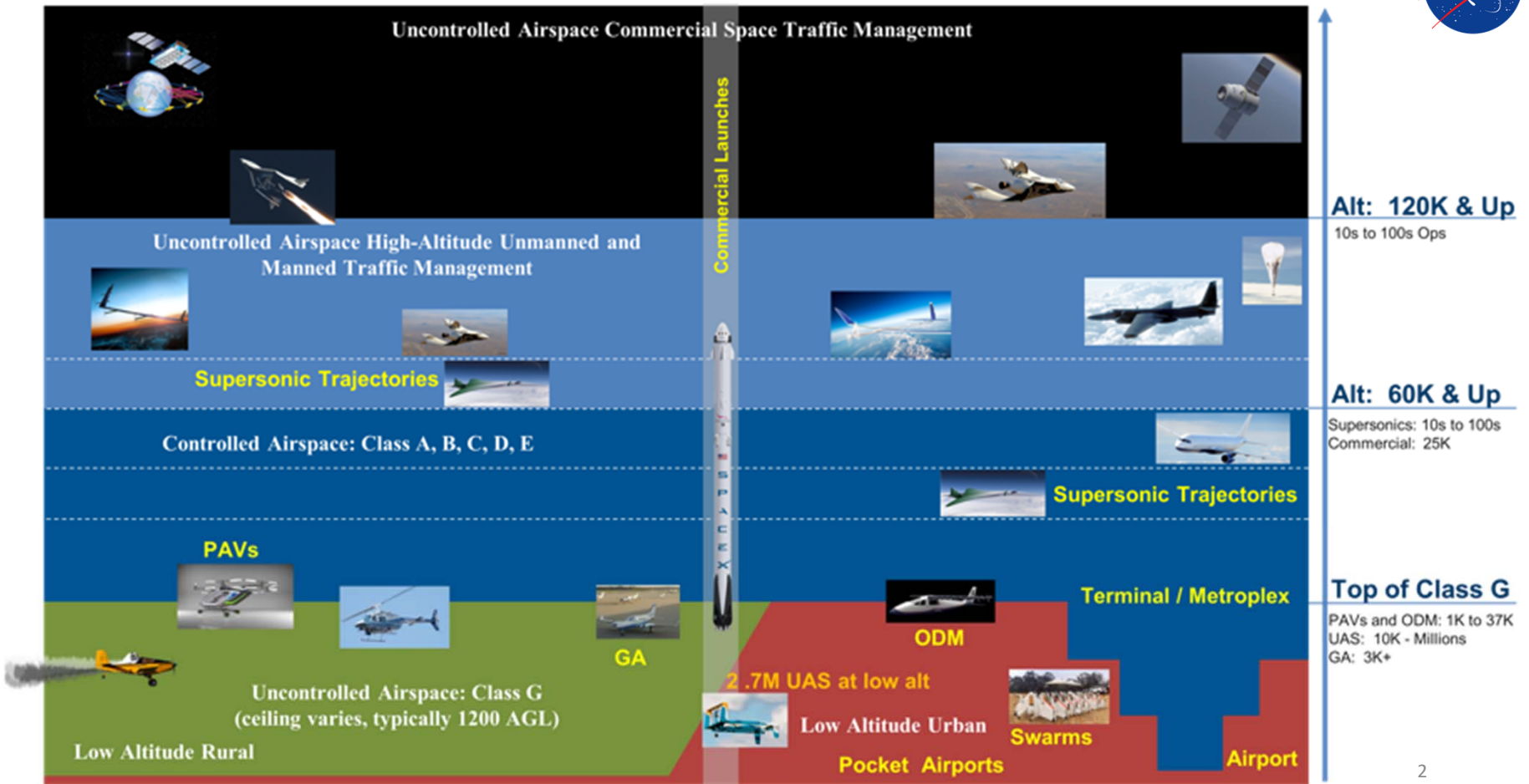# Embracing Innovation in Aviation While Respecting Its Safety Tradition

Parimal Kopardekar, Ph.D.

