Airspace Future Vision Beyond NextGen

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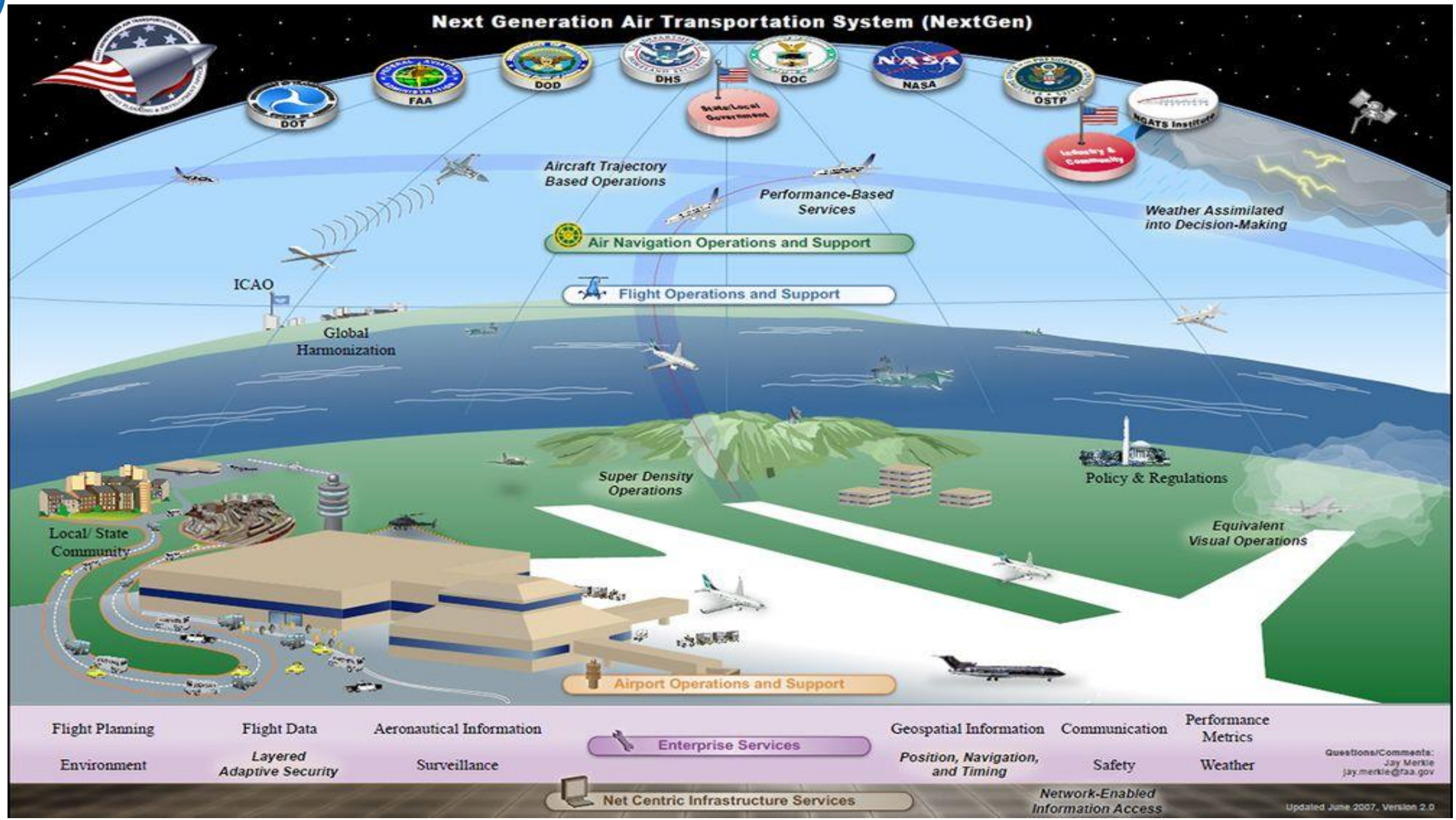
Next Generation Air Transportation System (NextGen)
DOT
FAA
DOD
DHS
DOC
NASA
OSTP
NGATS Institute
Aircraft Trajectory Based Operations
Performance-Based Services
Weather Assimilated into Decision-Making
Air Navigation Operations and Support
Flight Operations and Support
ICAO
Global Harmonization
Super Density Operations
Policy & Regulations
Local/ State Community
Equivalent Visual Operations
Airport Operations and Support
Flight Planning
Flight Data
Aeronautical Information
Geospatial Information
Communication
Performance Metrics
Enterprise Services
Environment
Layered Adaptive Security
Surveillance
Position, Navigation, and Timing
Safety
Weather
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Net Centric Infrastructure Services
Network-Enabled Information Access
Updated June 2007, Version 2.0

