



Future Airspace Operations: UTM-inspired Air Traffic Management

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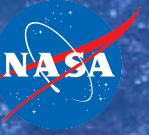
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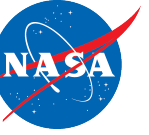
NEED

Airspace “System”
Should be Ready
when Vehicles
are Ready





Big Picture

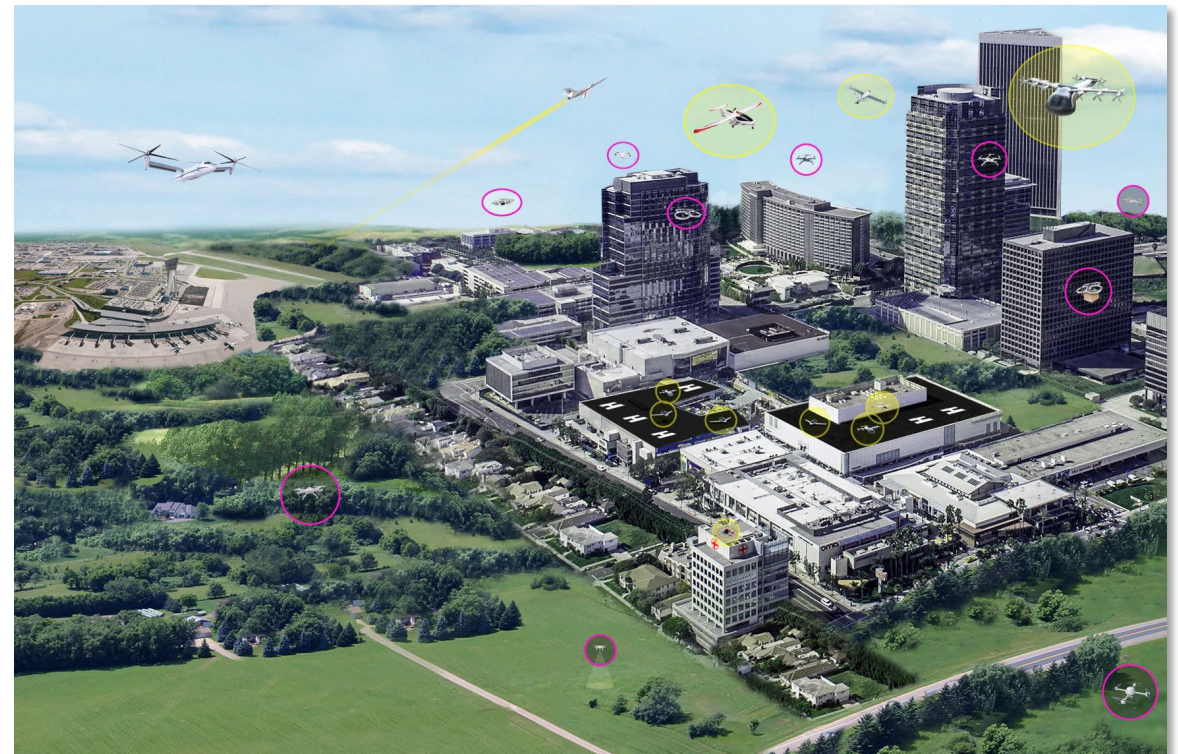


One mile of surface transportation takes you one mile, whereas one mile of aviation land can take you *anywhere*

Vector 1: Driver/Environmental Considerations

Society and transportation could change

- Quieter, faster, and farther
- No need to congregate into higher density geographical areas
- Connects businesses without congestion
- More integrated living: business, residential, and recreational.



Big Picture

One mile of surface transportation takes you one mile, whereas one mile of aviation land can take you **anywhere**

Vector 2: Enablers

New technology needs to be embraced

- IOT, digitization, electrification, autonomy, and ML/AI

Vector 3: Drivers/needs

Diversity and density, volume, and complexity will continue to increase

- Commercial space
- UAS of all sizes
- Autonomy
- UAM/AAM
- Current aviation operators





