Unmanned Aircraft Systems Traffic Management (UTM)
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 101(e) [Hobbyists]
14 CFR Part 107 [Commercial]

No Operations over People
Daylight Only
Up to 400 ft AGL
Operation in controlled airspace allowed

Beyond Visual Line of Sight
Operations Near Airports
Command and Control
Aircraft Performance
Tracking and UAS Identification

Separation
Weather
Awareness
Operations over People
What is UAS Traffic Management?

- UTM is an “air traffic management” ecosystem for uncontrolled operations
- UTM utilizes industry’s ability to supply services under FAA’s regulatory authority where these services do not exist
- UTM development will ultimately enable the management of large scale, low-altitude UAS operations
  - Operational concept will address beyond visual line of sight UAS operations under 400 ft. AGL
  - Information architecture, data exchange protocols, software functions
  - Roles/responsibilities of FAA and operators
  - Performance requirements

UTM addresses critical gaps associated with lack of support for small UAS
Key Operational Assumptions

- FAA maintains regulatory AND operational authority for airspace and traffic operations
- UTM is used by FAA to issue directives, constraints, and airspace configurations
- Air traffic controllers are not required to actively “control” every UAS in uncontrolled airspace or uncontrolled operations inside controlled airspace
- FAA has on-demand access to airspace users and can maintain situation awareness through UTM
- UTM roles/responsibilities: Regulator, UAS Operator, and UAS Service Supplier (USS)
- FAA Air Traffic can institute operational constraints for safety reasons anytime

Key principle is safely integrate UAS in uncontrolled airspace without burdening current ATM
Flight Information Management System
- Enables airspace controls
- Facilitates requests
- Supports response in emergencies impacting NAS

UAS Service Supplier
- Federated Structure
- Cloud-based system
- Automated System
- Supports UAS with services (e.g. separation, weather, flight planning, contingency management, etc.)

Supplemental Data Service Provider
- Supplies supplemental data to USS and UAS Operator to support operations

UAS / UAS Operator
- Individual Operator
- Fleet Management
- On-board capabilities to support safe operations
• Very close collaboration with FAA through Research Transition Teams (RTT) working groups. The working groups have over 40 partner organizations

• Over 250 UTM partners in industry, government and academia with RFI responses or space act agreements

• Close to 100 Space Act Agreements

• Funded six FAA UAS test sites for TCL-2,3 National Campaigns

• Each site collaborates with NASA partners
UTM Outcomes

Research Activities
- Research Transition Team Working Groups
  - Concepts and Use Cases
  - Data and Information Exchange
  - Sense and Avoid
  - Communications and Navigation
- Concept and Software Development
  - Flight Information Management System
  - UAS Service Supplier
  - Supplemental Data Service Providers
  - Public Portal
- Field Testing and Technology Evaluation
  - TCL Field Demonstrations
  - Targeted Technology Evaluations
- Simulation and Risk Analysis
  - Real-time and Fast-time Studies
  - Hazard Analysis.

Products
- Software Prototypes
  - FIMS Prototype
  - NASA UAS Service Supplier (USS)
  - USS Discovery Service
  - UAS Operator Client
  - Authentication/Authorization Service
- ICDs and APIs
  - USS-FIMS Specification
  - USS-USS Specification
  - Weather and Surveillance SDSP ICD
  - V2V Communication Specification
- Concept Documents
  - UTM CONOPS and Use Cases
  - USS Onboarding Process
  - Communication and Navigation Model
  - UTM Conflict Mitigation Model
  - Hazard Identification and Analysis
- Reference Technology Implementations
  - UAS Detect and Avoid System
  - Urban Operations UAS System

Outcomes
- Fielded Systems
  - FAA to use UTM in their Pilot Program (UPP) demonstration in FY2019
  - DoT/FAA expected to use UTM system for the Integrated Pilot Program (IPP)
- UAS Rule Making
  - Beyond Part 107 (BVLOS)
  - FIMS/USS Roles and Responsibilities
- Industry Guidance
  - Safety Case Development
  - Data Exchange and Protocols
  - Industry Standards
- International Harmonization
  - UTM Construct and Architecture (e.g. ICAO)
  - Use Cases
Goal:
Safely enabling large scale visual and beyond visual line of sight operations in the low altitude airspace

