Airspace Operations and Safety Program

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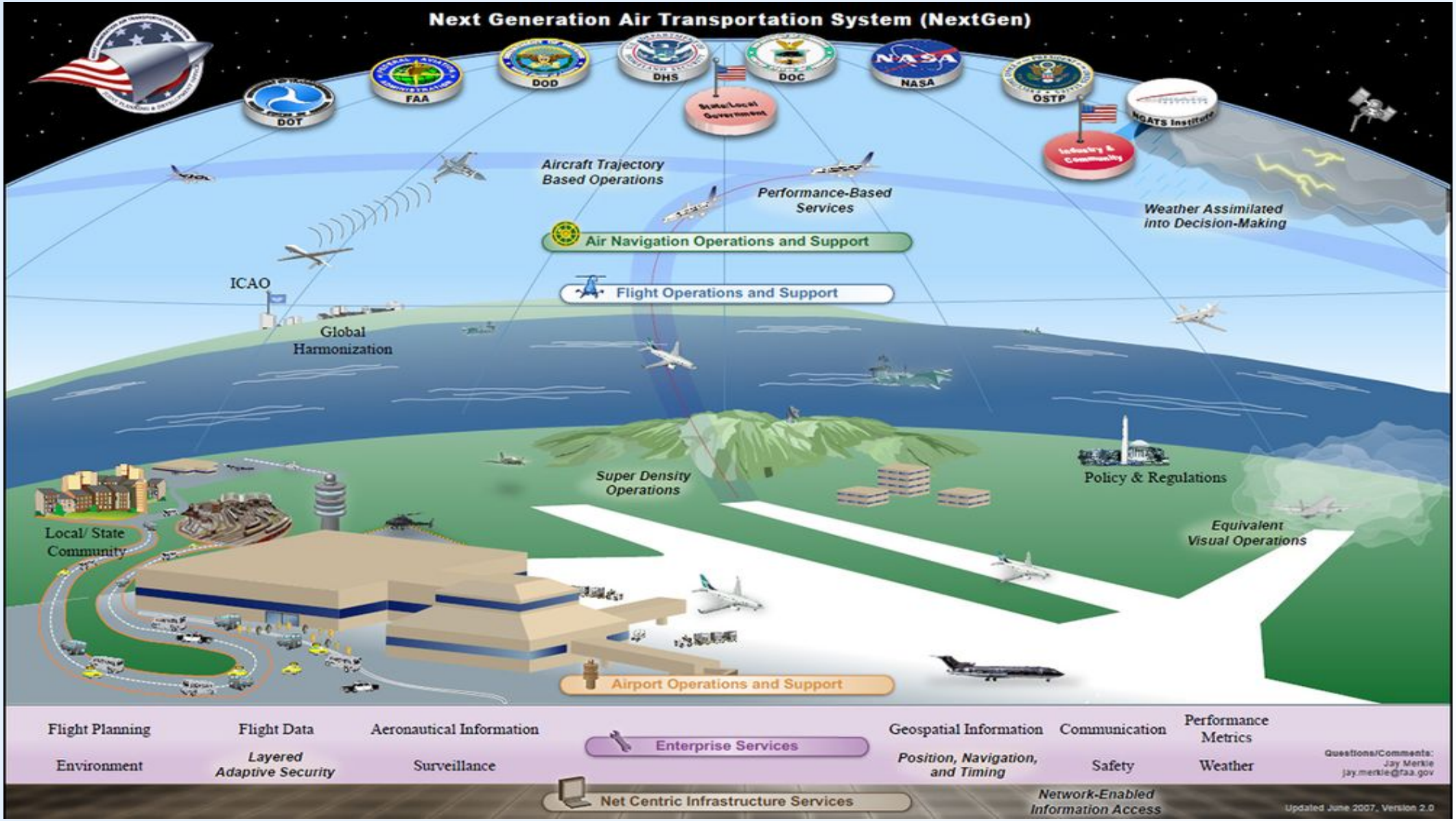
NextGen Accomplishments



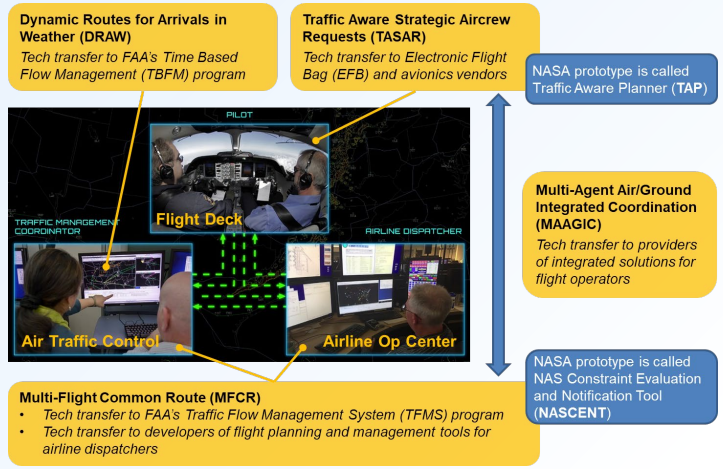
Airspace Technology Demonstrators (ATDs)

