National Aeronautics and Space Administration

Unmanned Aircraft Systems Traffic Management (UTM)

SAFELY ENABLING UAS OPERATIONS IN LOW-ALTITUDE AIRSPACE

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on behalf of

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Outline

- Overview
- Approach and schedule
- TCL2 Demonstration overview and results
- Next Steps

Overview

Low Altitude UAS Operations

- Small UAS forecast – 7M total, 2.6M commercial by 2020
- Vehicles are automated and airspace integration is necessary
- New entrants desire access and flexibility for operations
- Current users want to ensure safety and continued access
- Regulators need a way to put structures as needed
- Operational concept being developed to address beyond visual line of sight UAS operations under 400 ft. AGL in uncontrolled airspace using UTM construct

What is UTM?

- UTM is an “air traffic management” ecosystem for uncontrolled airspace
- UTM utilizes industry’s ability to supply services under FAA’s regulatory authority where these services do not exist
- UTM development will ultimately identify services, roles/responsibilities, information architecture, data exchange protocols, software functions, infrastructure, and performance requirements for enabling the management of low-altitude uncontrolled UAS operations

UTM addresses critical gaps associated with lack of support for uncontrolled operations

How to enable multiple BVLOS operations in low-altitude airspace?

Key Operational Assumptions

- FAA maintains regulatory *AND* operational authority for airspace and traffic operations
- UTM is used by FAA to issue directives, constraints, and airspace configurations
- Air traffic controllers **are not required** to actively "control" every UAS in uncontrolled airspace or uncontrolled operations inside controlled airspace
- FAA has on-demand access to airspace users and can maintain situation awareness through UTM
- UTM roles/responsibilities: Regulator, UAS Operator, and UAS Service Supplier
- FAA Air Traffic can institute operational constraints for safety reasons anytime

Key principle is safely integrate UAS in uncontrolled airspace without burdening current ATM

UTM Approach and Schedule

UTM Progression

TCL1: ***multiple VLOS***

→ API-based networked ops

→ Info sharing

TCL2: ***multiple BVLOS, rural***

→ Initial BVLOS

→ Intent sharing

→ Geo-fenced ops

TCL3: ***multiple BVLOS, near airports, suburban***

→ Routine BVLOS

→ Airborne DAA, V2V

→ Avoid static obstacles

TCL4: ***complex urban BVLOS***

→ BVLOS to doorstep

→ Track and locate

→ Avoid dynamic obstacles

→ Large scale contingencies

UTM Technical Capability Levels (TCLs)

Capability 1: Demonstrated 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

Products: Overall ConOps, architecture, and roles

Capability 2: Demonstrated 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

Product: Requirements for multiple BVLOS operations including off-nominal dynamic changes

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

Product: Requirements for heterogeneous operations

Capability 4: Focuses on Enabling Multiple Heterogeneous High Density Urban Operations

- Beyond visual line of sight
- Urban environments, higher density
- Autonomous V2V, internet connected
- Large-scale contingencies mitigation
- Urban use cases

Product: Requirements to manage contingencies in high density, heterogeneous, and constrained operations

TCL2 Demonstration Overview and Results

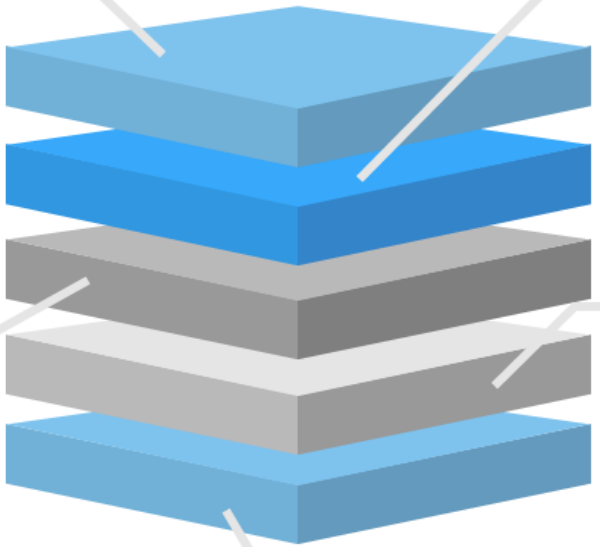
UTM TCL2: Scheduling and Executing Multiple BVLOS Operations

Conflict Alerts

Alert triggered by proximity to other aircraft

Intruder Alerts

Alert triggered from radar submitted warning regions to UTM research prototype



Contingency Alerts

Simulated in-flight emergency reported to the UTM research prototype and relayed to impacted operations

Flight Conformance Alerts

Alert triggered from departing from operational area and relayed to impacted operations

Priority Operations

Users with special privileges are given priority of the airspace and impacted operations are informed of any conflicts

Scheduling and tracking operations and contingency management

Key Findings using UTM to support Expanded Operations

1 **Information sharing provided situation awareness of airspace constraints**

UTM clearly raised situation awareness and shifted flight crew's perspective of safety from a self-centered view to an airspace view.

2 **Informative weather products are lacking**

The test used numerous weather sensing equipment and weather products for forecasting, however the differences in local conditions and when the aircraft was aloft were dramatic.

3 **User reported information enhanced safety**

When users had the ability to communicate conflicts, like RF interference or weather conditions, it improved the safety and confidence in conducting operations. This was especially true in aggressive weather conditions.

4 **Alerting is useful but alerting criteria is needed**

Operators benefited from raised situation awareness due to notifications and alerts, but the frequency and severity diluted the usefulness for some operators.

A common awareness of all airspace constraints and hazards is essential for safe BVLOS operations

Key Findings using UTM to support Expanded Operations

5 **Minimum set of GCS information is required**

Mixed operations require additional information to maintain situation awareness. A minimum set of required display information and common units are needed to ensure each operator has a common dialect to communicate hazards in the airspace.

6 **Differences in altitude reporting poses hazards**

A common altitude measure for information sharing and reporting, common units of measure, and an acceptable error tolerance for each measurement are needed.

7 **Reliable and redundant C2 links are essential**

Even in favorable radio line of sight conditions lost link conditions occur and when operating in close proximity of other operations interference when aloft is an issue.

8 **Vehicle performance should be rated by environment**

Several vehicles greatly underperformed from what was listed by the manufacturers due to the environmental conditions. More uniformity and transparency as to how UAS are tested and at what conditions, is needed.

Industry standardization can reduce risk for BVLOS Operations

Summary/Next Steps

Next Steps

- TCL3 preparations ongoing
- Working groups continue for concept use cases, data exchange, sense and avoid, and communication/navigation/surveillance
- Continue to work closely with FAA on UTM project through the UTM Research Transition Team

UTM POCs

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