NASA Senior Technologist for Air Transportation System

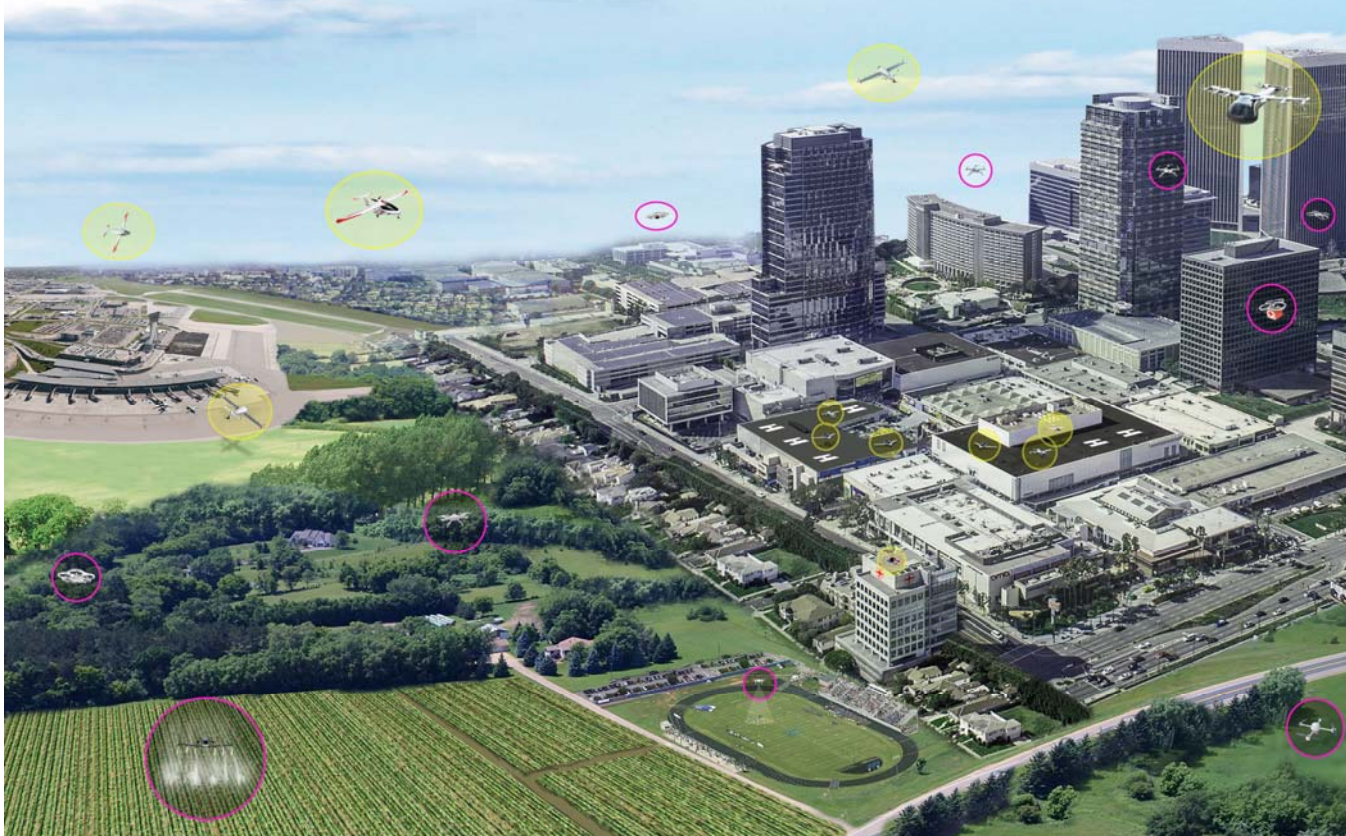Acting Director, NASA Aeronautics Research Institute (NARI)
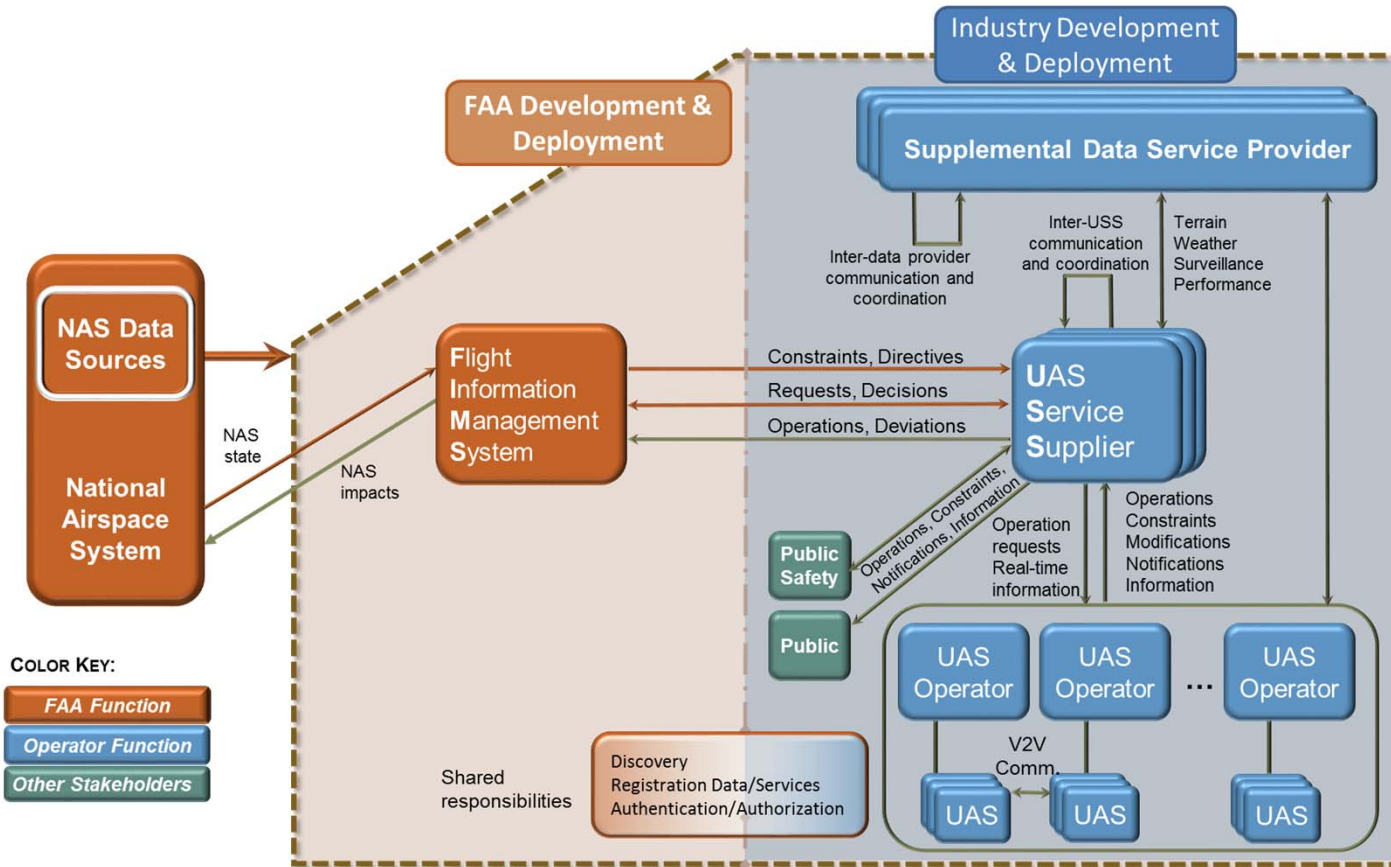
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1