- **Terminal Sequencing and Spacing (TSAS) and Flight Deck Interval Management (FIM)**
  - Forecast $500 million national fuel savings
  - Harness FAA and industry investment into precision arrival routes, procedures, ADS-B
  - Developed Terminal Sequencing and Spacing (TSAS) and Flight Deck Interval Management (FIM)
  - Joint partnership with FAA, Boeing, UAL, Honeywell, Raytheon
  - FAA national deployment in Time Based Flow Management (TBFM) starting with Denver in 2021

Source: Boeing

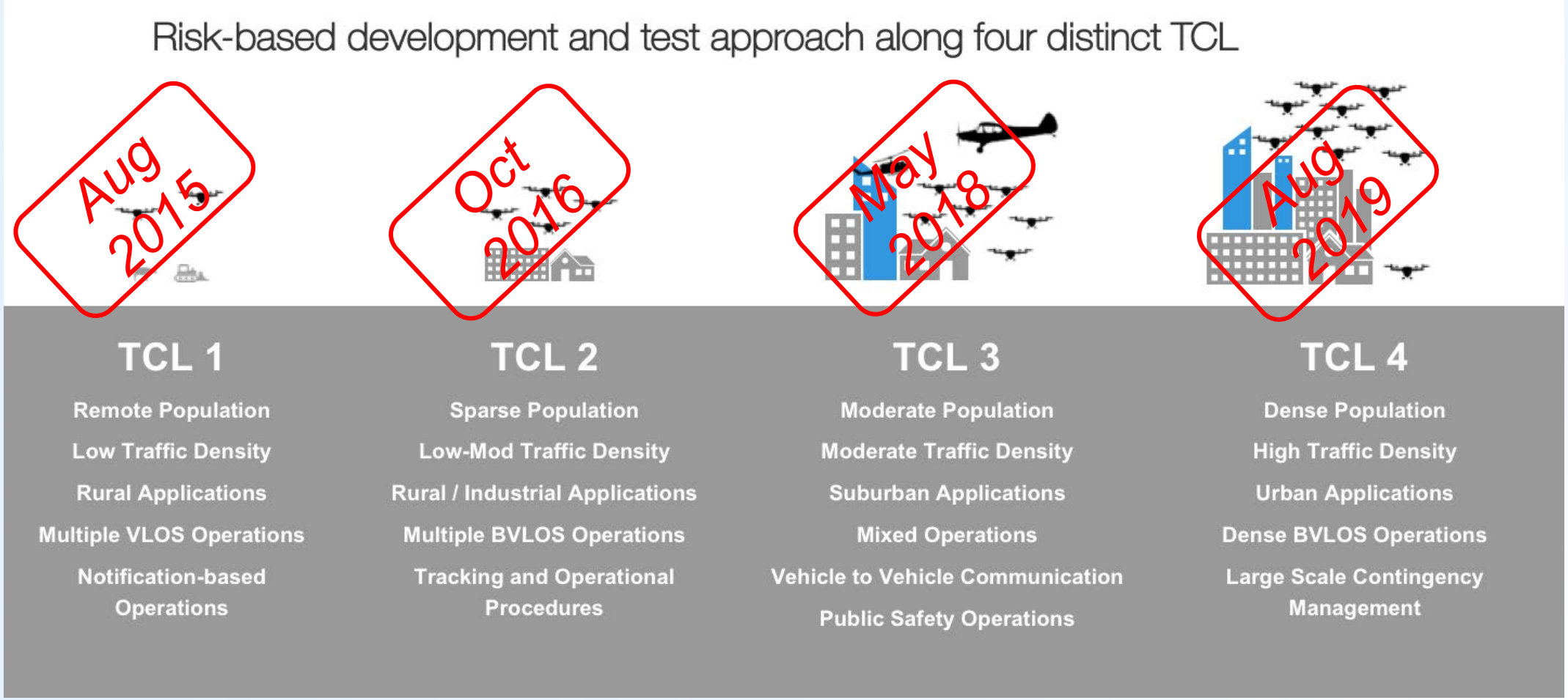
- **Integrated Arrival, Departure, Surface Operations**
  - 462,211 gal of fuel saved and 9,552,417 lbs CO_2 emissions reduction equivalent to 71,031 urban trees, 2,448 hours reduced engine runtime (as of Sept 30, 2019 CLT trials)
  - FAA's Terminal Flight Data Manager (TFDM) Program will deploy IADS 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 (MFCR) and Dynamic Routing Around Weather (DRAW) transferred to FAA
  - FAA will integrate and deploy nationally through their Traffic Flow Management System (TFMS)
  - TAP/TASAR Licensed to APiJET (Alaska Airlines) and Rockwell-Collins



