Embracing Innovation in Aviation
While Respecting Its Safety Tradition

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CURRENT AIRSPACE OPERATIONS
*Connections & communications are internet-based & built on industry standards & protocols
Technology Capability Levels (TCLs)
Transformation – Urban Air Mobility

Increasingly autonomous – focused on access, safety and scalability
URBAN AIR MOBILITY: SMALL DRONES TO LARGER PASSENGER CARRYING VTOLS
Emerging and Heritage Users

- Commercial Space Operations
- Supersonics and Hypersonics
- High Altitude Operations (upper E)
- Subsonic Transport Aviation
- Urban Air Mobility
- Small Unmanned Aircraft Systems

- Access
- Efficiency
- Safety
- Scalability

Economy Affordability Ubiquitous

Air Navigation Service Provider
Autonomy alone will not lead to efficiency and large-scale disturbance management. Connectivity is crucial – air/ground/cloud/infrastructure integration will be key.
Space Traffic Management

High Altitude UTM (Upper E)

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

Urban Air Mobility

Low-altitude small UAS

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

Very little interaction among users, and 3rd party services

- Human in the epicenter of information integration
- Every data moves through FAA systems for every vehicle
- Each change focused on 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

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

- Automation in the epicenter 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, safety assurance, certification/acceptance approaches, and technology transitions.
Inter-island Autonomous Cargo Delivery (2025+)
Larger vehicle – single pilot, off-board manager, or fully autonomous depending on vehicle size
Transformation – In stages – Initial Applications
Larger than small drones (~2020+?)

Lowest risk – Grand Canyon or over water deliveries

Mail delivery by mule train in the Grand Canyon

JW Westcott mail delivery by boat

PictuRES FROM USPS.gov
Future Airspace Operations?

- Scalable – increasingly autonomous
- Cooperative – information needs, and technologies for cooperation among vehicles, and operators, and service providers
- Digital – data exchanges and standardized application protocols
- Resilient – technologies and procedures for faster recovery from disruptions
- Manage by exception – flexibility where possible and structure where necessary
- Safety assurance – in-time data, prognostics, V&V of increasingly autonomous systems
- Air/ground/cloud integrated
- Service oriented architecture – third party

...enabling beyond possible!
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
• Research issues remain – however goal should be “cross the finish line” to improve operations – research is means to an end and not an end in itself
• Highly scaled operations that are affordable and safe
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