UTM INSPIRED ATM

DISCUSSION DRAFT FOR AOSP STRATEGY MEETING 10/2017

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Outline

- Lessons from current status and past
- Needs of future
- Movement towards UTM-inspired-ATM

Lessons from Current Status and Past

- Bottlenecks in the national airspace system: gates, runways, and workload

- Weather causes majority of delays (75% of delays) – disruptions cause inconvenience and are costly

- Costs: 25% costs are labor and 25% fuel (roughly)

- Large monolithic efforts such as Advanced Automation System (AAS) – didn't have budget and transition strategy

Future Needs

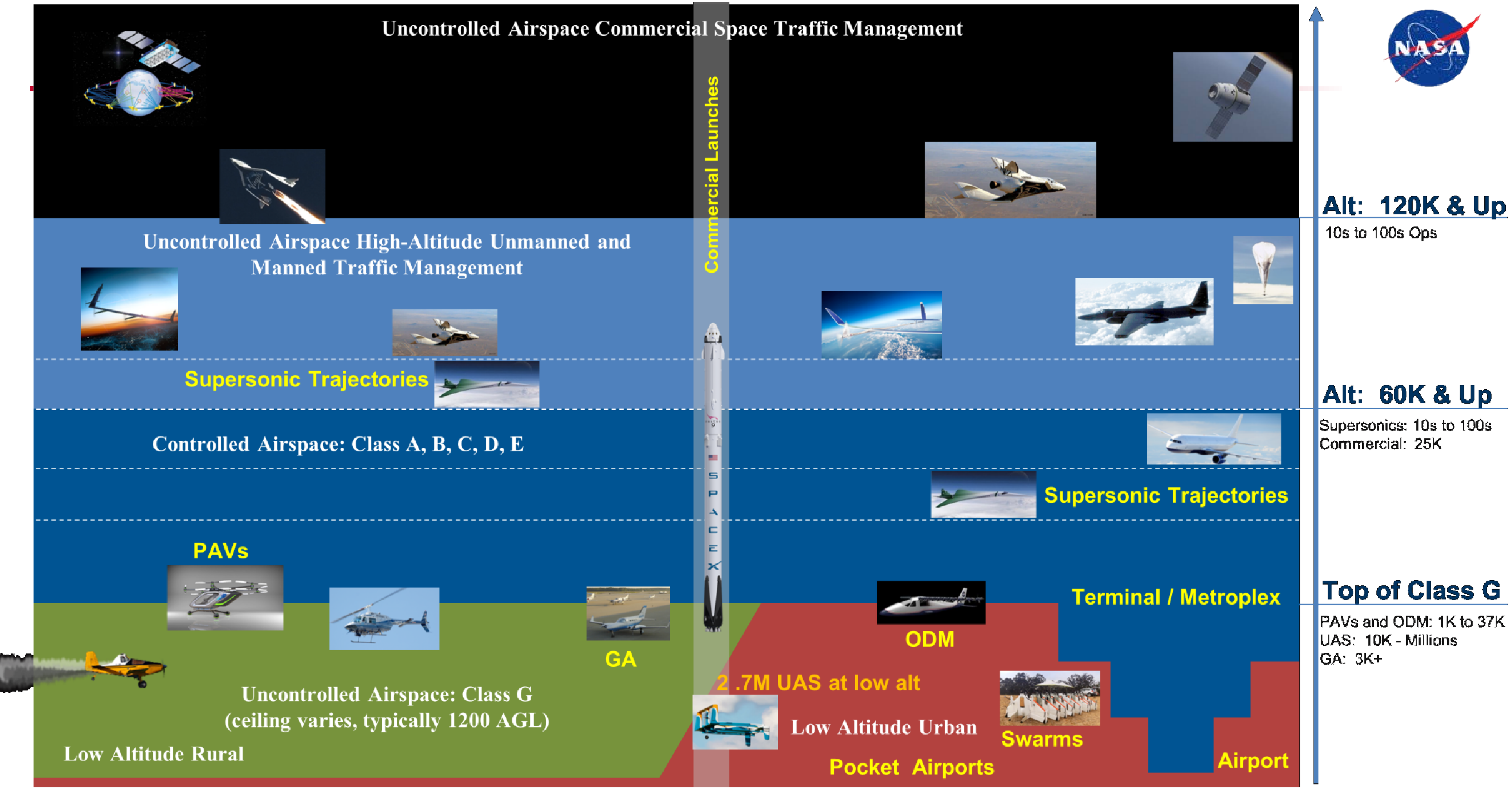
- Scalable – Density/diversity increase
- Resilient – continue operations through disruptions
- Agile – to add new entrants
- Sustainable – Government funding through trust fund, etc
- Safe – Departures and arrival ratio is 1.0
- Secure – No nefarious external interference
- Practical transition approach (successful examples RVSM)
- Access Diverse operators – No use case or user left behind regardless of size, weight, altitude, operating profile
- Equity – Diverse operations don't negatively impact each other
- Transformation As needed - transformation to accommodate evolving needs of airspace, leverage industry capabilities
- Affordable – Funding mechanisms and ticket taxes on passengers
- others