UAS Traffic Management (UTM) Technical Capability Levels (TCL)

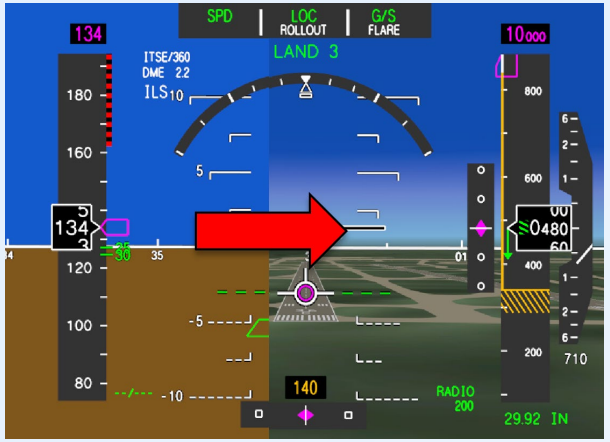
- Develop and validate airspace operations and integration requirements to enable safe, large-scale UAS operations under 400 ft. AGL, Class G airspace
- Provide prototype UTM system to FAA for further testing and development



Technologies for Airplane State Awareness

Complete research specified for six Commercial Aviation Safety Team (CAST) Safety Enhancements to reduce loss-of-control events

CAST SE	TASA Technical Area
207 Attitude & Energy State Awareness	**State and Prediction Technologies** • Prediction and alerting for loss of control and spatial disorientation • Crew and system interactions
208 Airplane Systems Awareness	
209 Simulator Fidelity	**Simulator Fidelity** • Refine simulator modeling requirements for stall training
210 Flight Crew Performance Data	**Flight Crew Performance** • Tools and methods to collect and analyze flight crew performance
211 Training for Attention Management	**Training for Attention Management** • Detect and measure attention limitations • Develop methods and guidelines for training scenarios
200 Virtual Day-VMC Displays	**Virtual Day-VMC Displays** • Technologies and standards for displays under upset or loss of control conditions



NextGen Was an Important Step Forward

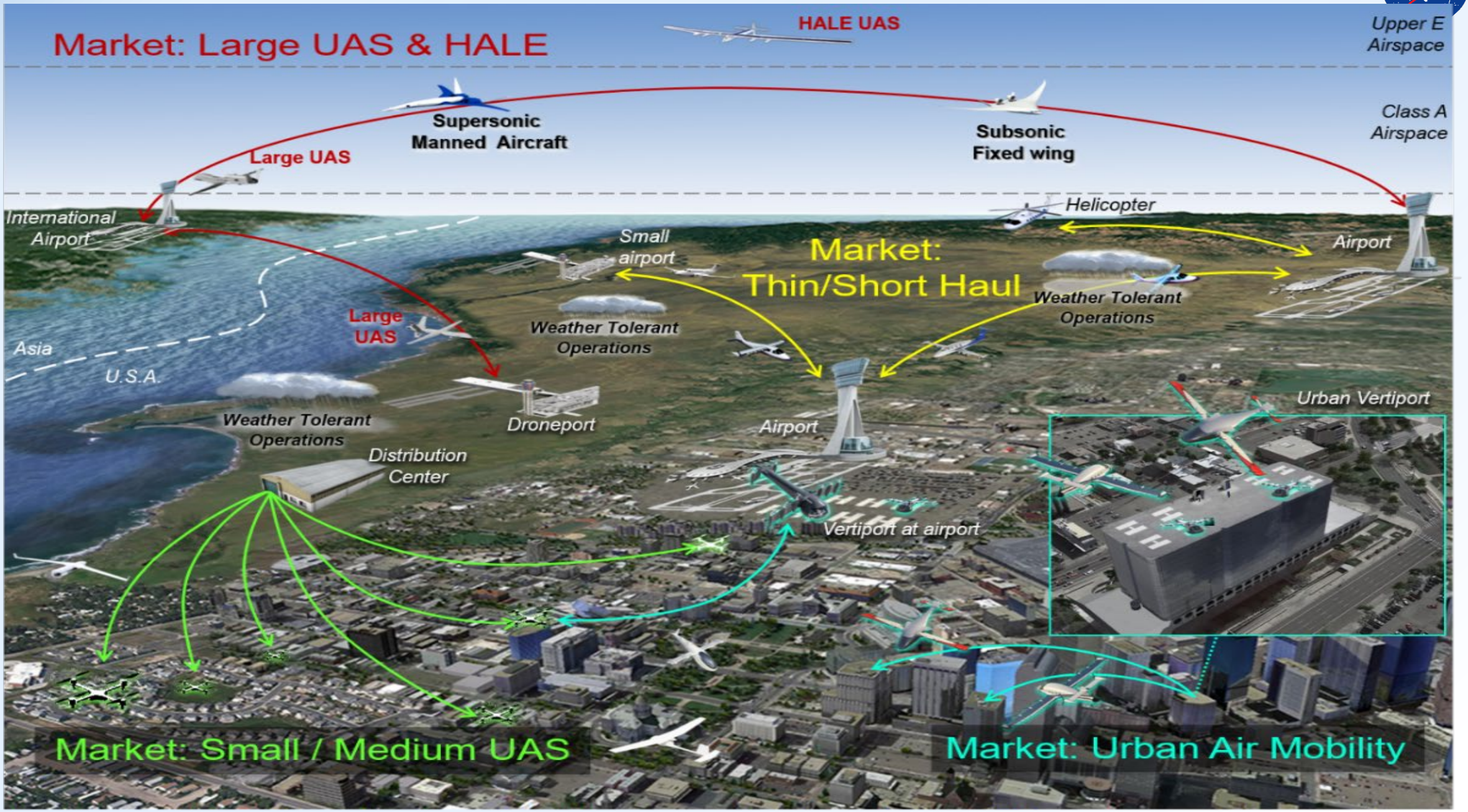
- At the time of its inception, NextGen was visionary and, to a certain extent, scalable
- It provided several important advances
  - ATS-B, Collaborative Decision Making, Limited Trajectory Based Operations, 3Ts (TBFM, TFDM, TFMS), etc
- NASA made important contribution with ATDs
- Extent of the demand for new vehicle classes, nor ATM-like services outside of the NAS were not fully known or anticipated
- To meet the requirements of these new demands, an innovative vision building on and beyond NextGen is needed, one that is not bound by the current structure or rules

