National Aeronautics and Space Administration

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Advanced Air Mobility

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AAM Mission Critical Commitment

Vehicle Development and Operations Develop concepts and technologies to define requirements and standards addressing key challenges such as safety, affordability, passenger acceptability, noise, automation, etc.

Airspace Design and Operations Develop UTM-inspired concepts and technologies to define requirements and standards addressing key challenges such as safety, access, scalability, efficiency, predictability, etc.

Community Integration Create robust implementation strategies that provide significant public benefits and catalyze public acceptance, local regulation, infrastructure development, insurance and legal frameworks, etc.

Critical Commitment:

Based on validated operational concepts, simulations, analyses, and results from National Campaign demonstrations, the AAM Mission will deliver aircraft, airspace, and infrastructure system and architecture requirements to enable sustainable and scalable medium density advanced air mobility operations

Achieving "systems and architecture requirements" will require *enabling activities* such as 1) the AAM National Campaign Series 2) a robust Ecosystem Partnership model and 3) NASA ARMD Portfolio Execution.

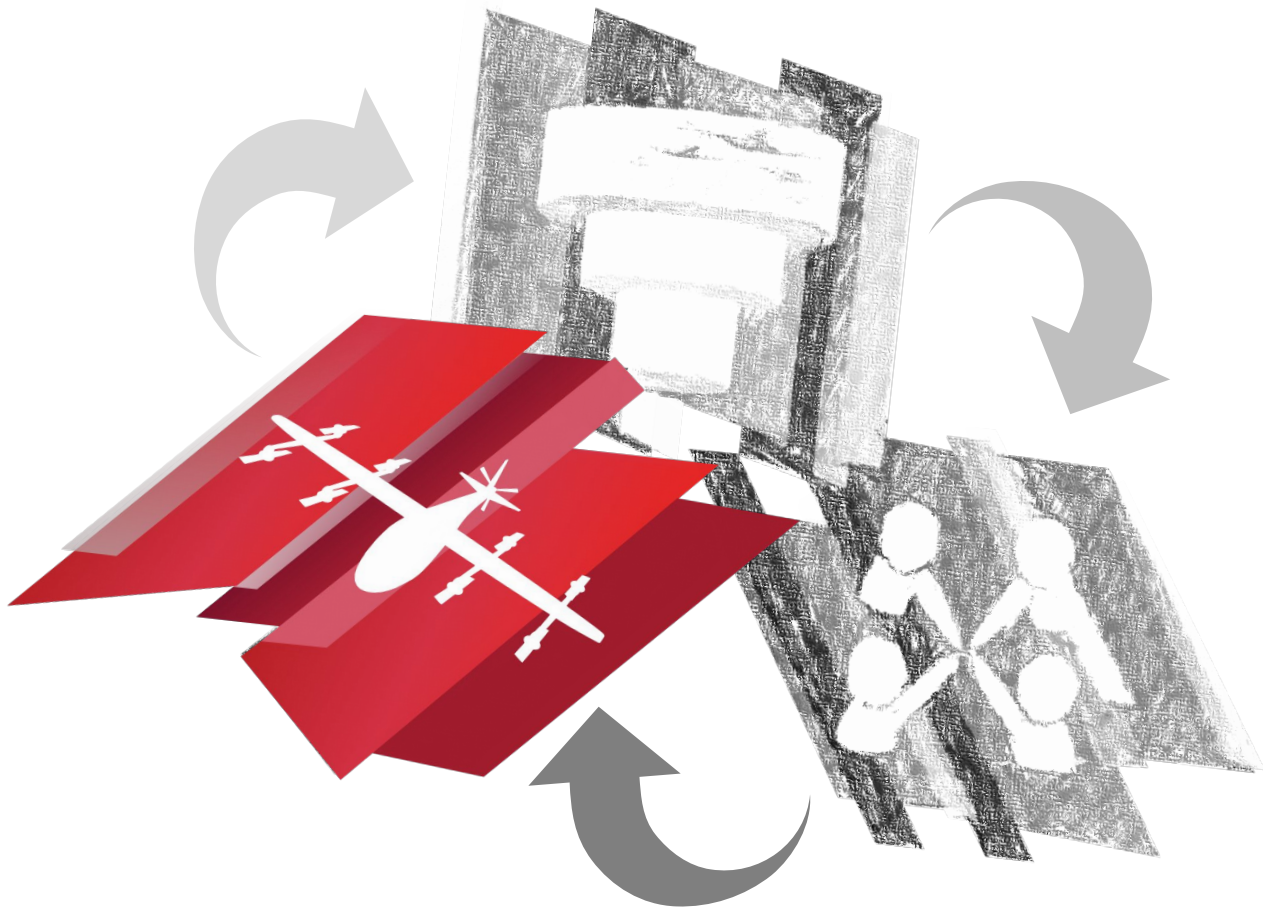
Aircraft

Vehicle Development & Production

- Design, manufacture, and system readiness of AAM vehicles

Individual Vehicle Management & Operations

- Operations and maintenance of a single AAM vehicle, independent of sharing of airspace or other system resources



