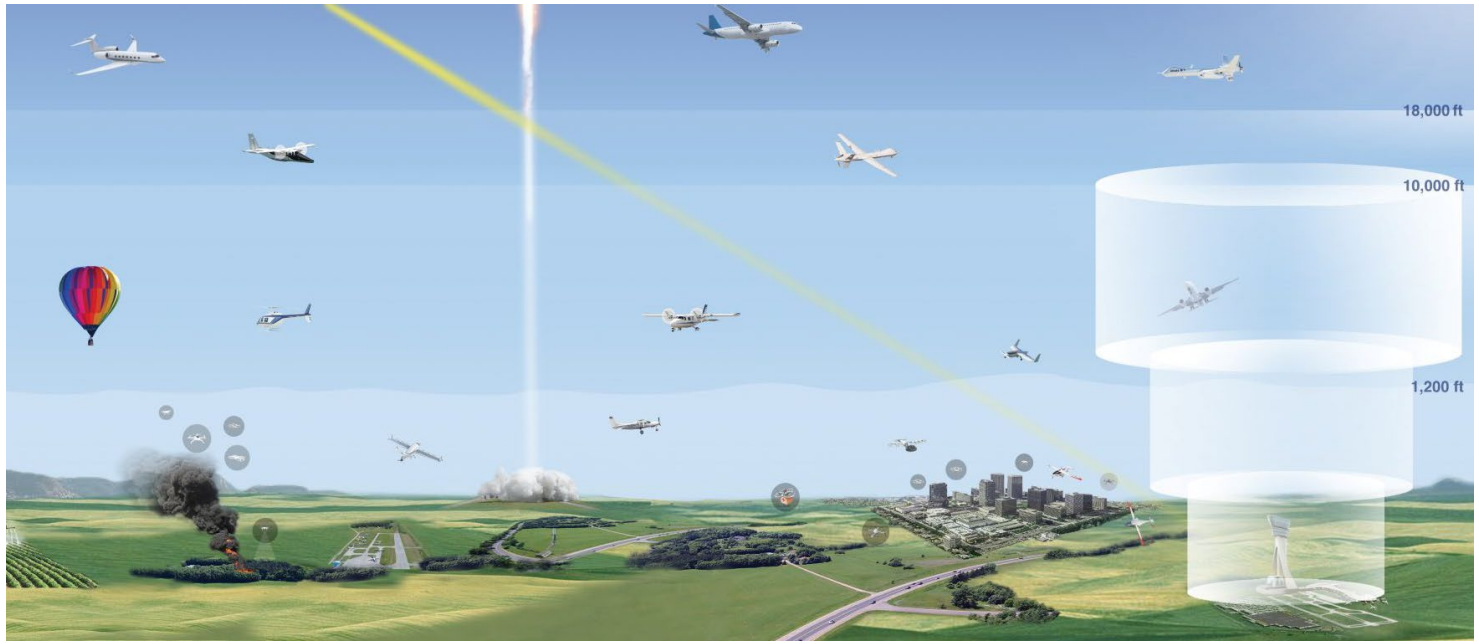
Future Airspace Operations



Parimal Kopardekar, PhD
Director, NASA Aeronautics Research Institute
Advanced Air Mobility Mission Integration Manager
Parimal.H.Kopardekar@nasa.gov