NASA's Long R&D and Transition Contributions

- Center-TRACON Automation System (CTAS) which resulted in multiple operational improvements – TMA, SMS, etc.
- SATS
- DAG-TM
- ATD 1, 2, and 3 portfolio products
- UTM
- Many others..

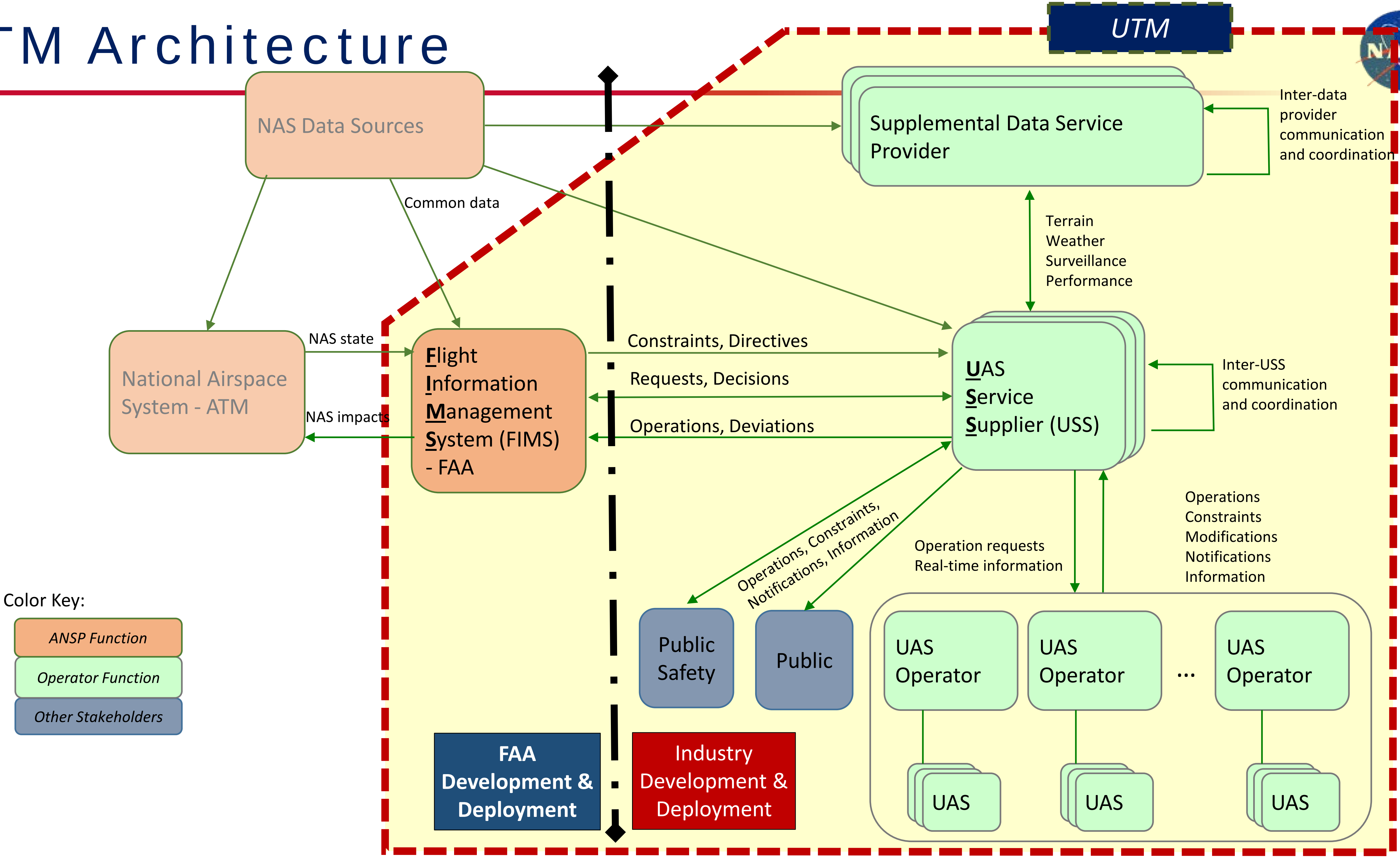
Core Attributes

- Interoperable (different users/domains/data exchanges/airspace class/altitude transitions are seamless)
- Cooperative (Users cooperate for intent, etc. to reduce burden on controller)
- Federated (multiple service suppliers work together for same or different services – some functions distributed, some centralized)
- Flexibility when possible, structure when necessary
- Risk based (e.g., oceanic separation, UTM levels, etc.)
- Adaptable to external conditions (e.g., weather, emergencies)
- Secure (cyber physical security for data, information, hardware/software, etc.)
- Safe (real-time and in-time understanding and prognostics for better decision making)
- Sustainable (be able to last long time)
- Others…



Uncontrolled Airspace Commercial Space Traffic Management
Commercial Launches
Uncontrolled Airspace High-Altitude Unmanned and Manned Traffic Management
Supersonic Trajectories
Controlled Airspace: Class A, B, C, D, E
Supersonic Trajectories
PAVs
GA
ODM
Terminal / Metroplex