Aircraft

- At least 18 companies are developing electric vertical takeoff and landing (eVTOL) aircraft
- Generally, have a range of 100+ miles on one battery charge
- Will fly below 5,000 ft at up to 200 mph top speed
- Carry ~4 passengers and one pilot
- Most have wings that are used in forward flight

Joby Aviation

■ Alaka'i

■ Beta Flown

■ Bell

■ Elroy Air Flown

■ Joby Flown

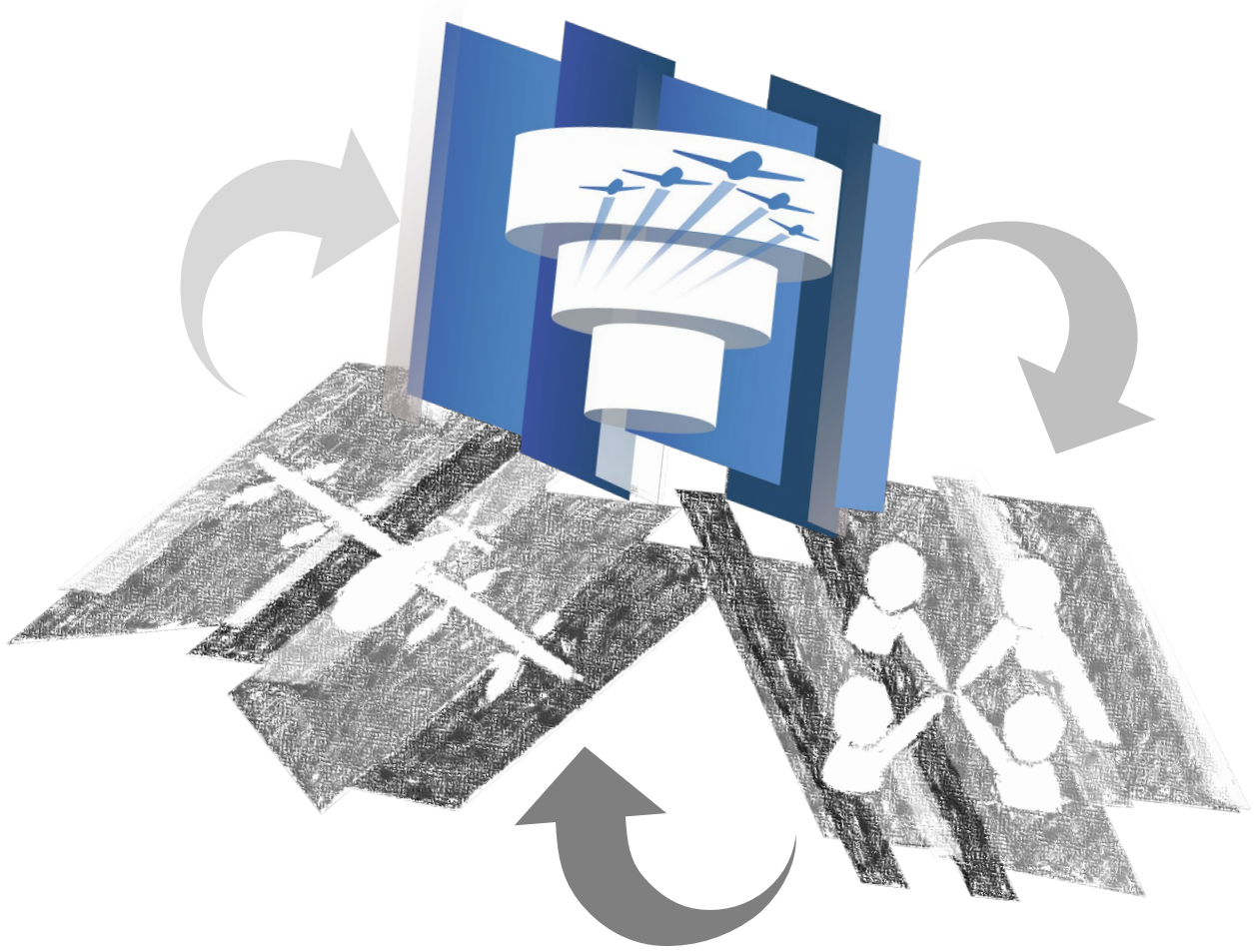
■ Jaunt Air Mobility

■ Kitty Hawk Flown

■ Wisk Flown

■ Workhorse/Moog Flown

Airspace



Airspace System Design & Implementation

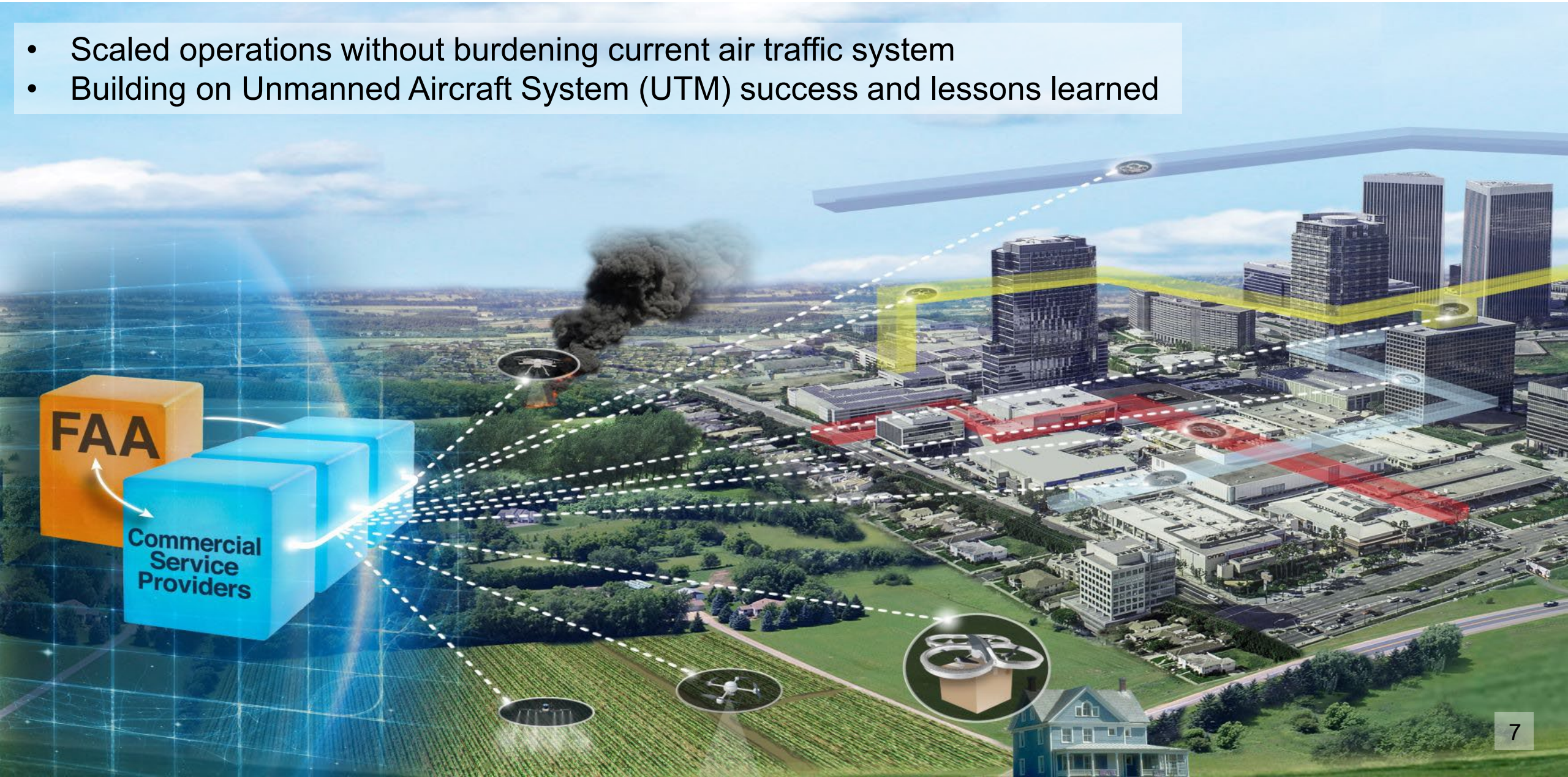
- Design, development, and implementation of infrastructure to enable safe and efficient multi-vehicle AAM Operations

