Safely Enabling Low-Altitude UAS Operations: Unmanned Aircraft System Traffic Management

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DFS Technology Conference – The Drone Challenge
Stadthalle Langen, Germany
Innovate Relentlessly

Embracing innovation while respecting aviation’s safety tradition
Unmanned Aircraft Systems Applications

Embracing innovation
Where were we?

• Lack of rule

• Gaps in concepts for expanded multiple operations

• Lack of understanding in roles/responsibilities

• Lack of requirements for safe and scalable expanded operations

• Lack of requirements for scale and scalable urban operations

Overall interest in moving forward
Where are we now?

- Part 107 operational
- Pathfinders in action
- UTM concept of operations accepted
- UTM roles/responsibilities accepted
- UTM tests show promise
- Research underway for urban operations

FAA has shown agility and NASA focused research
What’s coming next?

• By 2020, 7M total and 2.6M commercial small UAS

• Urban and suburban personal air mobility operations

• UAS everywhere: in class A, B, C, D, E, and G airspace

• High altitude airspace operations (60,000 ft. and up)

• Commercial space operations

Characterizing uncontrolled and controlled operations
Each capability is targeted to type of application, geographical area and uses risk-based approach

**CAPABILITY 1: SHOWED 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
- Enable agriculture, firefighting, infrastructure monitoring

**CAPABILITY 2: SHOWED 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

**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
- Public safety, limited package delivery

**CAPABILITY 4: FOCUSES ON ENABLING URBAN OPERATIONS**
- Beyond visual line of sight
- Urban environments, higher density
- Autonomous V2V, internet connected
- Large-scale contingencies mitigation
- News gathering, deliveries, personal use
Increasing Operational Risk, Complexity & Cost Drivers

**Critical Technology Enablers**

**Earl Lawrence, Presented at Drone Advisory Committee**

- **Hobbyist, VLOS (Part 101-E)**
- **Commercial Small UAS, VLOS (Part 107 and Ops over People Rule)**
- **BVLOS / Extended Operations (Part 107.xx)**
- **Integrated (Part xx)**

**Pathfinder**
- Pathfinder 1 VLOS Over People
- Pathfinder 2 EVLOS
- Pathfinder 3 BVLOS

**Technologies**
- Automated Airspace Notification & Authorization Tools
- Ground Based Sense & Avoid
- Low Altitude Automation and Scheduling (UTM)
- Geo-fencing Technologies
- Airborne Detect & Avoid

**Sectors**
- Hobbyist
- Commercial VLOS
- Commercial BVLOS
- Integrated

**Sectors Framework**
- Increasing Operational Risk, Complexity & Cost Drivers
- Registration Website
- Online Airspace Authorization
- Automated Airspace Notification & Authorization Tools
- Ground Based Sense & Avoid
- Low Altitude Automation and Scheduling (UTM)
- Geo-fencing Technologies
- Airborne Detect & Avoid
- Terminal Flight Data Manager
- NAS System Integration (CNS)

**Frameworks**
- Hobbyist, VLOS (Part 101-E)
- Commercial Small UAS, VLOS (Part 107 and Ops over People Rule)
- BVLOS / Extended Operations (Part 107.xx)
- Integrated (Part xx)
UTM Progress

- Concept of operations
- Roles/responsibilities – implications on who pays
- Information architecture paved way for FAA’s RFI
- Demonstrated initial feasibility of architecture, application protocol interface based approach, and overall construct
- Data exchange and protocols
- Demonstration of UTM TCL1 with all 6 test sites
- Initial demonstration of UTM TCL2 for BVLOS requirements

UTM R&D continues to make good progress
UTM Architecture

National Airspace System

Flight Information Management System

Supplemental Data Service Provider

UAS Service Provider

Public Safety

Public

Color Key:
- ANSP Function
- Operator Function
- Other Stakeholders

NAS Data Sources

Common data

NAS state

NAS impacts

Inter-data provider communication and coordination

Terrain Weather Surveillance Performance

Inter-USS communication and coordination

Operations, Constraints, Directives, Requests, Decisions

Operations, Deviations

Operation requests

Real-time information

Operations, Constraints, Modifications, Notifications, Information

UAS Operator

UAS

UAS Operator

UAS

UAS Operator

UAS
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Stages of Traffic Management: Balancing safety, efficiency, and scalability

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UTM Key Lessons: Proving safety together

Beyond basics

- Disruptions, off-nominals and contingencies
  - Weather and wind effects, and need for better predictions
  - Priority access: Clearing airspace based on dynamic conditions
  - Lost/delayed communications
  - Vehicle malfunctions
  - Rogue operation and its influence on other operations
  - Cyber security
  - Lack of availability of GPS and degraded conditions

Airspace operations requirements based on solid research
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National UAS Standardized Testing and Rating (NUSTAR)
• Performance data is critical to safety and acceptance
• Underwriter’s laboratory for UAS
  – Weather conditions: wind, icing, fog, rain
  – Security: Spoofing, hacking, and interference
  – Noise
  – Detect and avoid tests under variety of conditions
  – Failure modes
  – Drop tests
  – Sub-system level performance (e.g., battery, propulsion)
  – Conformance to geo-fence
• Users: Insurance, regulators, manufacturers, consumers, researchers
• Forensics testing and recreation of accidents
UTM Next Steps

• Exercises with all FAA test sites for expanded/BVLOS operations
• Working groups: active collaboration
  – Concept of operations and use cases, Data exchange, Detect and avoid, Communication and navigation, and Performance
  – Spectrum and Weather
• Airspace research: Architecture, high density and constraints, airspace configurations, demand/capacity balance, communication and navigation, and contingencies
• Vehicle research: geo-fence conformance, DAA, track and locate, hazard avoidance, trajectory uncertainty, and last/first 50 feet operations
• Air/ground capabilities: Towards complex and heterogeneous operations

Culminate in joint FAA-NASA UTM pilot project
Expanding Vision

• Airspace categories: services provided and not provided by ANSP
• Ensure UTM success and deliver
• Personal air mobility – uncontrolled airspace and/or uncontrolled operation
• High altitude UTM construct for airspace operations
• Ultra high altitude construct for space traffic management
• Interest where services could be provided to improve current operations

UTM type paradigm appears to be expandable to other airspace
Beaver is a keystone species: UTM has potential to do so!
Beavers - beavering - to beaver!
Thank you for your contributions!