2 .7M UAS at low alt
Uncontrolled Airspace: Class G
(ceiling varies, typically 1200 AGL)
Low Altitude Rural
Low Altitude Urban
Swarms
Pocket Airports
Airport
SPACEX
Alt: 120K & Up
10s to 100s Ops
Alt: 60K & Up
Supersonics: 10s to 100s
Commercial: 25K
Top of Class G
PAVs and ODM: 1K to 37K
UAS: 10K - Millions
GA: 3K+

UTM Architecture



UTM Technical Capability Levels (TCLs)

Capability 1: Demonstrated how to enable multiple operations under constraints

- Notification of area of operation
- Over unpopulated land or water
- Minimal general aviation traffic in area
- Contingencies handled by UAS pilot

Product: Overall con ops, architecture, and roles

Capability 3: Focuses on how to Enable Multiple Heterogeneous Operations

- Beyond visual line of sight/expanded
- Over moderately populated land
- Some interaction with manned aircraft
- Tracking, V2V, V2UTM and internet connected

Product: Requirements for heterogeneous operations

Capability 2: Demonstrated How to Enable Expanded Multiple Operations

- Beyond visual line-of-sight
- Tracking and low density operations
- Sparsely populated areas
- Procedures and "rules-of-the road"
- Longer range applications

Product: Requirements for multiple BVLOS operations including off-nominal dynamic changes