The Future of Civil Aviation

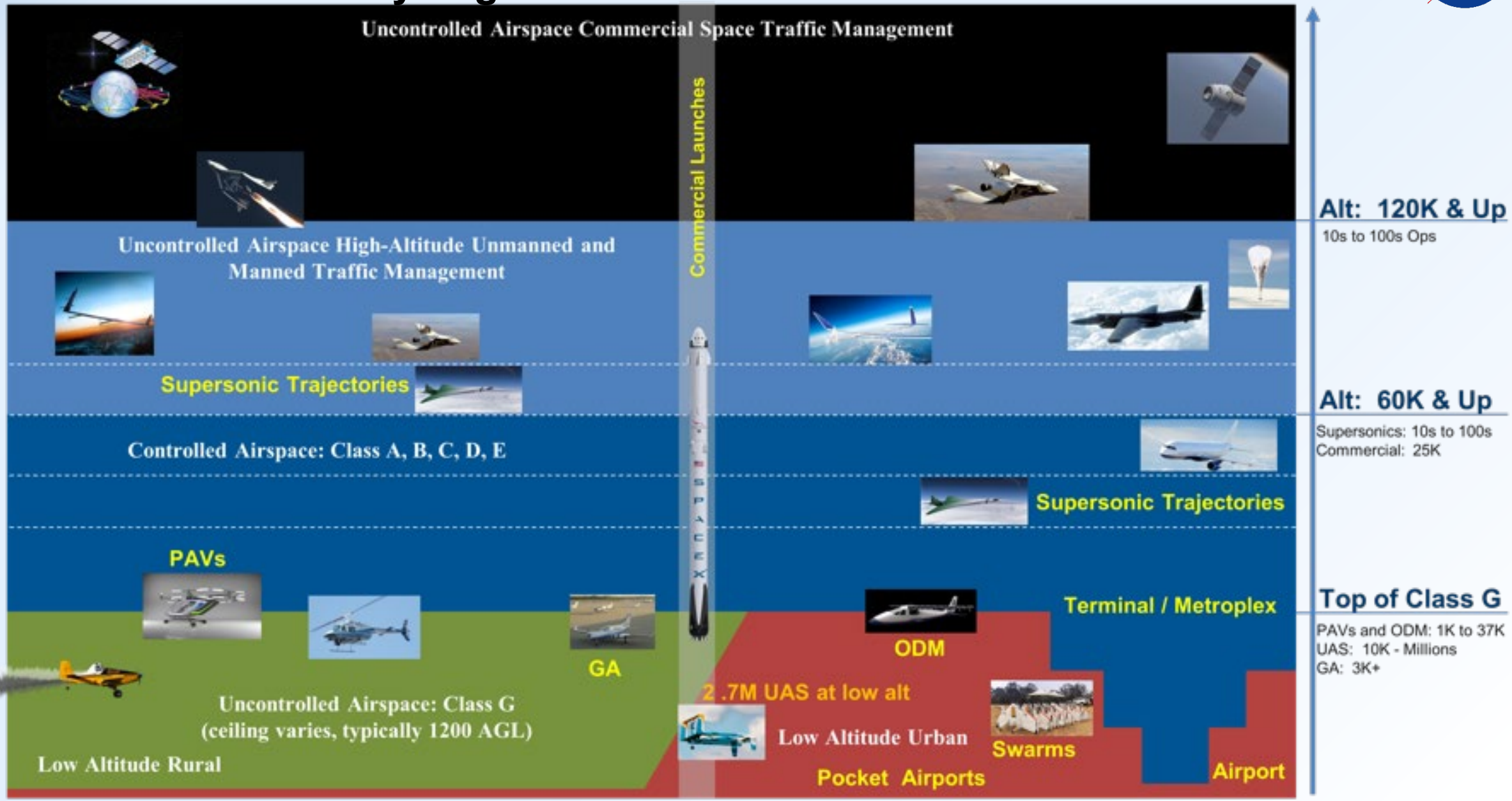
- The ATM system is no longer a simple combination of commercial transports and GA plus a few others typically handled by exception
- Will include many new vehicle classes and operating models, most of which will drive new ATM requirements
- Additionally, game-changing technologies will further impact the requirements
  - Network enabled operations will maximize operational efficiency
  - Advanced information systems will enable unmanned and autonomous operations
  - Autonomous operations will drastically reduce the cost of operations and drastically change the requirements for piloting skills

