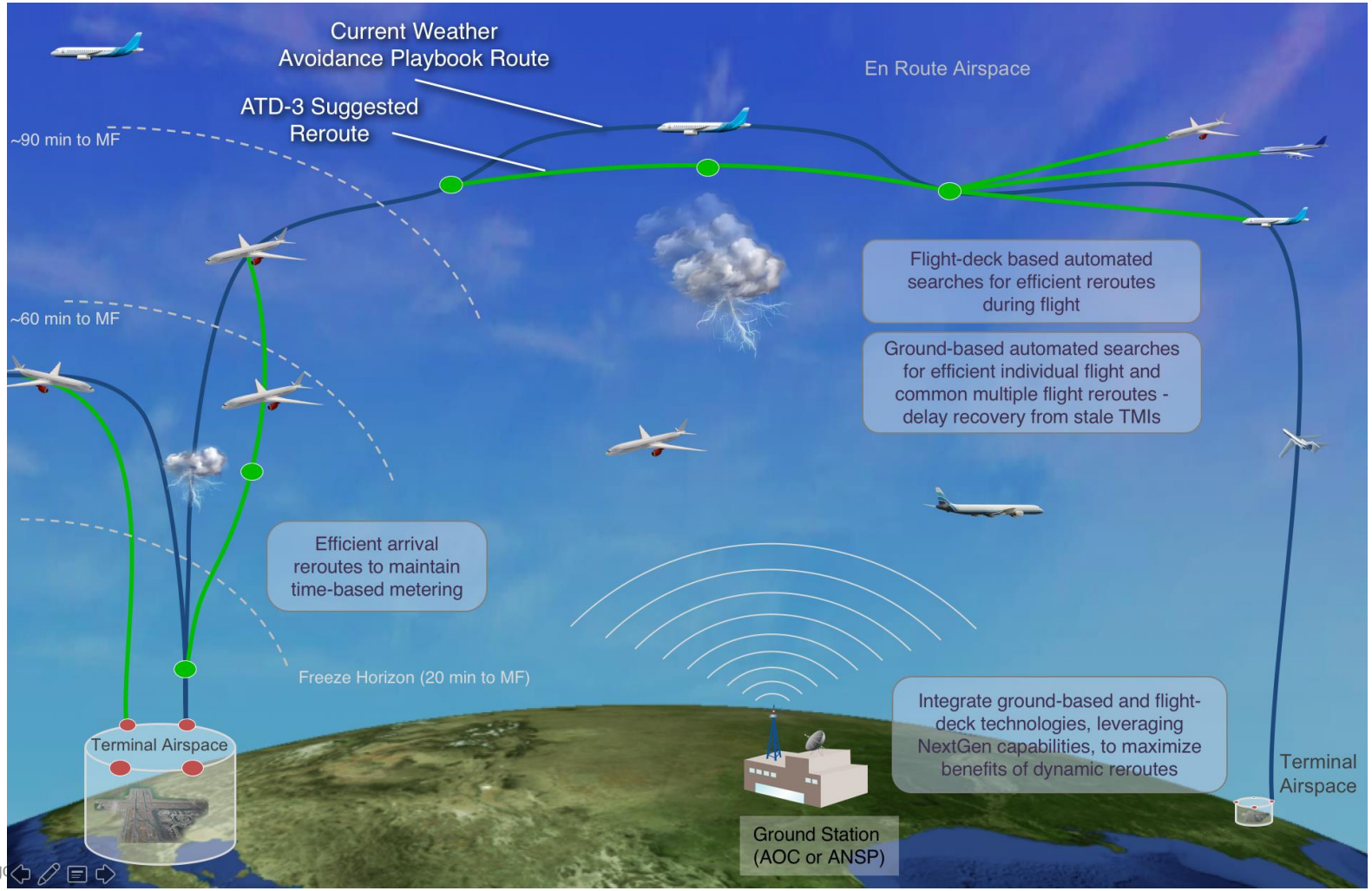


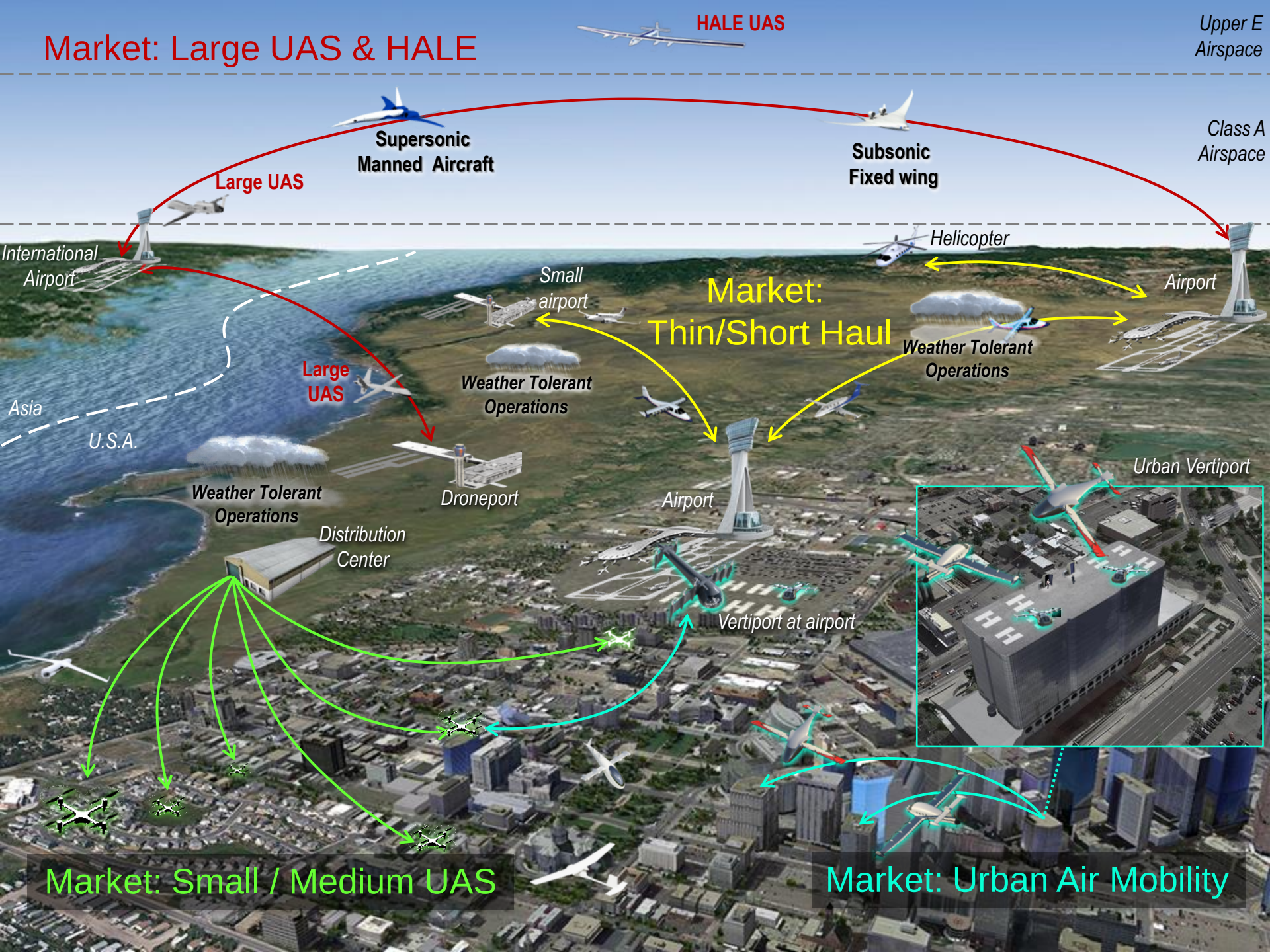
Early benefit findings from the first 3 months of the 3 year demonstration include:

1. More efficient overhead stream scheduling has saved over 20 hours of surface delay on CLT airport surface, 42,824 lbs. of fuel via just-in-time delivery of departures from the gate to the runway to meet their assigned takeoff times
2. Surface metering during a single departure bank (one of nine banks at CLT) has saved approximately 51,868 lbs. of fuel and 72 tons of CO2, equivalent to planting 1,858 urban trees, and 2)