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

PAVs

Supersonic Trajectories

GA

ODM

Terminal / Metroplex

2.7M UAS at low alt

Uncontrolled Airspace: Class G
(ceiling varies, typically 1200 AGL)

Low Altitude Urban

Swarms

Low Altitude Rural

Pocket Airports

Airport

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+

2

SMALL UNMANNED AIRCRAFT SYSTEMS

URBAN AIR MOBILITY: SMALL DRONES TO LARGER PASSENGER CARRYING VTOLS

UAS TRAFFIC MANAGEMENT ARCHITECTURE

Industry Development & Deployment

FAA Development & Deployment

Supplemental Data Service Provider

Inter-data provider communication and coordination

Inter-USS communication and coordination

Terrain Weather Surveillance Performance

NAS Data Sources

NAS state

NAS impacts

National Airspace System

Flight Information Management System

Constraints, Directives

Requests, Decisions

Operations, Deviations

UAS Service Supplier

Operations, Constraints, Notifications, Information

Operation requests Real-time information

Operations Constraints Modifications Notifications Information

Public Safety

Public

UAS Operator

UAS Operator

...

UAS Operator

V2V Comm.

UAS

UAS

UAS

Discovery Registration Data/Services Authentication/Authorization

Shared responsibilities

COLOR KEY:
- *FAA Function*
- *Operator Function*
- *Other Stakeholders*

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
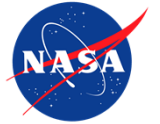→ Supplies supplemental data to USS and UAS Operator to support operations

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

*Connections & communications are internet-based & built on industry standards & protocols

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 UTM (Upper E)

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

Urban Air Mobility

Low-altitude small UAS

Current ATM

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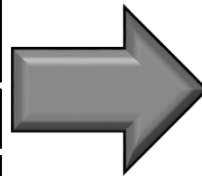- Every vehicle interaction in real-time.

FAA Systems

Humans address off-nominal and contingencies

Airspace User
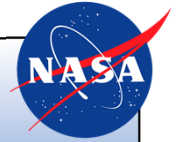Airspace User

Airspace User
Airspace User
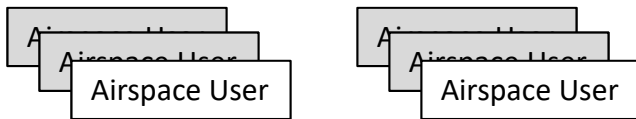
Very little interaction among users and third-party services.

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

UTM-inspired ATM

**Some services are provided by the 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
Airspace User

Airspace User
Airspace User

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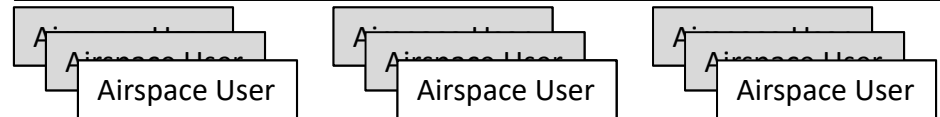
Users collaborate/cooperate for efficiency, intra-user preferences for flights into constrained resources.

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

NASA's 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, safety assurance, certification/acceptance approaches and technology transition.

CONCLUDING REMARKS

- Need for change is real, current systems are not sustainable

- Sense of urgency due to emerging markets and diversity of operations

- Build-a-little-test-a-little and deploy

- International harmonization – many areas

- Highly scaled operations that are affordable and safe

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embracing innovation in aviation while respecting its safety tradition