To enable these new operations, the future NAS must address the unique requirements of unconventional aircraft without adversely affecting other airspace users

Future Airspace with Dramatically Varied Users



Daily Flight Demand for All Users in 2025



Need For Highly Integrated, Heterogenous Airspace

- New vehicles and missions will stress the ATM system in ways that it was never designed to encompass
  - Super high density, especially at low altitudes (UAS, UAM, traditional)
  - Unmanned aircraft interacting with manned aircraft
  - Access sometimes means in-and-out and transition through existing airspace structures (SST, Traditional, Quasi-Satellites, Space Launch)
  - Widely diverse performance characteristics throughout the airspace
  - Increasing automation and even autonomy on the vehicle
- Ability to accommodate envisioned millions of vehicle operations in the NAS requires a fundamental transformation of the NAS
  - Cannot address via additional workforce/NAS infrastructure
  - Cannot address by incremental technology upgrades/operational changes

Predicting Safety is Critical to Designing the Future System

- Our current data-driven approach, monitor-assess-mitigate, is effective for deployed systems like NextGen
- However, delivering expected safety in the future system demands a different approach
  - Little or no data exist to inform designers – scenarios envisioned differ significantly from today's operations
  - Discovering problems late in the development process leads to costly redesign
  - Our goal is to infuse safety measures and mitigations at the *design* stage, which is much earlier in the process than has been done heretofore
- As airspace concepts are proposed, we must be able to analyze and configure them for safety
  - This requires a *predictive* approach based on models, simulation, and probabilistic analysis
  - We will leverage proven risk analysis methodologies to predict system performance and inform modifications necessary to ensure safety
- This approach will be embedded in our concept development and technology development efforts rather than treating safety as a separate problem

Vision 2045 Team

- The FAA and NASA have a need for a community-supported vision of the future NAS to guide their R&D investment decisions

- 2045 selected as the target date to encourage stakeholders to think beyond the lifecycles of their immediate investments

- Vision 2045 task will build on prior vision defining efforts with a particular emphasis on engaging with the principal stakeholders of the future NAS to obtain their input and support

- Vision 2045 proposal approved at March 2nd RTT convening authority meeting with additional direction provided at June 11th meeting

Characteristics of the Future NAS

Collaborative Traffic Management is characterized as follows:

- Cooperative
- Intent-sharing
- Digital: data exchanges among operators
- Interoperable: Standardized application protocol interfaces
- Air/ground/cloud integrated
- Service-oriented architecture
- Role for third parties
- Increasingly autonomous

Fundamental Enablers for NAS Transformation

- Development and evaluation of artificial intelligence capabilities and machine learning for command and control and collision avoidance systems
  - Integrated, Heterogeneous, Interoperable increasingly autonomous/unmanned operations with traditional systems
  - Contingency Management and System/Fleet Negotiation/Learning/Management
  - Human/Machine Vehicle/Cloud/Ground System Functional Allocation
  - Human/Machine Roles and Responsibilities/Accountability