NextGen Accomplishments

- **Terminal Sequencing and Spacing (TSAS) and Flight Deck Interval Management (FIM)**
  - Forecast $500 million national fuel savings
  - FAA national deployment in Time Based Flow Management (TBFM) starting with Denver in 2020

- **Integrated Arrival, Departure, Surface Operations**
  - 2.8 million pounds of fuel saved and CO_2 emissions reduction equivalent to 63,101 urban trees, 2,122 hours reduced engine runtime (as of July 31, 2019 CLT trials)
  - FAA's Terminal Flight Data Manager (TFDM) Program will deploy IADS capabilities to 27 airports beginning in 2021

- **Efficient re-routes around weather which are more direct, fuel-efficient, wind optimal, conflict free, and avoid congested airspace**
  - Multi-flight Common Routes and Dynamic Routing Around Weather informing FAA Traffic Flow Management System (TFMS)

- **Low-altitude small UAS operations in dense urban environments**
  - Reno, NV, June 17-28, 2019 and Corpus Christi, TX, August 12-23, 2019
  - Enable FAA's UTM Pilot Program and UAS Integration Pilot Program

- **Deliver to six Commercial Aviation Safety Team Safety Enhancements**
  - Stall prevention and recovery, aircraft state awareness

Source: Boeing

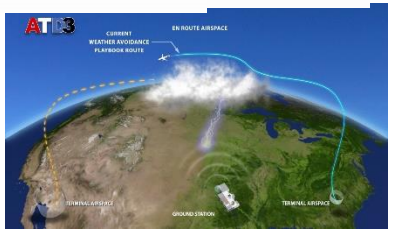
DFW DALLAS FORT WORTH INTERNATIONAL AIRPORT

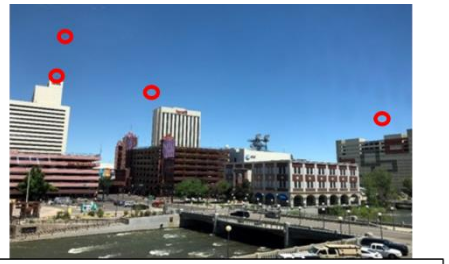
Dallas Love Field

Charlotte·Douglas INTERNATIONAL AIRPORT

AA AmericanAirlines

SOUTHWEST AIRLINES

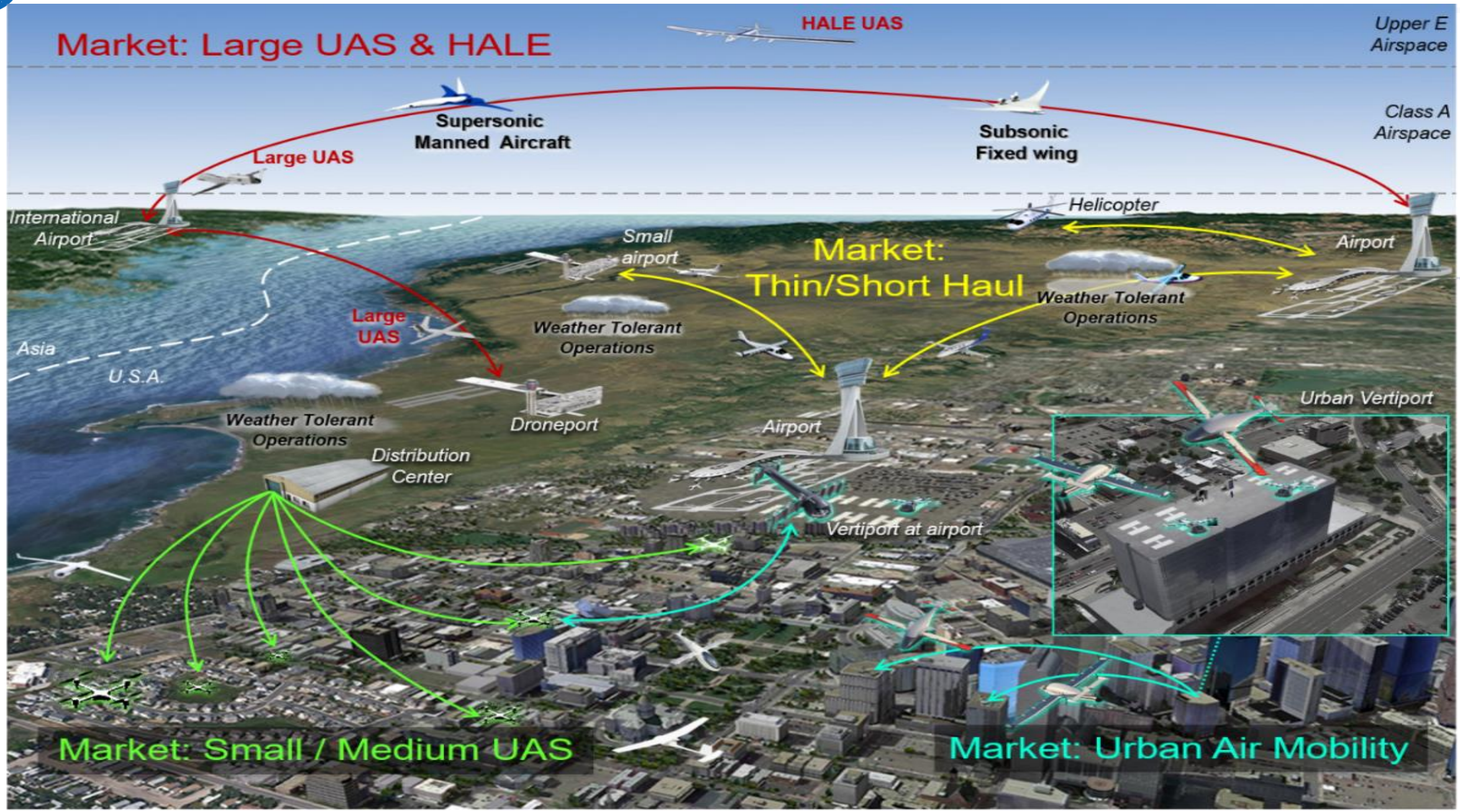



Four UAS autonomously flying over Reno managed by UTM

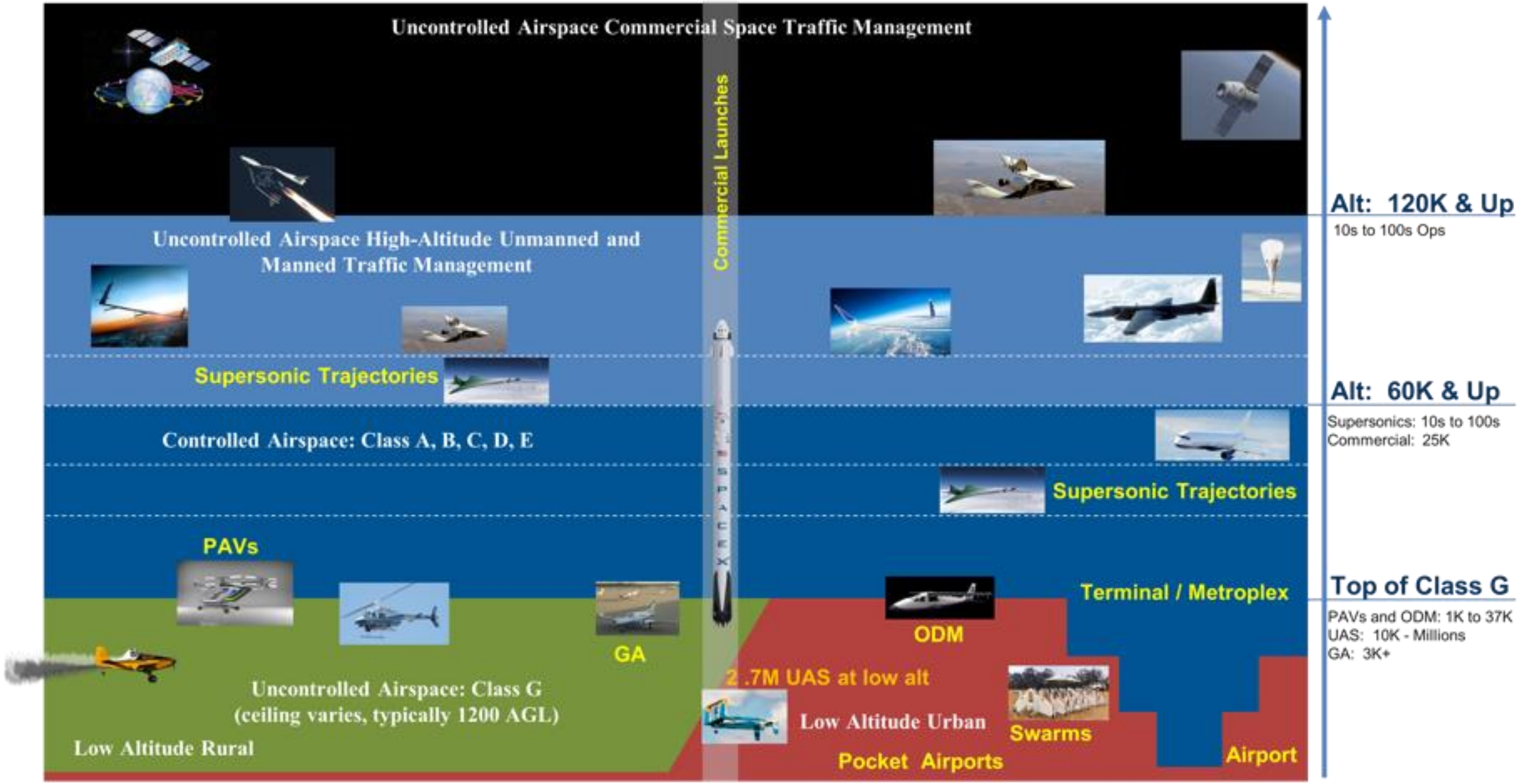
CAST | The Commercial Aviation Safety Team