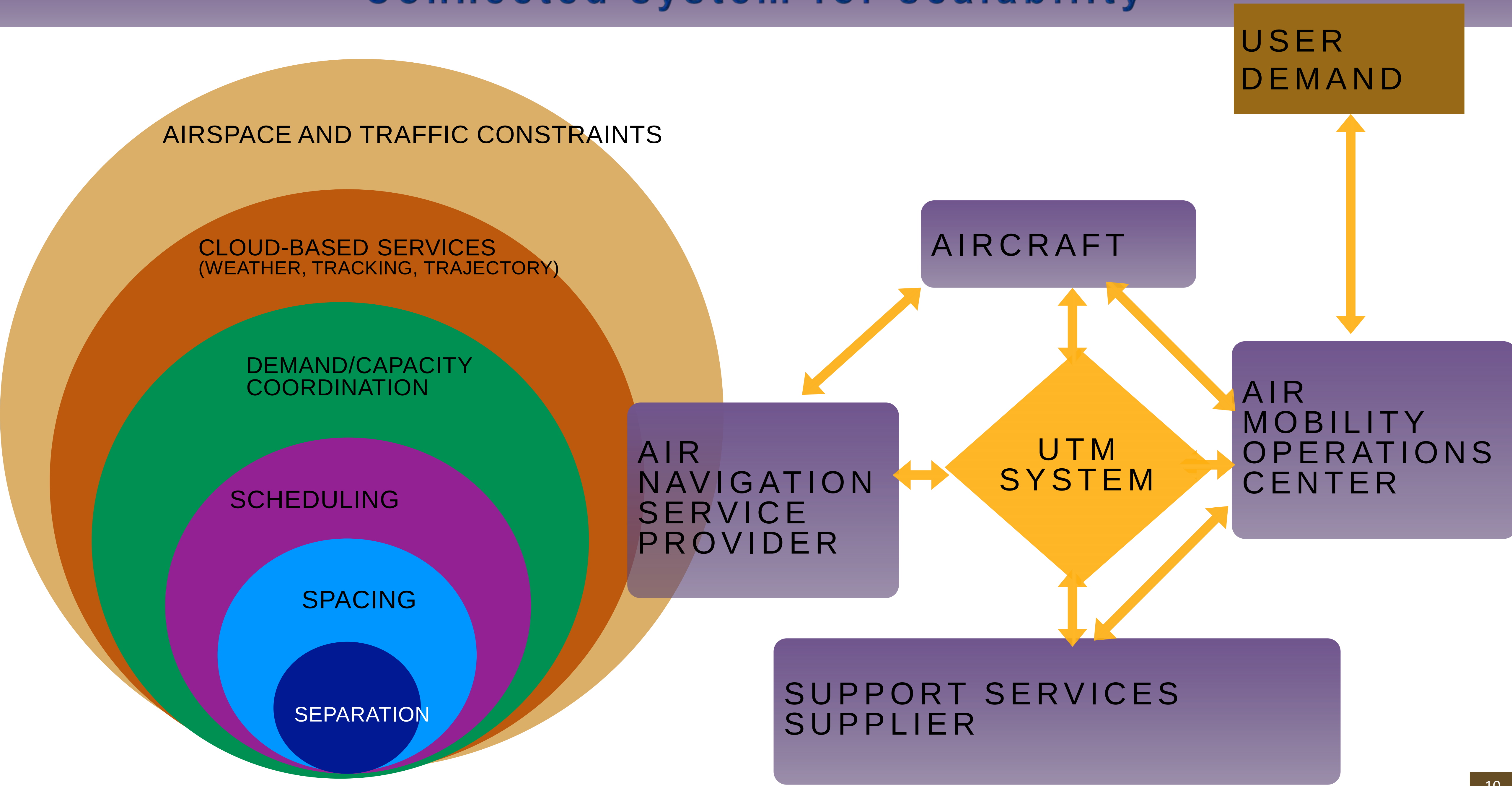
Capability 4: Focuses on Enabling Multiple Heterogeneous High Density Urban Operations

- Beyond visual line of sight
- Urban environments, higher density
- Autonomous V2V, internet connected
- Large-scale contingencies mitigation
- Urban use cases

Product: Requirements to manage contingencies in high density, heterogeneous, and constrained operations

Risk-based approach: depends on application and geography

Connected system for scalability



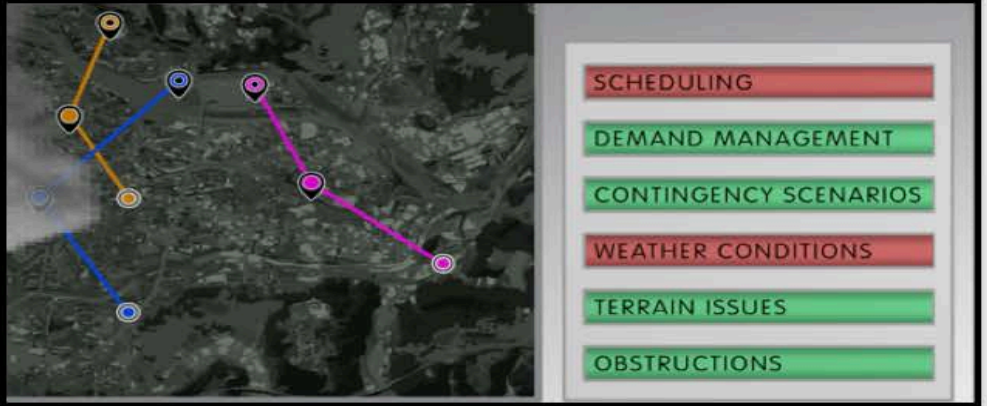
CRAWL-WALK-RUN APPROACH

Low-density: Initial Operational Capability

- Helicopter routes using today's procedures
- Clearance into controlled airspace (UTM - authorization and notification)
- User created conflict-free trajectories and own tracking

