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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

BVLOS
Separation
Weather

Command and Control
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**
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
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

Nevada UAS Test Range

SRHawk Radar
Weather Equipment
LSTAR Radar

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

Flights: 74
UAS Vehicles: 11
Partnerships: 14

Scenarios: 4
Minutes per scenario: 30
Days of Flight: 5
Scenario 2: Lost Hiker

1. Dynamic Re-Routing
2. VLOS Altitude Stratification
3. Priority Operation
4. Constraint Notifications
TCL 2 Flight Test Lessons Learned
Areas for improvement:

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

Use of the UTM Research Platform

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**
Locality Impact on Operations

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
Operators should **display airspace information** and have access to other operator’s operational intent and contingency actions in off-nominal conditions.

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

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

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

4. **Flight trajectories** should be **contained within geo-fence boundaries** that are shared with the UTM research platform to support separation.
Next Steps
TCL 2 National Campaign

May 15th – June 9th 2017

- ~40 partners total across 6 testing locations
- 6 USS Implementers (Amazon Prime Air, Google Project Wing, Airmap, Simulyze, ANRA, NASA)
- NASA USS and FIMS run in the cloud
- Data feeds monitored in UTM lab and at each location
- Multiple Media days

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<th>Test Sites</th>
<th>USS Technology</th>
<th>Geofence Technology</th>
<th>Ground-based Sense &amp; Avoid</th>
<th>Airborne Sense &amp; Avoid</th>
<th>Communication, Navigation, Surveillance</th>
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TCL 3: Multiple BVLOS operations near airports and suburban areas
Parcel Delivery

Real Estate Photography

Operations near airports

Operations over populated areas

Weather Services

Infrastructure Inspection

Cell Tower Inspection

Remote Identification

Traffic Monitoring

Airspace / Ground Constraints

Contingency Management

Real Estate Photography
Augmented Navigation

Vehicle-to-Vehicle Communication

Direct C2

DSRC

FIMS

USS 1

Inter-USS Communication

USS 2

Detect and Avoid

Airborne Radar

Obstacle Avoidance

Ground Radar

Distributed C2

4G LTE

USS 1

USS 2

Inter-USS Communication

FIMS
TCL 2 Demonstration successfully showed the feasibility of supporting multiple BVLOS operations in a rural environment and highlighted areas of future research.

TCL 2 National Campaign successfully demonstrated the UTM architecture, collected data to support the NASA-FAA UTM Research Transition Team, and engaged industry to contribute to the development of UTM.

TCL 3 Demonstration will evaluate the effectiveness and interoperability of technologies to support separation, communication, navigation, data-exchange, and airspace management in a complex operational environment.
Questions?