AOSP

Future Airspace



Daily Flight Demand for All Users in 2025



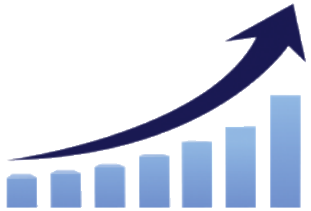
Future Airspace System Vision and Framework

- ARMD will leverage work in NextGen, UAS Traffic Management and Systemwide Safety to enable a range of diverse operations in an increasingly more dynamic and complex airspace system
  - Provide leadership to enable safe, seamless integration of emerging vehicles and operational concepts into the National Airspace.
  - Utilize more than 200 established partnerships through ATDs and UTM for joint requirements development, concept validation, and benefits demonstrations
  - Leverage and build upon FAA's 3-Ts (TBFM, TFDM, TFMS)
  - Transform airspace management to a Service-Oriented Architecture that enables scalability and is collaborative, flexible, and resilient to uncertainty.
  - Establish of In-Time System Wide Safety for prognostic risk identification for emergent and commercial transport operations

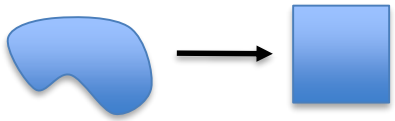
Future System Tenets

Goal: Enable safe efficient airspace access all users, vehicles, and missions by creating new airspace management concepts and technologies leveraging UTM principles

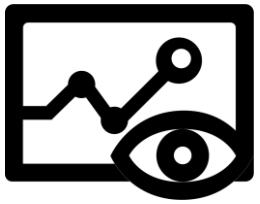
Seamless access to the airspace for users and missions—both on-demand (UAM, UAS) and scheduled (Supersonic, Space)



Scalability for increased demand across users and missions

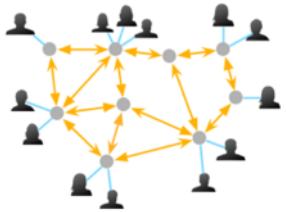


Flexibility whenever possible and structure only when necessary



In-Time System Wide Safety prognostic data driven identification of precursors and system V&V

Collaboration through integrated information exchange



Resilience to uncertainty, degradation, and disruptions

Increased availability and use of **user and third-party services**

System and Data Security Availability, integrity, privacy, transport, storage

RESEARCH NEEDS

NAS Transformation, UTM-Inspired ATM

- Federated, Flexible architecture
  - Sectors
  - Systems
  - Interfaces
  - Users
  - ……..
- Service Oriented architecture
  - Enable true bi-lateral collaboration
  - Enable third party services
  - Enable fusion, leveraging of data, and data-driven proactive decision making
  - Enable smart-digital-airline services

RESEARCH NEEDS

Autonomous Systems

- **Integrated, Heterogeneous, Interoperable operations with non-autonomous systems**
- **Contingency Management**
- **Fleet Management**
- **Human/Machine Functional Allocation**
- **Human/Machine Roles and Responsibilities/Accountability**

Emergent Operations

- **UAS, sUAS, UAM, Autonomous Cargo, ETM, Supersonic, Electric, RCO, …….**
- **Before researching solutions need:**
    - **Identification of use cases**
    - **Development of ConOps**

RESEARCH NEEDS

Data

- **Lots of data is not necessarily information**
- **Translation of data**
- **Data Transport (timeliness, security, etc.)**
- **Current methods and protocols insufficient for expected volume**
- **What new data transport/transmission capabilities needed, and who is capable of providing them**
- **What data needs to be where, when, how, and in what form**

RESEARCH NEEDS

In-Time System Wide Safety

- Data-driven approach to asses the cumulative effect of individual risks instead of assessing them in isolation
- In-Flight Safety Predictions to monitor, asses and mitigate risks to sUAS, UAS, UAM in dense urban operations.
- Enable certification of autonomous systems that incorporate machine learning, which cannot be assured with currently available methods
- Assure system-level safety in a future aerospace system with heterogeneous and rapidly-changing decision-making components (vehicles, third-party service providers, etc.).
- Information architecture and data-sharing approach to a Safety Management System for UAM and Transformed NAS airspace