Risk-based approach along four distinct Technical Capability Levels (TCL)
UTM Technical Capability Level Progression

TCL 1
- Remote Population
- Low Traffic Density
- Rural Applications
  - Multiple VLOS Operations
  - Notification-based Operations

TCL 2
- Sparse Population
- Moderate-Low Traffic Density
- Rural / Industrial Applications
  - Multiple BVLOS Operations
  - Tracking and Operational Procedures

TCL 3
- Moderate Population
- Moderate Traffic Density
- Suburban Applications
  - Mixed Operations
  - Vehicle to Vehicle Communication
  - Public Safety Operations

TCL 4
- Dense Population
- High Traffic Density
- Urban Applications
  - Dense BVLOS Operations
  - Large Scale Contingency Management
Technical Capability Level 1 Flight Test

Evaluate the feasibility of multiple VLOS operations using scheduling and planning through an API connection to the UTM research platform
TCL 1
August 2015

UAS Range
Elevation: 166 feet MSL
Flat Agricultural Farmland
Operations at 2 Locations

Acoustic Sensors
Weather Sensors
100 ft Weather Tower
Radiosonde Weather Balloon
Remote Automated Weather Station

Crows Landing, CA

SRHawk Radar
Used to detect small UAS
UTM TCL 1 Demonstration Highlights

- **Partner Organizations**: 11
- **Simultaneous VLOS Operations**: 2
- **UAS Platforms**: 10

- **Days of Flight**: 8
- **Test Conditions**: 4
- **Flights**: 108
- **Flight Hours**: 18
Technical Capability Level 2 Flight Test

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
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
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

Flights: 2 + 3 = 5

UAS Vehicles: 11

Partnerships: 14

Days of Flight: 5

Scenarios: 4

Minutes per scenario: 30
TCL 2 National Campaign

May 15th – June 9th 2017

- ~40 partners total across 6 testing locations
- 6 USS Implementers
- 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>
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Technical Capability Level 3 Flight Test

Evaluate the feasibility of multiple BVLOS operations near airports and in suburban environments using a UTM research platform
Mar-May 2018
Technical Capability Level 3 Test Objectives
Technical Capability Level 4 Flight Test

Evaluate the feasibility of multiple BVLOS operations in urban environments and large scale contingency mitigations using a UTM research platform
Mid-2019
UAS Traffic Management is an automated cloud-based “air traffic management” ecosystem for uncontrolled airspace where services do not exist.

TCL 2 Demonstration and TCL 2 National Campaign successfully showed the feasibility of supporting multiple BVLOS operations in a rural environment, engaged industry to contribute to the development of UTM and highlighted areas of future research.

Next Steps will evaluate the effectiveness and interoperability of technologies to support separation, communication, navigation, data-exchange, and airspace management in more complex operational environments (suburban and urban).
These Use Cases have operational and technical challenges that would be important to test:

- Operations in Mountainous Areas
- Operations in Maritime Environment
UAS Operations in Designated Mountainous Areas

**Operations Challenges**
- Disruption due to information latency and drop-outs
- Contingency management procedures given intermittent communications
- Failover of safety-critical and non-safety critical services
- Localized and Area-wide weather impacts (e.g. density altitude, thermals, icing, canyon wind effects)
- Limited UAS Operator situation awareness

**Technology Challenges**
- Intermittent and degraded communications (e.g. beyond radio line of sight)
- Degraded navigation (e.g. multi-pathing, GPS-denied environment)
- Intermittent surveillance and tracking (e.g. impeded line of sight)
- Flight planning and separation mitigations (e.g. terrain avoidance, altitude consistency, etc.)
UAS Operations in Maritime Environments

Operations Challenges

→ Disruption due to information latency and drop-outs
→ Contingency management procedures given intermittent communications
→ Failover of safety-critical and non-safety critical services
→ Localized and Area-wide weather impacts (e.g.)
→ Limited UAS Operator situation awareness

Technology Challenges

→ Degraded navigation (e.g. localization, mobile ground control station)
→ Surveillance limitations (e.g. coastal radar limits, incomplete/inconsistent coverage)
→ Command and control limitations (e.g. SATCOM)
→ Flight planning and separation mitigations (e.g. battery management, detect and avoid, V2V communication, etc.)