Adverse Weather Mitigation Integrated Concept

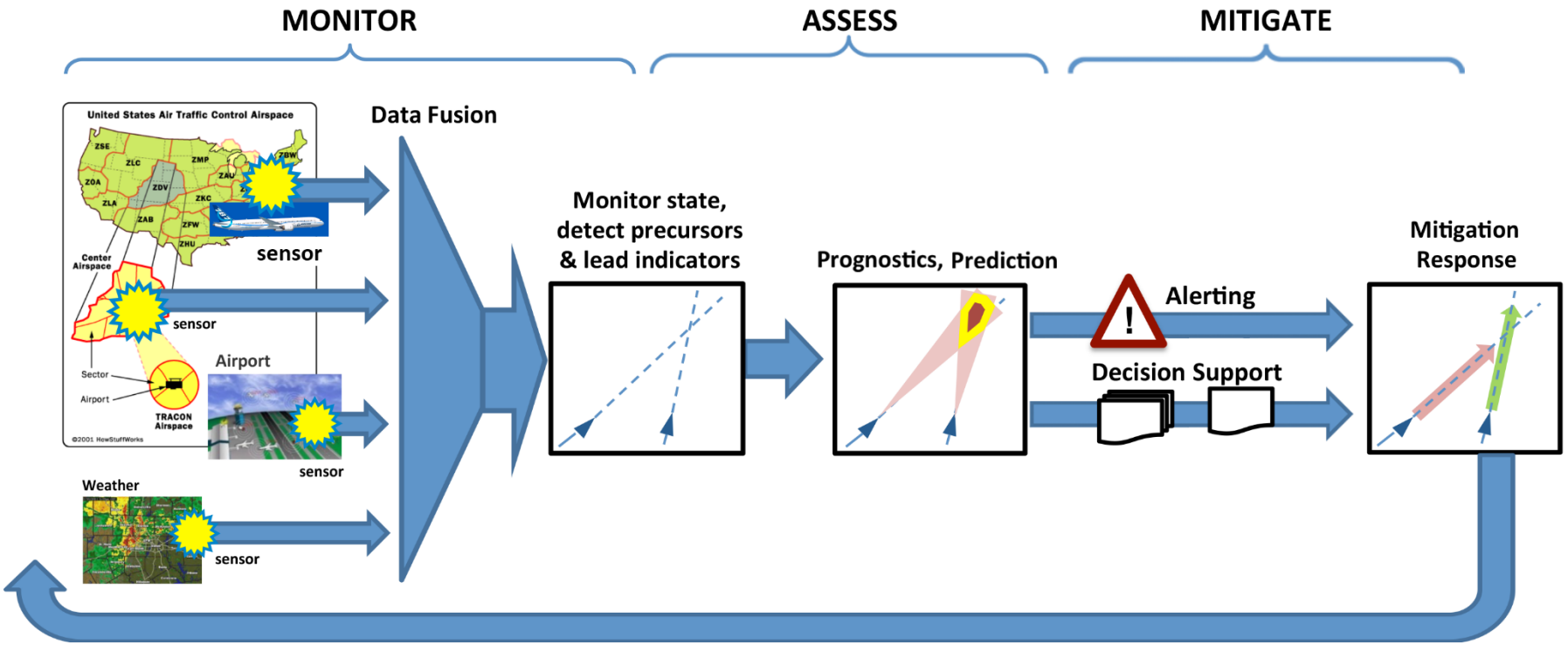
Develop and deliver air/ground technologies and procedures to the FAA and flight operators that enable reduced weather-induced delays through the integration of weather information to better manage aircraft, traffic flow, airspace and schedule constraints. (ATD-3)




Market: Large UAS & HALE
HALE UAS
Upper E Airspace
Supersonic Manned Aircraft
Subsonic Fixed wing
Class A Airspace
Large UAS
International Airport
Helicopter
Small airport
Market: Thin/Short Haul
Airport
Weather Tolerant Operations
Large UAS
Asia
U.S.A.
Weather Tolerant Operations
Droneport
Weather Tolerant Operations
Urban Vertiport
Airport
Distribution Center
Vertiport at airport
Market: Small / Medium UAS
Market: Urban Air Mobility

In-Time System Wide Safety - Overview Chart

In-time system-wide safety assurance requires the ability to monitor operations and assets across the system, assess the current and future state of the system, and provide mitigation strategies to eliminate or minimize risk.



Strategies for In-Time System Wide Safety Assurance

- Leverage growing **sources of aviation data**, commercial data analytics methods, architectures, “internet of things” to enable safety **monitoring, prediction,** and **prognostics capabilities**
- Conduct **fundamental safety research to understand the general or composite properties of and margins for safe operations** across the NAS and enable eventual broad RSSA capabilities
- Expand functionality through **evolutionary development, demonstration** and adoption of capabilities
- Leverage the strengths of **both human and machine agents** to support intelligent, adaptive mitigation strategies for optimum threat management
- Achieve stakeholder trust and consensus through **frequent demonstration of benefits** to ensure access to the rapidly growing body of safety relevant data from FAA, operators, and system providers

Research/Technical Challenge Overview

RSSA

- TC-1: In-Time Terminal Area Risk Management
- TC-2: In-Time Safety Nets for Emerging Operations

Traditional/commercial Aviation operations

Support for new entrants

V&V

- TC-3: Safe Avionics for Future ATM Evolution
- TC-4: Complex Autonomous Systems Assurance

Certification cost/ Evidence from new methods

Develop tools for assurance of increasingly autonomous systems

ASA

- TC-5: Technologies for Airplane State Awareness

Support for Commercial Aviation Safety Team SEs

Questions