Airspace & Fleet Operations Management

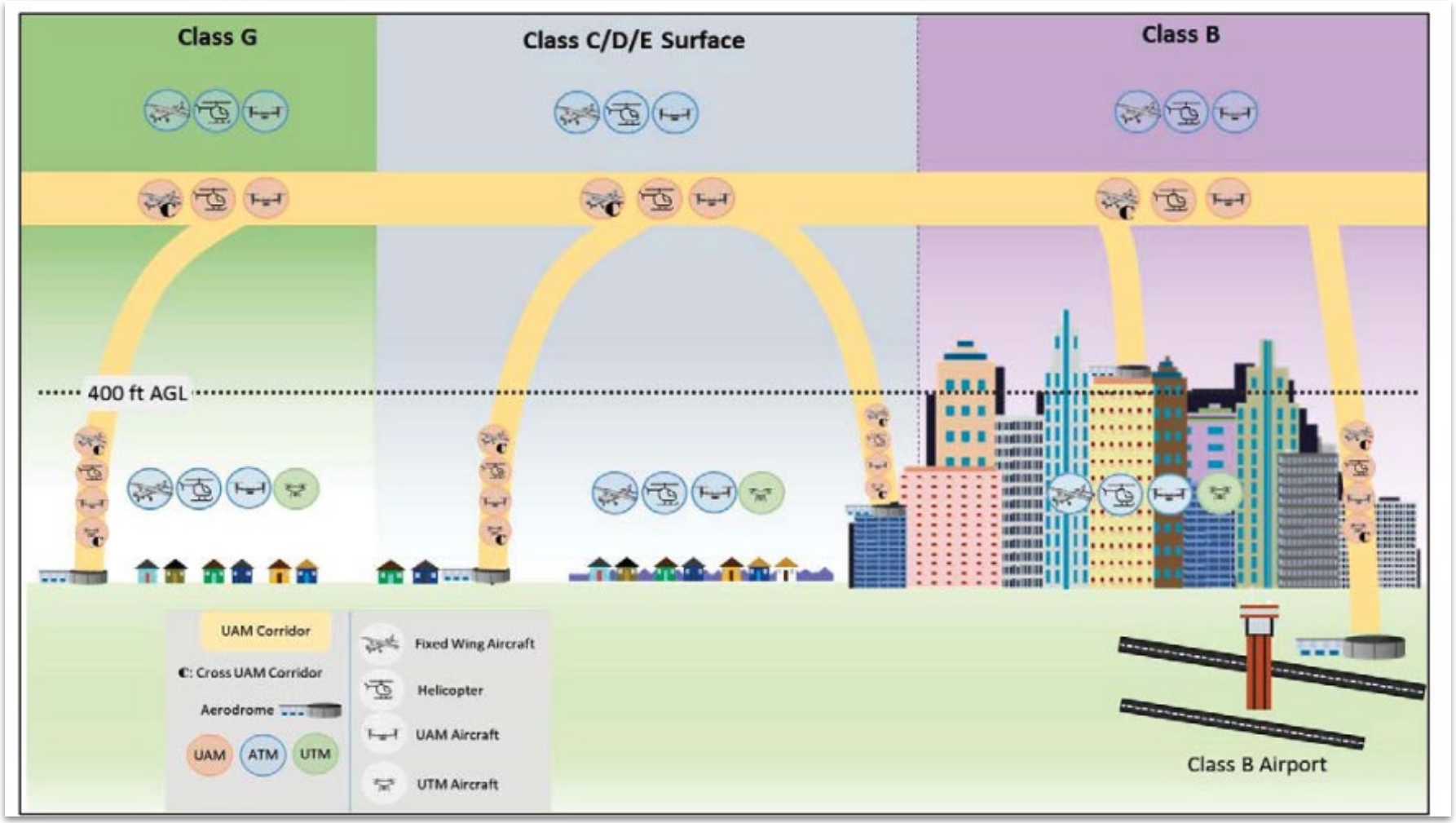
- Operations and management of multiple vehicles within an AAM system that enable safe and efficient sharing of airspace and other system resources

Airspace Considerations

- Scaled operations without burdening current air traffic system
- Building on Unmanned Aircraft System (UTM) success and lessons learned