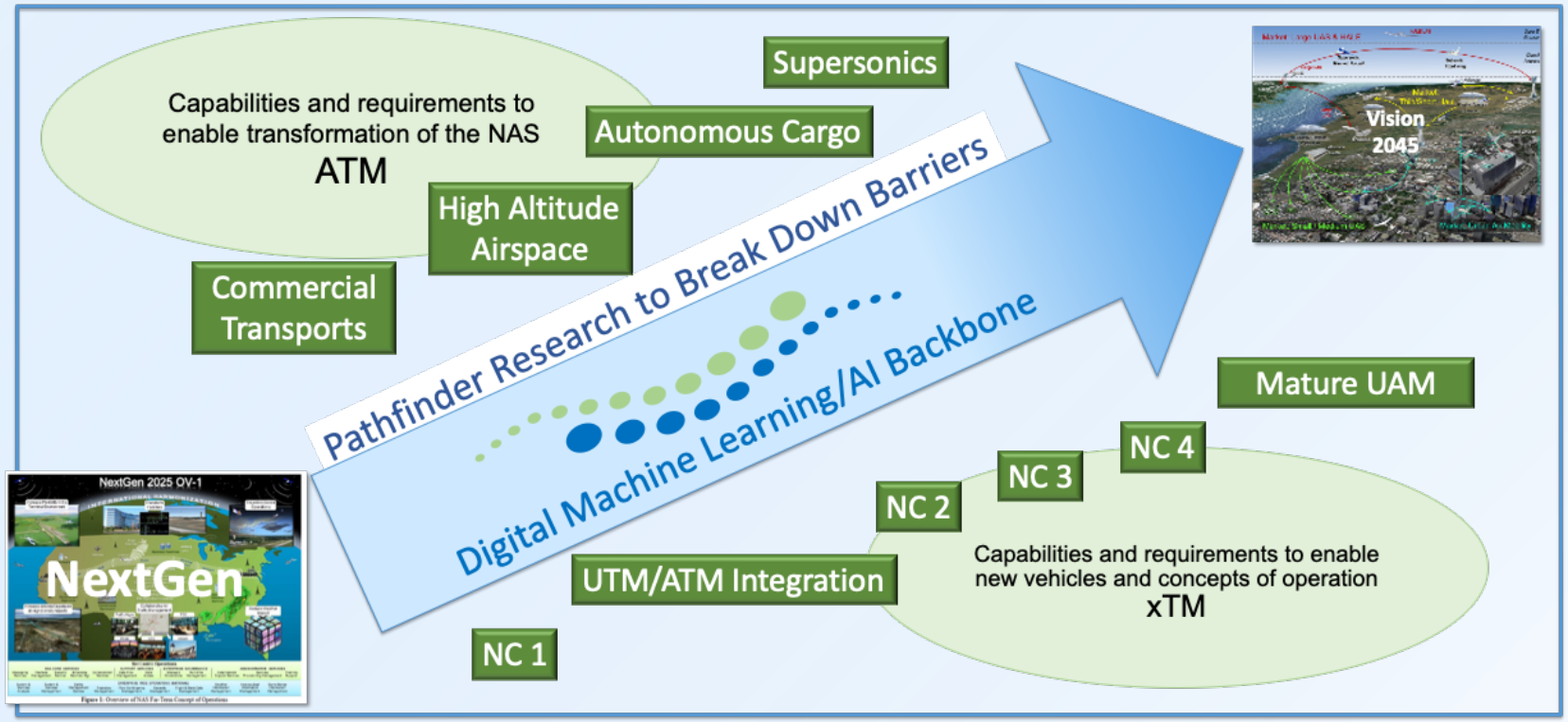
- Super Density Operations
  - Key barrier is trajectory and conflict prediction in transition airspace
  - Enable the very high density vehicle flows that are consistent with the UAS or UAM demand

Relationship Between NAS 2035 and Vision 2045

AOSP Objective: NAS Transformation

Research and Development
Conduct research and development to define system requirements informed by technologies based on the FAA Vision 2035 and Vision 2045 and demos to refine system requirements showing tangible progress towards the future vision

xTM Research & UAM Airspace
Research to define system requirements informed by technologies based on the concept, develop UAM airspace management system



Vision 2045
Develop a community-supported vision for a transformed National Airspace System

Digital Information Platform
Development of the fully digital, machine-learning and artificial intelligence-enabled architecture to deliver tailored, user-specific operational and safety services