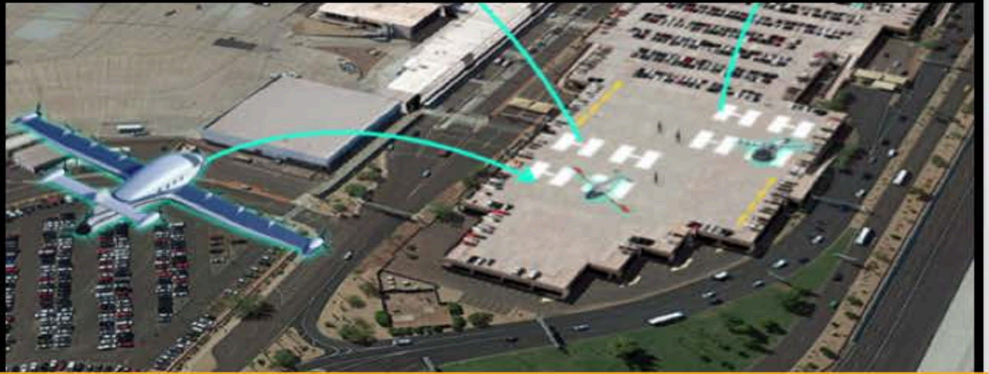
Medium-density: Interim Operational Capability

- User creates conflict-free trajectories
- Interoperable, cooperative, intent sharing through UTM
- Self-managed operations (e.g., detect and avoid, contingency management)



High-density: Mature Operational Capability

- Fully-autonomous planning, scheduling, separations, entry/exit controlled airspace, interoperability, and contingency management
- Multiple, simultaneous take-offs and landings



RESEARCH NEEDED TO IDENTIFY REQUIREMENTS FOR SCALED OPERATIONS

Current ATM

All services are provided by the FAA
- Traffic flow management
- Airspace directives/constraints
- Scheduling, sequencing and spacing
- Separation management
- Off-nominal management
- Every vehicle interaction in real-time

FAA Systems

Humans address off-nominal and contingencies

Airspace User

Airspace User

Very little interaction among users, and 3rd party services

- Human in the epi-center of information integration
- Every data moves through FAA systems for every vehicle
- Each change focused in on domain-specific FAA system

UTM-inspired-ATM

Some services are provided by FAA
- Airspace directives/constraints
- Resource availability and changes to resources (e.g., arrival/departure rates, resource schedules)
- Separation

FAA Systems

User or third party services
- Flow management
- Sequencing, and spacing
- User participation strategic Separation (e.g., oceanic)

Automation addresses off-nominal and contingencies

Airspace User

New Airspace User

Airspace User

Airspace User

Users collaborate/cooperate for efficiency, intra-user preferences for flights into constrained resources

- Automation in the epi-center of information integration
- New paradigm: digital and connected ecosystems-outside apps, scalability

NASA Unique Role: Architecture, data exchange, service allocation/roles/responsibilities, rules of engagement, service performance requirements, automation for contingency management and disruption handling, machine learning environment and algorithms for continuous improvement, certification/acceptance approaches, and technology transitions

Current Airspace Operations: Reason for Change

Current State of the Art

- Not scalable due to human-centric decisions and actions
- Virtually all interactions/data goes through FAA systems
- Does not leverage industry capabilities

Results In

- Does not accommodate new users and higher density of current users
- Modernization becomes slow process
- All costs are borne by government

Change is needed/Redefine

- Methods and techniques
- Interactions among operators and FAA system
- Service-oriented architecture
- Safety systems – increasing airspace access while ensuring safety

If we don't change now the global leadership will suffer

Summary

- Tenets of UTM-inspired-ATM – movement towards cooperative traffic management

- Leverages industry services

- Practical implementation strategy

QUESTIONS?

Embracing innovation in aviation while respecting its safety tradition