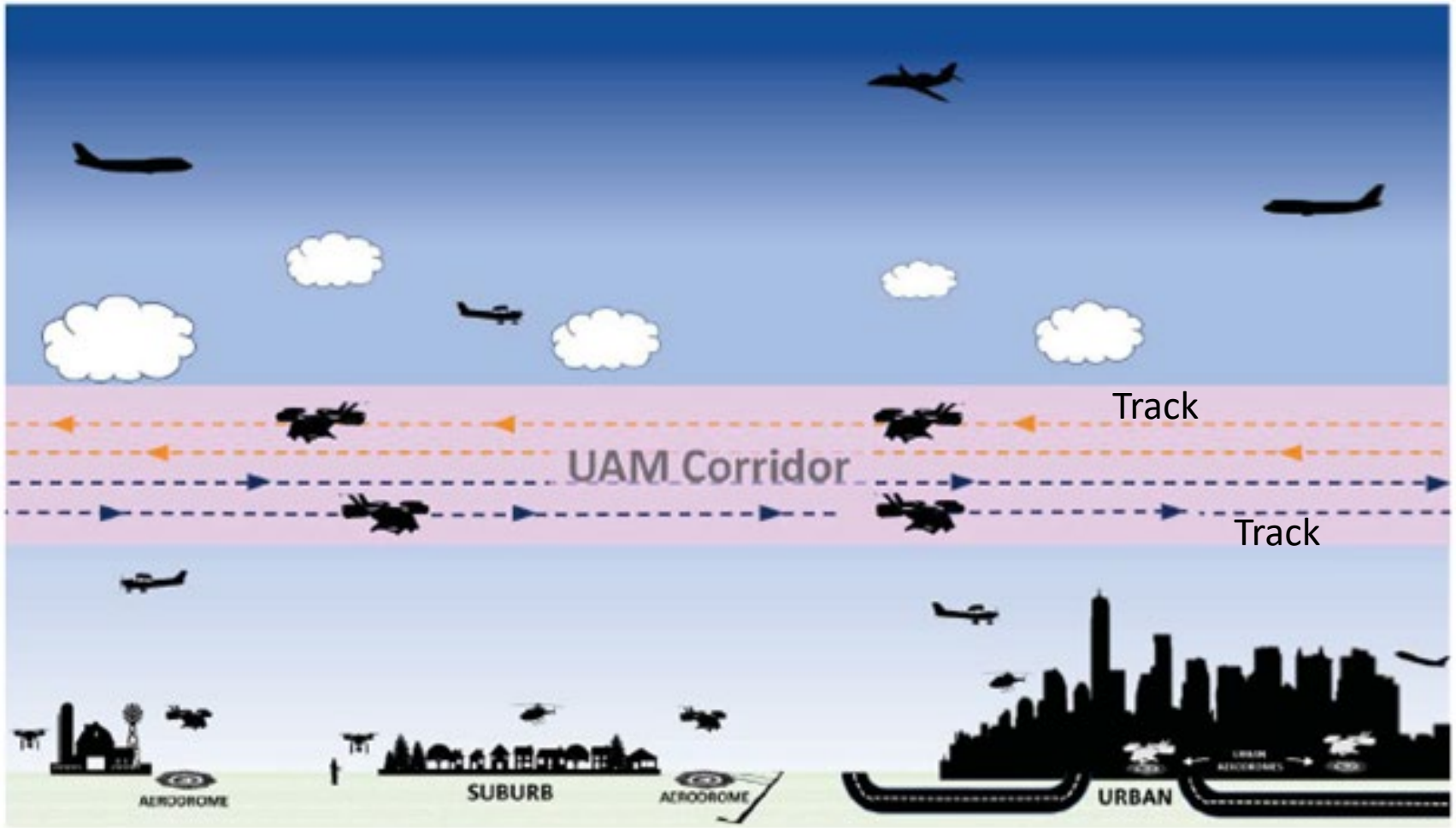
Airspace Structure and Procedures



Corridors

UAM corridors are performance-based airspaces of defined dimensions in which aircraft abide by UAM-specific rules, procedures, and performance requirements

Airspace Structure and Procedures



Tracks

Additional structure within the UAM Corridor to help organize UAM traffic at higher operational tempo (Derived from FAA NextGen UAM ConOps v1.0)