Lessons learned from successful unmanned aircraft system traffic management

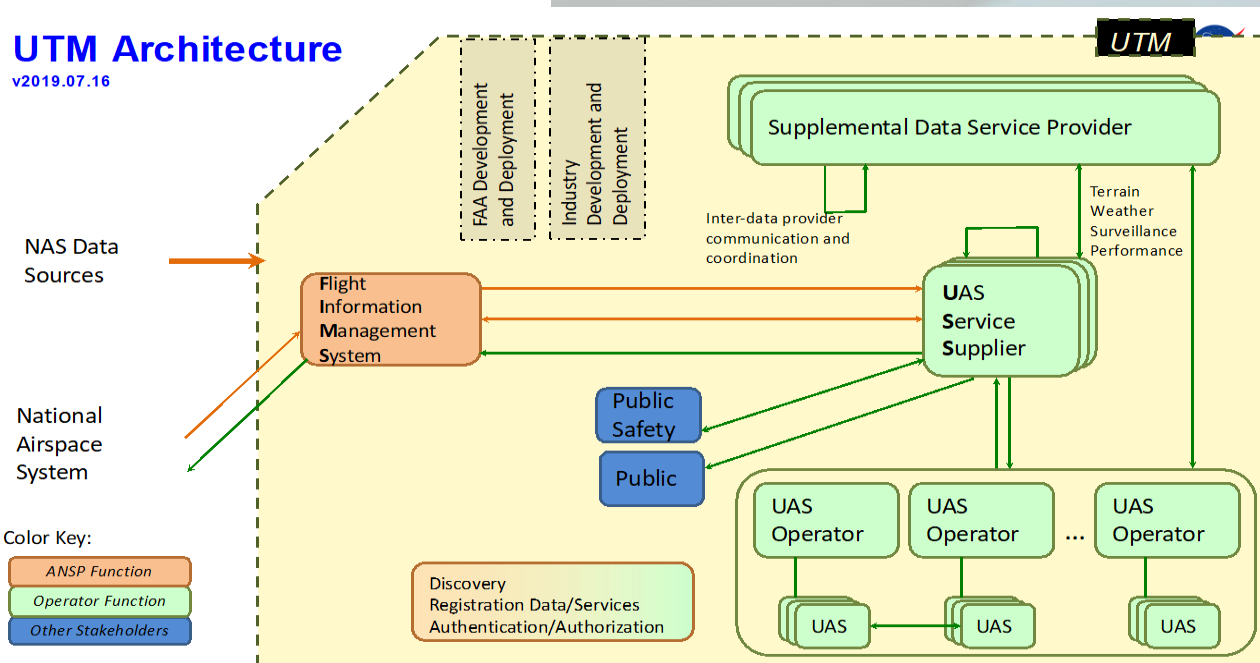
Unmanned Aircraft System Traffic Management (UTM) - Attributes



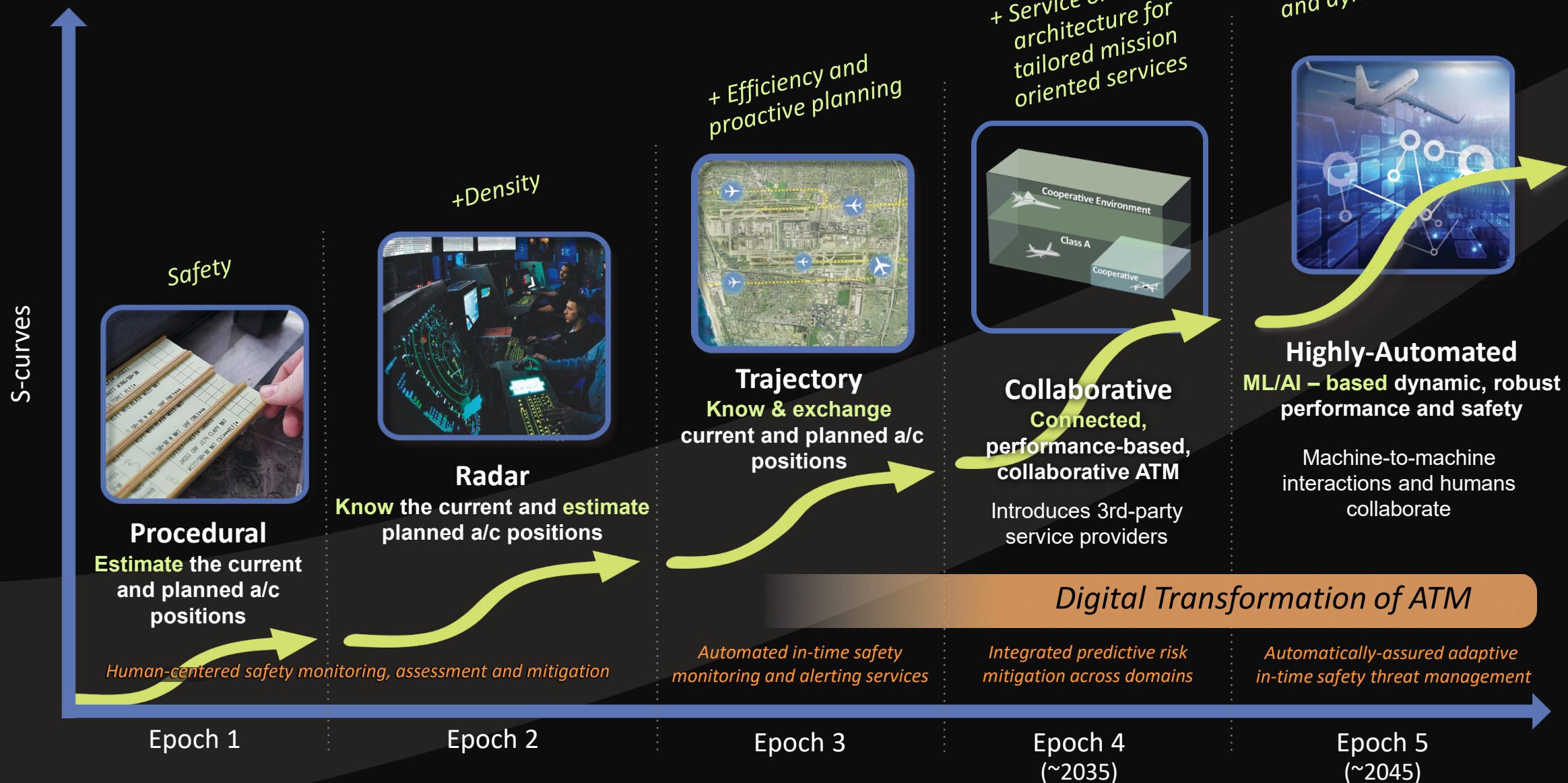
- Cooperative (share and care)
- Intent-sharing
- Digital: data exchanges among operators
- Standardized application protocol interfaces
- Air/ground integrated
- Service-oriented architecture
- Role for third-parties
- Management by exception

