
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
- Command and Control
- Aircraft Performance
- BVLOS
- Separation
- Weather
- Awareness
- 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)
Flight Information Management System (FIMS)

UAS Service Supplier(s) (USS)

Supplemental Data Service Provider(s)

Airspace Displays

National Airspace System - ATM
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

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
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
2

Visual Line of Sight
3

Simultaneous Operations
5

Flights
74

UAS Vehicles
11

Partnerships
14

Scenarios
4

Days of Flight
5

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

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.
**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?