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Low Altitude UAS Operations

FAA 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 safety structures in airspace

Operational concept being developed to address beyond-visual-line-of-sight (BVLOS) UAS operations at low altitude in uncontrolled airspace using UTM construct.
Challenges with Expanding Operations

Visual Line of Sight
14 CFR Part 107

Command and Control

BVLOS

Separation

Weather

Awareness

Aircraft Performance

Operations over People
What is UAS Traffic Management?

**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 to enable the management of low-altitude uncontrolled UAS operations.

**UTM addresses critical gaps associated with lack of support for UAS operations in uncontrolled airspace**
UTM Principles and Services

**Principles**
- Only authenticated UAS operations allowed
- UAS stay clear of each other
- UAS and manned aircraft stay clear of each other
- UAS operator has awareness of airspace and other constraints
- Public safety UAS have priority over other UAS

**Key UAS-related services**
- Authorization/Authentication
- Airspace configuration and static and dynamic geo-fence definitions
- Track and locate
- Communications and control (spectrum)
- Weather and wind prediction and sensing
- Conflict avoidance (e.g., airspace notification)
- Demand/capacity management
- Large-scale contingency management (e.g., GPS or cell outage)
Technical Capability Level (TCL) Progression

TCL1: multiple VLOS
- Networked Operations
- Info sharing

TCL2: multiple BVLOS, rural
- Initial BVLOS
- Intent sharing
- Separation by geo-fencing

TCL3: multiple BVLOS, near airports, suburban
- Routine BVLOS
- Detect and Avoid (DAA) / Vehicle to Vehicle (V2V)
- Avoid static obstacles

TCL4: complex urban BVLOS
- BVLOS to doorstep
- Track and locate
- Avoiding dynamic obstacles
- Large scale contingencies
TCL 2 UTM Functionality

- Scheduling and Planning
- Tracking
- Contingency Management

- Intruder Alerts
- Conflict Alerts
- Contingency Alerts
- Flight Conformance Alerts
- Priority Operations

UTM Mobile Application

Scheduling and Planning, Tracking, and Contingency Management
TCL 2 Flight Test Objective

Evaluate the feasibility of multiple BVLOS operations using a UTM research platform
Flight Test Overview

Operational Area

Reno-Stead Airport

UAS Range
- Elevation: 5050 feet
- Desert Terrain
- Missions up to 500 ft
- Operations at 5 Locations

SRHawk Radar

Weather Equipment

LSTAR Radar

Nevada UAS Test Range

October 2016
Flight Test Highlights

**Situation Awareness Displays**
Critical alerts, operational plan information and map displays

**Altitude Stratified Operations**

**Live-Virtual Constructive Environment**

**BVLOS** + **Visual Line of Sight** = **Simultaneous Operations**

- BVLOS: 2
- Visual Line of Sight: 3
- Simultaneous Operations: 5

**Flight Test Highlights**

- **Flights**: 74
- **UAS Vehicles**: 11
- **Partnerships**: 14
- **Days of Flight**: 5
- **Minutes per scenario**: 30
- **Scenarios**: 4
Scenario 2: Lost Hiker

1. Dynamic Re-Routing
2. VLOS Altitude Stratification
3. Priority Operation
4. Constraint Notifications
TCL 2 Flight Test Lessons Learned
Use of the UTM Research Platform

Areas for improvement:
- Spectrum Usage
- Contingency Management Actions
- User reported information (e.g. UREP)
- Integrated Airspace Display

Observations

Few flight crews had experience flying amongst other operations

Due to differences in the equipment and practices of other operators information sharing was critical for safety

Flight crew progressed from reluctance to acceptance to endorsement of shared airspace information

UTM provided situation awareness with respect to other operations that was generally accepted by operators
Inconsistent Altitude Reporting

Increased risk of controlled flight into terrain and airborne collision hazard

Altitude reporting should be consistent or translatable across airspace users
Weather Impact on UAS

Nominal Aircraft Endurance
- Multi-Rotors: 20-40 minutes
- Fixed-Wing: 45-200+ minutes
- Reno-Stead Elevation: 5,050 ft

Cool Temperatures
- Density Altitude: 4,000 ft
- Winds: 5-35 knots
- Aircraft encountered *thermals, microbursts* and *high winds* which resulted in *reduced endurance* and degraded flight plan conformance

Warm Temperatures
- Density Altitude: 9,000+ ft
- Winds: 5-15 knots
- Aircraft experienced substantially *shorter endurance*

UAS should be tested and rated against different operational environments
Basin and range topography yielded local micro-climates with observably different wind conditions

Local weather and national forecasts not indicative of observed conditions on site

Ground reports were not indicative of conditions UAS experienced aloft

Ground reports local to GCS location was not indicative of conditions UAS experience while BVLOS

Improvements in weather products are needed to support BVLOS
Conformance to Operational Plan

35 flights conducted for data collection

46% of data collection flights experienced at least 1 instance of a flight geography violation

Common Factors leading to violation:

- Vehicle Performance
- Erroneous Waypoint / Altitude
- Erroneous Flight Geography
- Changing Launch Direction
- Pilot Error in Manual Flight Mode
- Un-reported Contingency Management Actions

Operational plans were not always consistent between UTM, GCS and UAS
Operators should **display airspace information** and have access to other operator’s operational intent and contingency actions in off-nominal conditions.

Altitude reporting should be **standardized** and consistent/translatable to current airspace users.

In the absence of acceptable weather products, **atmospheric conditions** should be **self-reported from GCS and UAS**.

Initial BVLOS should **avoid altitude stratification**, until improved position sharing (e.g. V2V) and weather products.

**Flight trajectories** should be **contained within geo-fence boundaries** that are shared with the UTM research platform to **support separation**.
**Summary**

**TCL 2 Demonstration** successfully showed the feasibility of supporting multiple BVLOS operations in a rural environment.

**Areas of Improvement** successfully include weather products, industry standards, and engagement from UAS manufacturers in integrating UTM functionality to support BVLOS operations.

**Future work: (TCL 3 Demonstration)** will evaluate the effectiveness and interoperability of technologies to support separation, communication, navigation, data-exchange, and airspace management in a complex (suburban and near airports) operational environment.
Questions?