UTM Architecture

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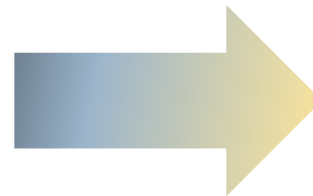
Evolution of Airspace Operations and Safety



Transition to UTM-inspired Airspace Traffic Management



Current ATM



UTM-inspired-ATM



All services are provided by FAA



Services are provided by FAA and third-parties

Humans address off-nominal situations and contingencies to ensure safety



Automation addresses off-nominal situations and contingencies to ensure scalability while maintaining safety

Very little interaction among users and third parties



Users collaborate/cooperate for efficiency, preferences for flights into constraints resources

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



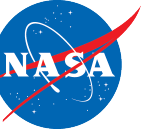
- Automation at the epi-center of information integration
- New paradigm: digital, connected ecosystems, third-party applications, service-oriented architecture
- **Management by exception**
- Focus on **total system performance**



NASA Unique Role: Architecture, data exchanges, service allocation/roles/responsibilities, rules of engagement, performance requirements for aircraft and airspace system technologies, automation for contingency management and disruption handling, machine learning environment and algorithms for continuous improvement, safety assurance/certification/acceptance approaches, and technology transfers.

Manage by Exception Everywhere

- Performance-based
- Leverages UTM paradigm in entire airspace—from ground to heavens!
- Scalability everywhere



Embracing Innovation in Aviation while Respecting its Safety Tradition

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Airspace System Must Continue to Evolve with Relatively Quicker Cycles

- Integrated, service-oriented architecture with modular implementation for real-time use to serve users
- Disruptions, off-nominal conditions, and contingencies managed by automation
- Automation to create solutions for Total System Performance (e.g., safety, risk, efficiency, resiliency, scalability)
- Continuous common situation awareness for all users and providers by going digital

Airspace Operations Transformation Approach

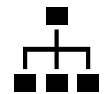
Question current assumptions – which limit user flexibility and system capacity, and conduct research to set system characteristics and requirements



Revisit visual and instrument flight rules: electronic/digital flight rules to promote cooperative traffic management



Revisit separation minima as "track and locate" accuracy is consistent and more precise with GPS instead of radar



Revisit architecture, and roles and responsibilities to move towards federated, service-oriented, manage by exception system for scalability



Revisit management of large-scale disruptions: use more data driven, integrated, machine learning based approaches



Revisit how routine weather-related delays are managed: use predictive and machine learning based algorithms



Enable regional and local operations by accommodating local considerations about vertiports and surroundings



Revisit integrated arrival/departure/surface movement, runway lengths and flows in/out of airports/vertiports with increasingly quieter electrified aircraft

Enabling Future Airspace Operations



Planning for future

UTM-inspired-ATM (digital, cooperative, intent sharing, service-oriented architecture, etc.)



Revisiting flight information exchanges

Digital, intent sharing, CNS, etc.



Revisiting roles and responsibilities

federated, management by exception



Revisiting separation minima

new technology with higher precision

Enabling Future Airspace Operations



Using technologies to reduce weather induced delays
Machine learning and artificial intelligence



Enabling increased local and regional operations
Benefits societal change



Enabling better disruption management
Primary focus on large-scale disruptions



Developing architecture, information integration, automation and roles and responsibilities
Dynamic: performance, risk, and demand based