Routes

Concatenation of tracks, corridors, and terminal procedures that defines the operation from origin to destination

What is Unmanned Aircraft System Traffic Management?

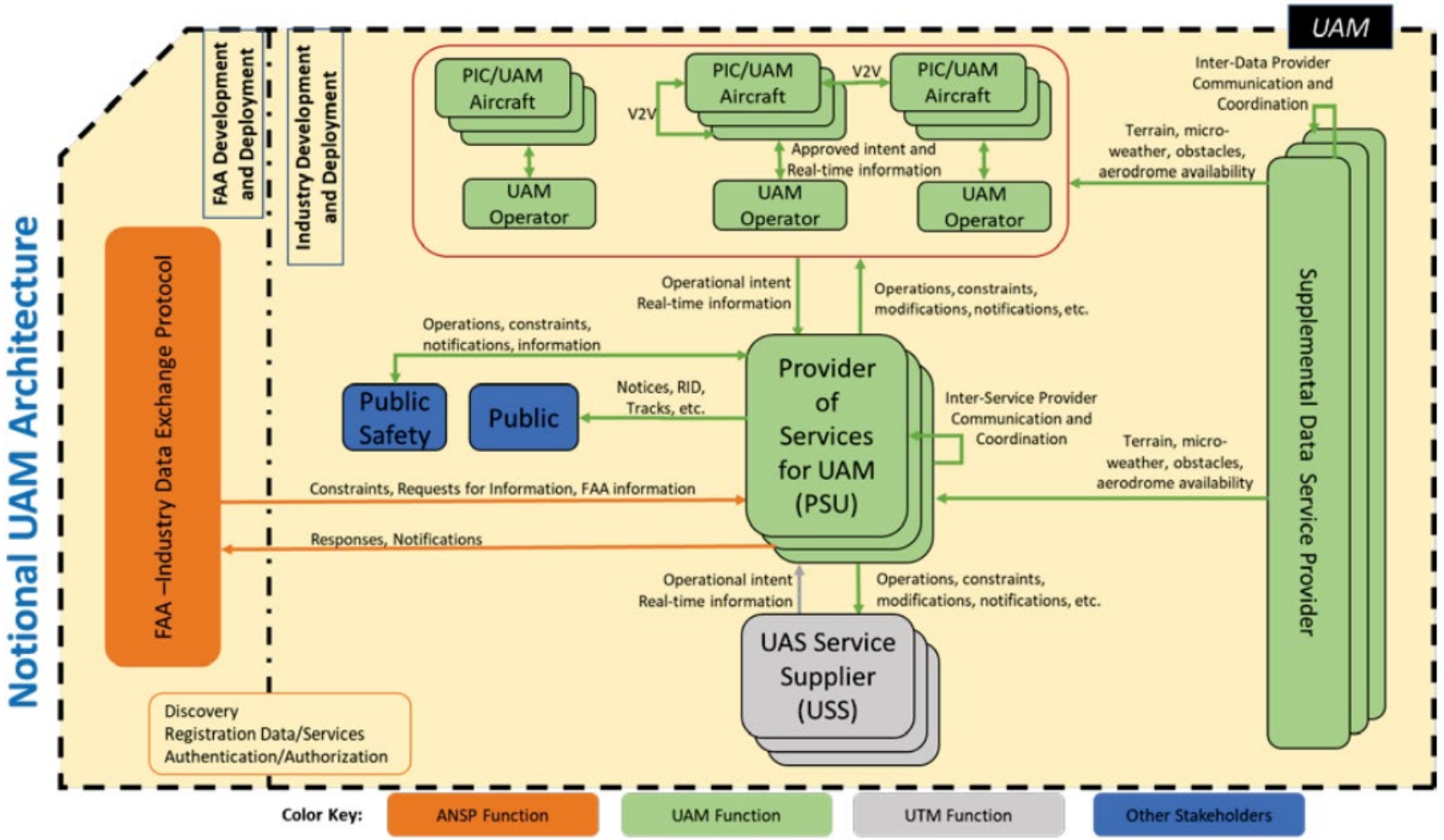
UTM is an "air traffic management" ecosystem for small UAS in low altitude airspace

UTM utilizes industry's ability to supply services under FAA's regulatory authority where these services do not exist.

