Unmanned Aerial Systems Traffic Management (UTM)

SAFELY ENABLING UAS OPERATIONS IN LOW-ALTITUDE AIRSPACE

NASA

http://www.utm.arc.nasa.gov

Moffett Field, CA

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Requirements are Different

http://www.kcet.org/updaily/socal_focus/history/la-as-subject/7th-and-broadway.html
1920, Photo Collection, Los Angeles Public Library
Goal: Ensure safe and efficient operations
NASA’s UTM Research Goals and Characteristics

- Conduct research, development and testing to identify airspace operations requirements to enable large-scale visual and beyond visual line of sight UAS operations in the low-altitude airspace
  - Collaborate with FAA, DOD, DOI, and DHS through Research Transition Team
  - Collaborate and leverage industry capabilities and insights
  - Partner with FAA test sites for testing
  - Partner with FAA COE for key research needs

- Use build-a-little-test-a-little strategy – remote areas to urban areas
  - Low density: No traffic management required but understanding of airspace constraints
  - Cooperative traffic management – Understanding of airspace constraints and other operations
  - Manned and unmanned traffic management – Scalable and heterogeneous operations

- UTM construct consistent with FAA’s risk-based strategy
- UTM research platform is used for simulations and tests
- UTM offers path towards scalability
Balancing Multiple Needs

National and Regional Security
Protecting key assets

Safe Airspace Integration
Mantra 1: Flexibility where possible and structure where needed
Mantra 2: Risk based- Geographical needs, application, and performance-based airspace operations

Scalable Operations for Economic Growth
Ever-increasing applications of UAS: Commercial, Agricultural, and Personal
Principles and Services for Safe Integration

• Principles
  – Authenticated users and UAS are allowed to operate in the airspace
  – UAS stay clear of each other
  – UAS and manned aircraft stay clear of each other
  – UAS operator has complete awareness of airspace and other constraints and stay clear of them
  – Public safety UAS have priority over other UAS

• Key UAS related services
  – Authentication
  – Airspace configuration and static and dynamic geo-fence definitions
  – Weather and wind prediction and sensing
  – Conflict avoidance (e.g., airspace notification, V2V)
  – Demand/capacity management
  – Large-scale contingency management – GPS outage, cell outage, etc.

• Research prototype is cloud-based

• UTM research identifies roles and responsibilities of operator, air navigation service provider, and UAS support service providers
### Defining UAS Operator and ANSP/UTM Roles

**UAS Operator**
- Work with Original equipment manufacturer
- Communication, Navigation, and Surveillance (CNS)
- Register
- Train/qualify to operate
- Avoid other aircraft, terrain and obstacles
- Respect airspace constraints
- Avoid incompatible weather

**Through**
- Performance-based regulation where practical
- Limited categories of operator types, matched to regulations

**Air Navigation Service Provider (ANSP)**

- Define airspace constraints
- Foster collaboration among UAS operators to deconflict their operations
- Where demand warrants, provide air traffic control

**UAS Traffic Management (UTM)**

- Near real-time airspace control
- Where it is needed, air traffic control integrated with manned aircraft traffic control

**Third-party entities may provide support services but are not separately categorized or regulated.**
UAS Operator/UTM Functions

UTM: AIRSPACE MANAGEMENT
• Notifications accessible to UAS operators and public
• Static (like TFR) and dynamic (like security or public health scenario)

UAS OPERATOR
• Broadcast identity (and possibly intent)
• Operations accessible by all
• No anonymous flying
UTM: Example Airspace Management

- Consider other traffic and underlying environment
- Can be keep-out or keep-in requirement
- May be static or dynamic (near-real time)

UAS Operator:

- Operator can comply through geofences or operational control
UAS Operator/UTM Functions

**UAS Operator: Traffic Avoidance**
- Detect Sense And Avoid (DSAA) to manned aircraft predicated on right of way
- Status and intent exchange in accordance with standards
- Collaborative decision making
- Contingency planning and response (system outages, unreported weather, etc.)

**UTM: Enable Collaborative Exchange**
- Standards for publish and access
- If needed, provision of data repository
UTM Functions

**ROUTE STRUCTURE**
- Only where needed for safety or efficiency of flight
- Procedural rules-of-road (corridors, altitudes, etc).

