
Dr. Marcus Johnson
Dr. Jaewoo Jung, Dr. Joseph Rios, Joey Mercer, Jeffrey Homola, Dr. Thomas Prevot, Daniel Mulfinger, and Dr. Parimal-Kopardekar

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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**
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)
National Airspace System - ATM

Supplemental Data Service Provider(s)

UAS Service Supplier(s) (USS)

Flight Information Management System (FIMS)

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

UTM Mobile Application

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

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**

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**BVLOS**
2

**Visual Line of Sight**
3

**Simultaneous Operations**
5

**Flights**
74

**UAS Vehicles**
11

**Partnerships**
14

**Days of Flight**
5

**Scenarios**
4

**Minutes per scenario**
30
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

UAS should be tested and rated against different operational environments

**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**
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
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.

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.
**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?