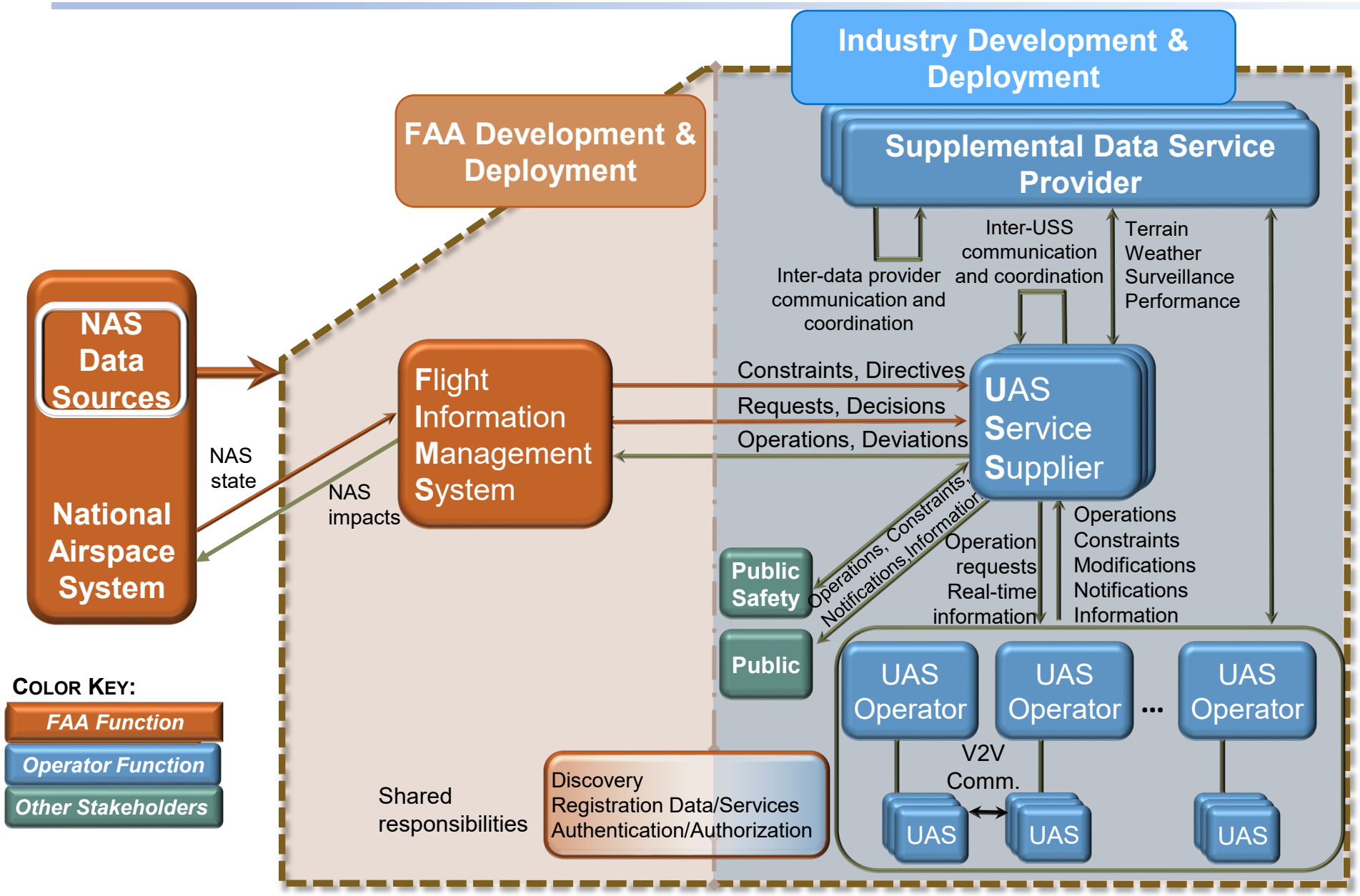
UTM development will ultimately identify services, roles/responsibilities, information architecture, data exchange protocols, software functions, infrastructure, and performance requirements to enable the management of low-altitude UAS operations.

Transparency **Security** **Safety** **Commerce** **Scalability**

Notional UAM Architecture



UTM Service-Based Architecture



Flight Information Management System
- → Enables airspace controls
- → Facilitates requests
- → Supports response in emergencies impacting NAS

UAS Service Supplier
- → Federated Structure
- → Cloud-based system
- → Automated System
- → Supports UAS with services (e.g. separation, weather, flight planning, contingency management, etc.)