**AIR TRAFFIC CONTROL**
- Integrated with manned air traffic control, where positive UAS control is required for safety or efficiency of flight
- Static or dynamic application (e.g., ability to respond in crisis situation where sustained mixed operations are required)

**FLOW CONTROL**
- Only where needed for safety or efficiency of flight
- Manage access into areas of operation, not particular operation

Mantra 1:
*Flexibility where possible and structure where needed*

Mantra 2:
*Risk based- Geographical needs, application, and performance-based airspace operations*
Supporting Functions

**Wind & Weather Integration**
- Operator responsibility, may be provided by third party
- Actual and predicted winds/weather
- No unique approval required
NASA UTM Simulation Capabilities

- Validation and Verification of UTM research prototype functions
- Develop, demonstrate, and evaluate advanced UTM services and operations
- Develop tools and procedures to manage UTM ops
- Accelerate and increase value of field tests and provide live virtual constructive (LVC) environments
- Simulate complex operations that cannot be done in the field (e.g. urban ops, 911 type scenarios)
UTM Research Technical Capability Level

Each capability is targeted to type of application, geographical area and uses risk-based approach.

**CAPABILITY 1 (AUGUST 2015)**
- Reservation of airspace volume
- Over unpopulated land or water
- Minimal general aviation traffic in area
- Contingencies handled by UAS pilot
- Enable agriculture, firefighting, infrastructure monitoring

**CAPABILITY 2 (OCTOBER 2016)**
- Beyond visual line-of-sight
- Tracking and low density operations
- Sparsely populated areas
- Procedures and “rules-of-the road”
- Longer range applications

**CAPABILITY 3 (JANUARY 2018)**
- Beyond visual line of sight
- Over moderately populated land
- Some interaction with manned aircraft
- Tracking, V2V, V2UTM and internet connected
- Public safety, limited package delivery

**CAPABILITY 4 (MARCH 2019)**
- Beyond visual line of sight
- Urban environments, higher density
- Autonomous V2V, internet connected
- Large-scale contingencies mitigation
- News gathering, deliveries, personal use
**Working Groups**

- Collaborations in place with over 200 partners: industry, academia, and government are all represented
- Leveraging this by frequently meeting, obtaining solid stakeholder buy-in early and often on concepts
- Establishing semi-formal working groups to tackle specific issues, open to all of our collaborators to participate

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<tr>
<th>Current Working Groups</th>
<th>Flight Planning</th>
<th>Conformance Monitoring</th>
<th>Separation Assurance</th>
<th>Public Safety</th>
<th>MultiUTM</th>
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<td>Ease use of the UTM System by developing services to bridge operators to UTM during flight planning. Additional services such as terrain checking, fleet optimization are possibilities</td>
<td>Ensure operations are staying where they said they would stay. Potential predictive capabilities to catch non-conformance as soon as possible.</td>
<td>Help monitor and alert for potential conflicts. Offer potential solutions to conflicts before vehicle to vehicle solutions are required.</td>
<td>Allow access to the airspace for public safety functions: police, fire, medical, national security, etc. Develop standards for prioritization of access.</td>
<td>Develop concepts for enabling multiple UTM instances to communicate. Potentially allow for several different UTM Service Suppliers.</td>
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National Safe UAS Integration Campaign

What: Demonstrated management of geographically diverse operations, 4 vehicles from each site flown simultaneously under UTM

Where: All 6 FAA UAS Test Sites

Who: NASA, Test Sites, support contractors

When: 19 April 2015

24 live vehicles, over 100 live plus simulated flights under UTM in one hour

Obtain detailed feedback from the FAA Test Sites on the UTM concepts, technologies and operations

Learn what requirements might be needed for management of geographically diverse operations
NuSTAR: Performance Benchmarking for sUAS

- Performance benchmarking: responsible, credible, collaborative
- National UAS Standardized Testing and Rating (NuSTAR)
- Parallel: Underwriter’s Laboratory, Consumer Reports, JD Powers, Which?
- Credible test bed and scenarios
  - Drop tests
  - Urban, rural, atmospheric conditions (e.g., fog, smog, rain)
  - Simulated pets
  - Failure modes
  - Sub-system level performance: engine/propulsion, networking, battery, sensor systems, software systems
  - Cyber-security, GPS denied conditions, etc.
- Support UAS manufacturers, consumers, insurance companies, and public at large through objective assessments for self-certification to meet FAA requirements
- Forensics analysis: Re-creation of incidents and accidents
• NASA works closely with many industry, academia, and government partners
• NASA and FAA have established Research Transition Team (RTT) to collaborate on UTM research – includes DOD, DHS, DOI
• NASA has over 200 collaborators and various work groups
• Test four technical capability levels
• Initial technical capability level 1 was initially tested in August 2015
• Capability 1 was further successfully tested simultaneously with all six FAA test sites
• Capability level 2 will be tested in October (target: Beyond Visual Line of Sight)
• Continue collaboration with all