Unmanned Aerial Systems Traffic Management (UTM)

SAFELY ENABLING UAS OPERATIONS IN LOW-ALTITUDE AIRSPACE

NASA

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

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Applications of Unmanned Aerial Systems

- Public Safety
- Cargo Delivery
- Surveillance
- Weather Monitoring
- News Gathering
- Agriculture
- Mapping
- Disaster Relief
- Entertainment
- Spraying/Seeding
Stages of Traffic Management: 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
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
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

• 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
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 platform is cloud-based**

• **UTM research identifies roles and responsibilities of operator, air navigation service provider, and UAS support service providers**
UAS Traffic Management

UTM

ATM API

DATA API

CNS API

PUBLIC SAFETY API

PUBLIC ACCESS API

Data Service Providers

Regulatory Agencies

Law Enforcement

Public Access

Community Groups

Hobbyists

General Public

UAS Traffic Management

UTM Clients

UAS Control

UAS Service Suppliers

UAS Operations

Public Safety

Deliveries

Precision Agriculture

Science Missions

Public Safety Data

Weather Data

User Credentials

Terrain Maps

Obstacle Data

Airspace Data

NOTAM Data

Vehicle Registration

Vehicle Performance

Public Safety

Terrain Maps

Obstacle Data

Weather Data

User Credentials

NOTAM Data

Vehicle Registration

Vehicle Performance

Public Access

Community Groups

Hobbyists

General Public

Precision Agriculture

Science Missions

Public Safety

Deliveries

ATM Systems

Traffic Management Systems

ATC System Command Center

Airport Tower

UAS

UAS Controllers

UAS Operators

func0on

func0on

ANSP
### UTM Research Technical Capability Level

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

<table>
<thead>
<tr>
<th>CAPABILITY 1</th>
<th>CAPABILITY 2</th>
<th>CAPABILITY 3</th>
<th>CAPABILITY 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Reservation of airspace volume</td>
<td>• Beyond visual line-of-sight</td>
<td>• Beyond visual line of sight</td>
<td>• Beyond visual line of sight</td>
</tr>
<tr>
<td>• Over unpopulated land or water</td>
<td>• Tracking and low density operations</td>
<td>• Over moderately populated land</td>
<td>• Urban environments, higher density</td>
</tr>
<tr>
<td>• Minimal general aviation traffic in area</td>
<td>• Sparsely populated areas</td>
<td>• Some interaction with manned aircraft</td>
<td>• Autonomous V2V, internet connected</td>
</tr>
<tr>
<td>• Contingencies handled by UAS pilot</td>
<td>• Procedures and “rules-of-the road”</td>
<td>• Tracking, V2V, V2UTM and internet connected</td>
<td>• Large-scale contingencies mitigation</td>
</tr>
<tr>
<td>• Enable agriculture, firefighting, infrastructure monitoring</td>
<td>• Longer range applications</td>
<td>• Public safety, limited package delivery</td>
<td>• News gathering, deliveries, personal use</td>
</tr>
</tbody>
</table>
NASA Deliverables

• Airspace Operations Performance
  – Concept of operations
  – Information architecture
    o Data and information needs (e.g., constraints)
    o Data exchanges among operators
    o Data exchanges with ATM
    o Interfaces
  – Roles and responsibilities among UAS operator, UAS Support Suppliers, and Regulator
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

Third-party entities may provide support services but are not separately categorized or regulated.

Air Navigation Service Provider (ANSP)

➔ UAS Traffic Management (UTM)

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

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

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

**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)

*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)
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 –Highly successful

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
API based model worked well – enabled operator autonomy, exchanged information, and maintained safe operations
• Performance benchmarking: responsible, credible, collaborative (move towards self-certification)
• 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
Research Transition Team with FAA, DHS, NOAA, DOI, and DoD
• 200+ industry and academia collaborators and increasing
• Initial UTM Concept of Operations: Industry, academia, and government
• Technical Capability Level 1 with 12 partners completed
• Technical Capability Level 2 in October 2016
• National Campaign with FAA Test Sites successful completed on April 19 2016
• UTM Weather Workshop in July 2016
• Established several working groups to help develop the concept
• International interest