Supplemental Data Service Provider
- → Supplies supplemental data to USS and UAS Operator to support operations

UAS / UAS Operator
- → Individual Operator
- → Fleet Management
- → On-board capabilities to support safe operations

Community Integration

Community Integration

- Societal integration and acceptance of AAM Operations

AAM-related Social Concerns

- Affordability
- Noise
- Privacy
- Legality

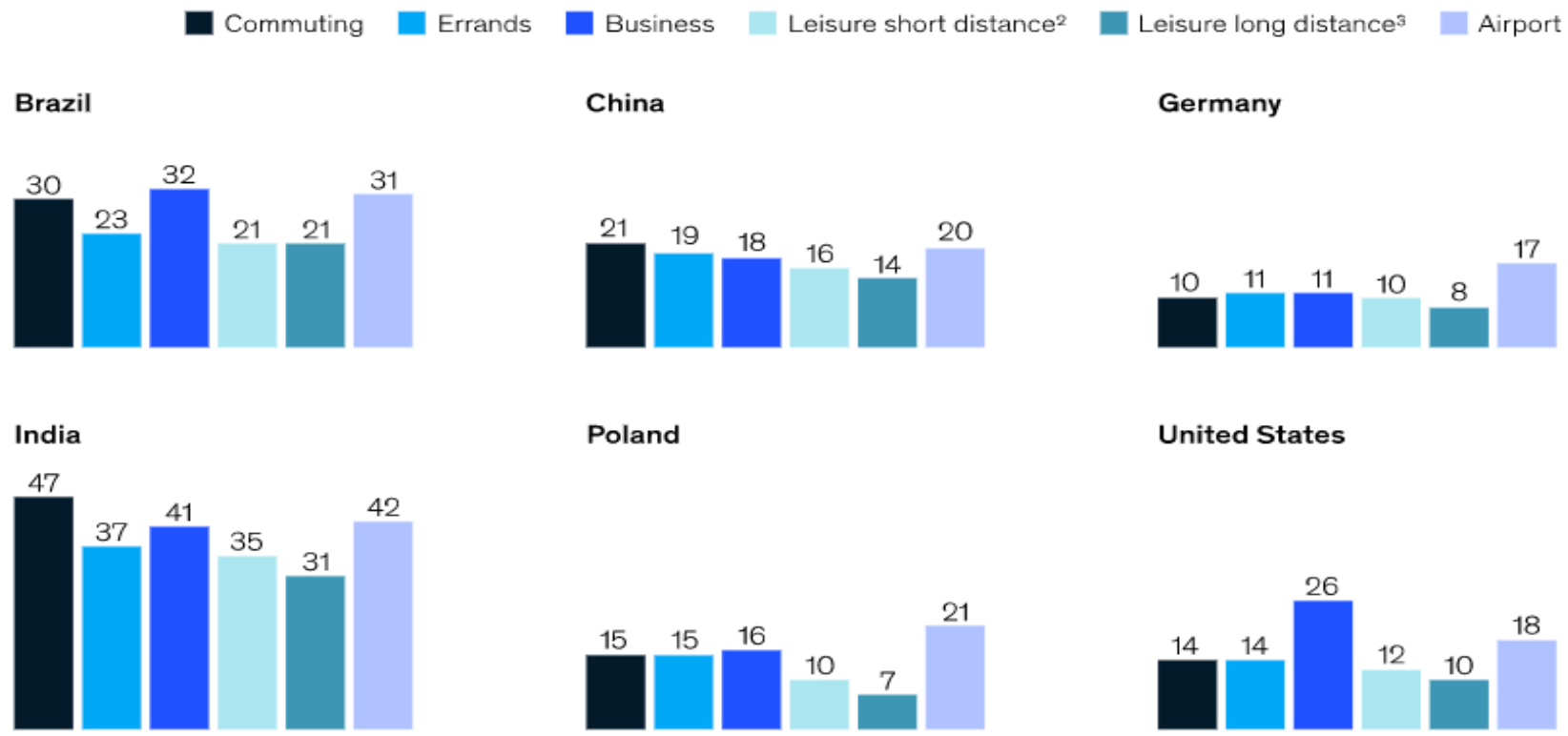
Urban Environment

- Off-airport takeoffs and landings will likely occur in confined, intra-city helipad/vertiport locations and on top of high-rise buildings
- Performing emergency procedures in these environments is a high-risk operation
- Pilots will need to make judgement calls on the safest alternative course or landing site, considering the busy air space, the battery life, and aircraft limitations
- Must allow for local urban and microclimate weather conditions and communication-blackout zones

From CAE Training White Paper

Willingness to adopt advanced air mobility (AAM) services varies

Adoption, by use case, % of respondents saying they would definitely switch to an AAM vehicle[1]



[1]Respondents were asked to "imagine that instead of using your current transport mode you outlined, you could opt to get around in the small aircraft described earlier"; n = 4,600, with 400–500 per country.
[2]Within city.
[3]Longer distance to outside of city.
Source: McKinsey Advanced Air Mobility Consumer Survey, March 2021

McKinsey & Company

https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/up-in-the-air-how-do-consumers-view-advanced-air-mobility