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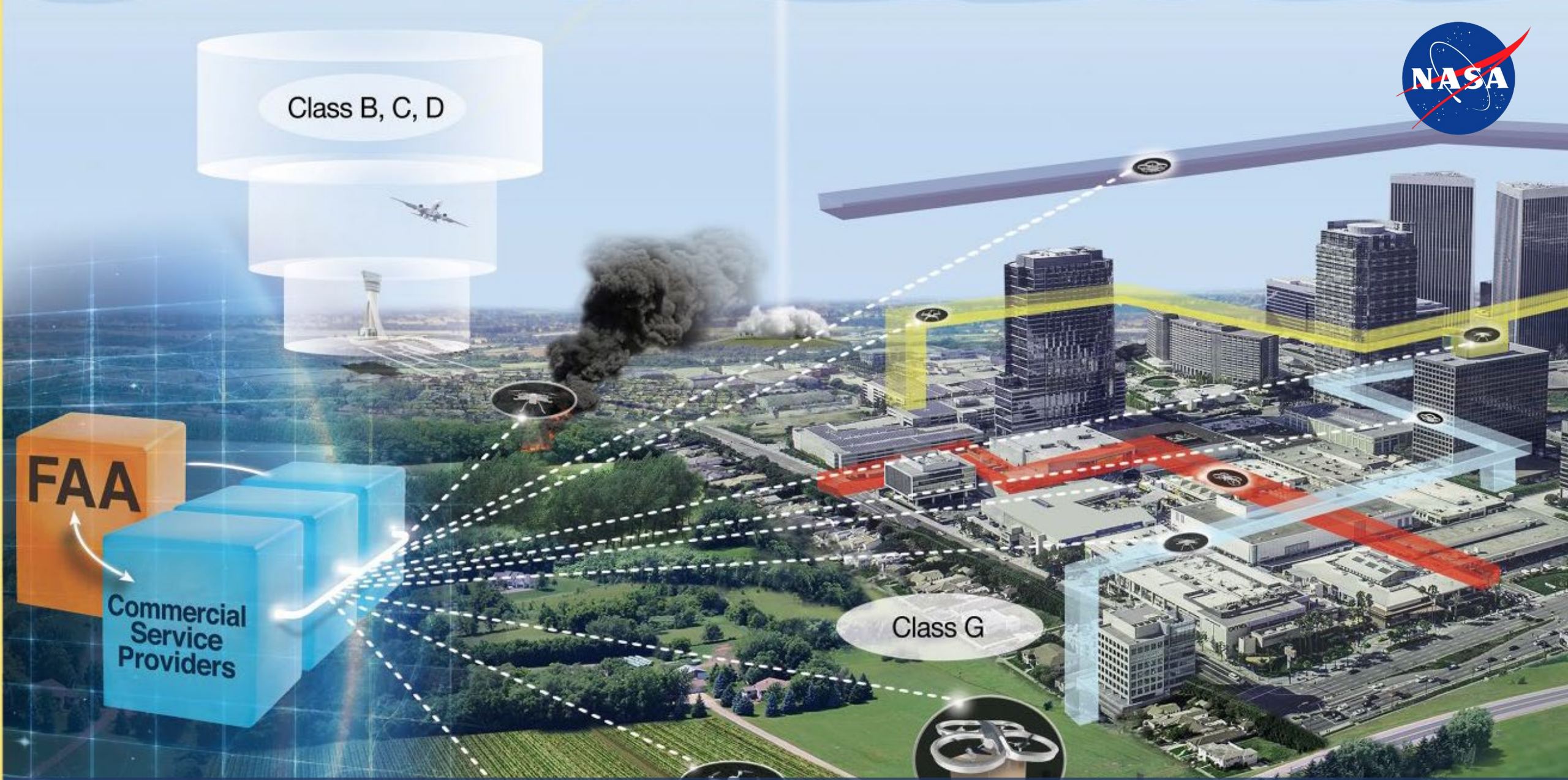
Outline

- Needs of new entrants
- Lessons learned from the small UAS operations
- Evolution of airspace operations
- Key characteristics of future system
- NASA’s Sky for All initiative