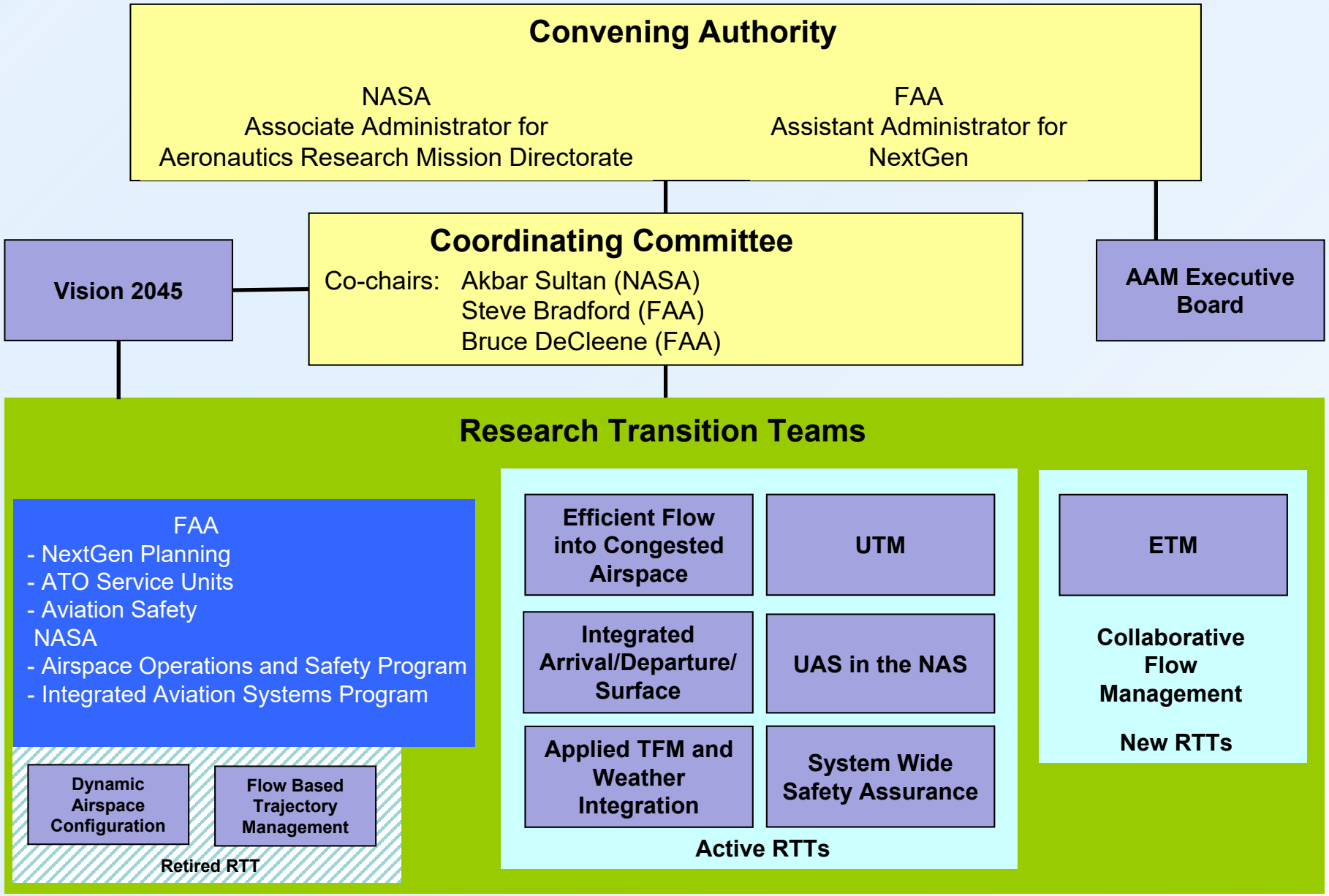
Vision 2045 – Next Steps

- Interagency Vision 2045 Team Formulation
  - Develop Joint Management Plan (JMP)
    - FAA and NASA developing initial draft
    - Additional revisions pending mission clarification from NASA leadership
  - Develop Interagency Communications Plan
    - Necessary precursor to interagency senior leadership kickoff requested by RTT CA
    - Harmonize with rapidly evolving NAS 2035 comm plan
  - Develop Stakeholder Engagement Plan
    - Broad stakeholder engagement
    - Direct engagements, workshops, TIMs, A4A, RTCA, FSF, ATCA, etc. to reach stakeholders in the most efficient manner possible
  - Develop a document that describes the characteristics of the 2045 NAS as envisioned by principal stakeholders of the future NAS.
    - Detailed concept of how the entire system will operate including future NAS use cases
    - Identify top-level requirements
    - Identify barriers that must be overcome and research questions that must be answered