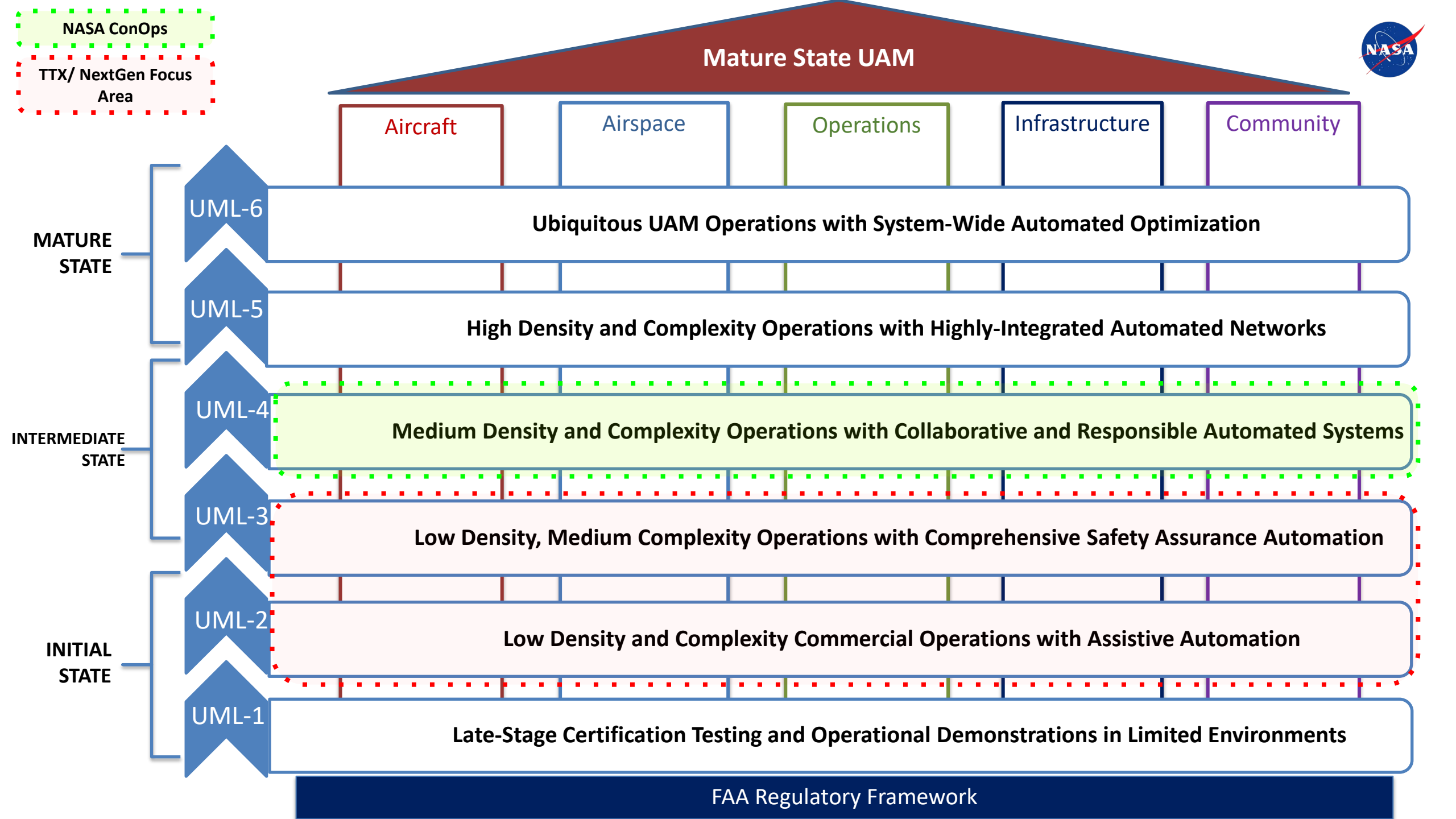
Crosscutting

Key elements that pertain to the entire AAM ecosystem - Aircraft, Airspace, and Community Integration

- Safety
- Security
- Autonomy

NASA's efforts that feed into the AAM Mission's Critical Commitment

- National Campaign
- Urban Air Mobility (UAM) Vision Concept of Operations (ConOps) Urban Maturity Level (UML) 4
- System & Architecture Requirements (Model-based Systems Engineering (MBSE))


NASA ConOps
TTX/ NextGen Focus Area
Mature State UAM
Aircraft
Airspace
Operations
Infrastructure
Community
MATURE STATE
INTERMEDIATE STATE
INITIAL STATE
UML-6
Ubiquitous UAM Operations with System-Wide Automated Optimization
UML-5
High Density and Complexity Operations with Highly-Integrated Automated Networks
UML-4
Medium Density and Complexity Operations with Collaborative and Responsible Automated Systems
UML-3
Low Density, Medium Complexity Operations with Comprehensive Safety Assurance Automation
UML-2
Low Density and Complexity Commercial Operations with Assistive Automation
UML-1
Late-Stage Certification Testing and Operational Demonstrations in Limited Environments
FAA Regulatory Framework

Innovating in aviation while respecting its safety tradition.

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