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NASA Ames Research Center June 2017
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**
National Airspace System - ATM

Supplemental Data Service Provider(s)

Flight Information Management System (FIMS)

UAS Service Supplier(s) (USS)

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

Operational Area

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

SRHawk Radar

Weather Equipment

LSTAR Radar

Reno-Stead Airport

Nevada UAS Test Range

October 2016
Flight Test Highlights

- **Situación 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
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.
Recommendations for BVLOS Operations

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

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

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

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

5. 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>
<th>Human Factors</th>
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TCL 3: Multiple BVLOS operations near airports and suburban areas
Parcel Delivery

Real Estate Photography

Operations near airports

Weather Services

Infrastructure Inspection

Operations over populated areas

Cell Tower Inspection

Traffic Monitoring

Contingency Management

Remote Identification

Airspace / Ground Constraints

Real Estate Photography
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?