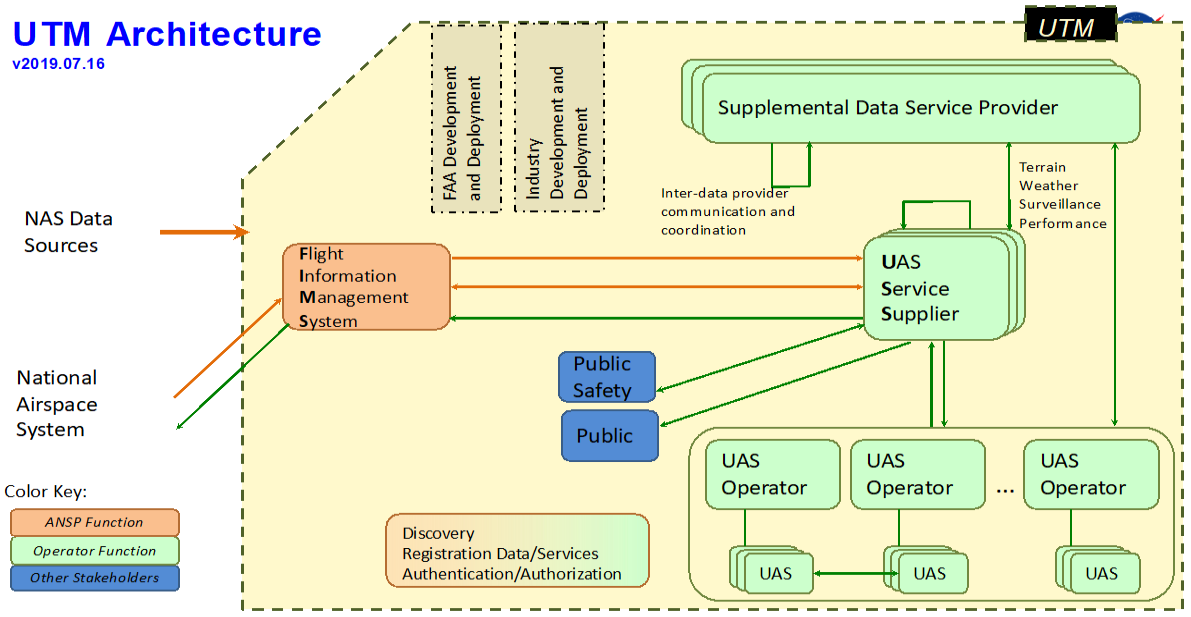
Needs of New Entrants

New entrants need quicker and sustained airspace access



Airspace “System” should be ready when vehicles are ready

Lessons Learned from Small UAS Operations



Lessons Learned from Successful Unmanned Aircraft System Traffic Management

- 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

Recent Success: Global Impact

Scaled operations without burdening current air traffic system

UTM-LIKE-ATM AIRSPACE OPERATIONS ENVIRONMENT

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

Space Traffic Management

High Altitude operations (upper E)

Conventional Manned Aviation (Class A, B, C, D, E)

Urban/Advanced Air Mobility

Low-altitude small UAS

Evolution of Airspace Operations

Evolution of Airspace Operations and Safety

S-curves

Safety

Procedural
Estimate the current and planned a/c positions

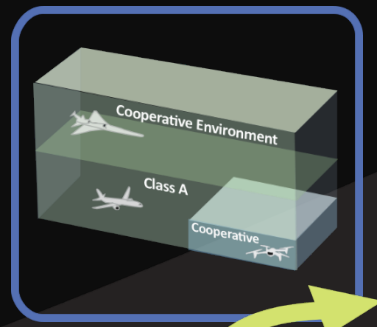
+Density

Radar
Know the current and **estimate** planned a/c positions

+ Efficiency and proactive planning

Trajectory
Know & exchange current and planned a/c positions

+ Service oriented architecture for tailored mission oriented services



Collaborative
Connected, performance-based, collaborative ATM

Introduces 3rd-party service providers

+ Complexity, scalability, and dynamic adaptation

Highly-Automated
ML/AI – based dynamic, robust performance and safety

Machine-to-machine interactions and humans collaborate

Digital Transformation of ATM

Human-centered safety monitoring, assessment and mitigation

Automated in-time safety monitoring and alerting services

Integrated predictive risk mitigation across domains

Automatically-assured adaptive in-time safety threat management

Epoch 1 | Epoch 2 | Epoch 3 | Epoch 4 (~2035) | Epoch 5 (~2045)

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, outside applications • Movement towards management by exceptions • Each change is focused on trajectory optimization

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.

Key Characteristics of Future System


Simultaneous Total System Performance
Management by Exception
Airspace Simplification
Disruption Management

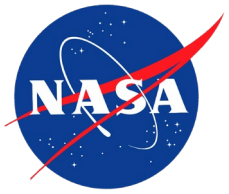
NASA’s Sky for All Initiative

SKY FOR ALL

- Builds on FAA's Information Centric NAS (ICN)
- Focuses on mid-century time frame to accommodate diversity, density, tempo, etc. related needs
- Builds on lessons learned from past (e.g., UTM, xTM, etc.)
- Considers total system performance, management by exception, cooperative operations, better disruption management, etc.
- Architecture is the deliverable

https://youtu.be/TftvDXKaG-s

https://www.nari.arc.nasa.gov/skyforall/



Embracing Innovation in Aviation while Respecting its Safety Tradition

Parimal.H.Kopardekar@nasa.gov