Vision 2045 Team – Next Steps

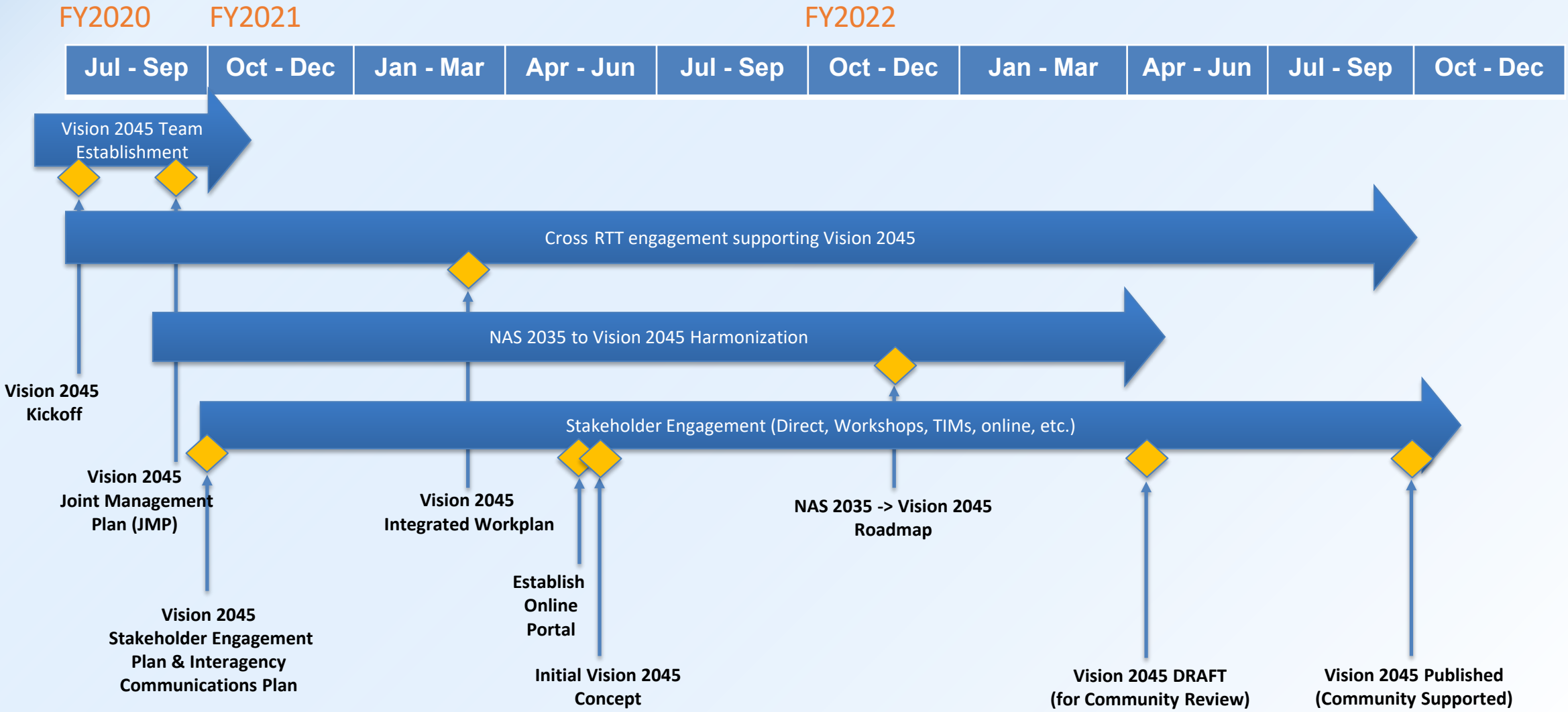
- Plan NASA / FAA Leadership Kickoff for Vision 2045
  - ANG has socialized kickoff with Administrator Dickson's office
  - Executive summary socialized with Administrator Bridenstine
- Draft Vision 2045 Joint Management Plan (JMP)
  - Identify principle stakeholders, supporting RTTs, POCs, and timelines
  - Develop interaction mechanism and processes for coordination across the organizations, RTTs, and workgroups
    - Reporting mechanisms
  - Solidify Vision 2045 milestones, work products, & dependencies
  - Coordinate Draft JMP; Final JMP planned for September 2020
- Harmonize with NASA Model Based Systems Engineering practices
- Initiate Vision 2045 Stakeholder engagement plan
  - Leverage NASA communications resources in concert with FAA communications

RTT Organizational Framework



Vision 2045 Team Schedule

– Notional schedule & milestones



Outlook

- We are at the inflection point of enabling the dawn of a new era in aviation operations
- Leveraging highly successful accomplishments and portfolio
- Great position to credibly address airspace access and operations of UAM, Autonomy, and NAS Transformation
- Dual focus on Autonomy:
  - Low-altitude regional AAM
  - High-altitude national/oceanic Freighter
- Key Enablers:
  - Vehicle/ground/cloud and human/machine integrated systems
  - Integrated Data Driven, Machine Learning, Artificial Intelligence ATM
  - Super Density Operations
- Enable the “sunrise” of new capabilities and shape the future landscape