Unmanned Aircraft Systems (UAS) Traffic Management (UTM) Project

Project Overview and History

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Vision
Define and safely enable future airspace operations (2025+) of small Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS)

Goals
- Allow diverse small UAS mix and airspace uses (e.g., package delivery, inspections, public safety and security)
- Safely enable scalability to accommodate future demand
- Accommodate a variety of business models (e.g., hub-and-spoke, point-to-point)
- Establish highly efficient, predictable, agile, safe, and affordable airspace operations system
- Maintain global competitiveness and domestic viability by innovation in technology and business models to manage airspace operations

Objectives
- Develop and validate airspace operations and integration requirements to enable safe, large-scale UAS operations
- Provide prototype (software) UTM system for further FAA testing and development
What is UTM?

- 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 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, Class G airspace.
  - Roles/responsibilities of FAA and operators.
  - Information architecture, data exchange protocols, software functions.
  - System performance requirements.
<table>
<thead>
<tr>
<th>Strategic Thrust</th>
<th>Critical Commitment</th>
<th>Related Technical Challenge, same as TC</th>
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<tr>
<td>6. Assured Autonomy for Aviation</td>
<td>6.1 Demonstrate the feasibility of highly automated, low altitude UAS traffic management and deliver validated requirements to FAA and industry</td>
<td>AOSP12 – UAS Traffic Management</td>
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<td>Transformation</td>
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UTM Activity Areas

• **System Development & Demonstrations**
  – Develop UTM system to meet the operational concept and requirements of a service-based architecture
  – Test UTM functionality in field with many newcomers to small UAS (sUAS) operations
  – Accelerate industry development

• **Focused Flight Tests**
  – Performance characterization of specific challenge areas

• **Simulations & Analyses**
  – Evaluate the scalability and robustness of the concept
एकान्तवादि-सप्तांधपुरुषा:
UTM Core Operating Principles

- Green check marks indicate allowed activities.
- Red prohibition signs indicate activities that are not allowed.

Activities shown include:
- Drones
- Helicopters
- Aircraft

Allowed activities:
- Drones flying horizontally
- Aircraft flying horizontally
- Aircraft displaying a name tag
- Drones carrying bananas

Prohibited activities:
- Drones colliding with each other
- Helicopters colliding with drones
- Aircraft colliding with drones
- Drones carrying apples and bananas
- Drones flying vertically
UTM Baseline Architecture and Information Flow Management Adopted and Adapted for Future NASA R&D

**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

**FAA Development & Deployment**
- FAA Development & Deployment
- Industry Development & Deployment

**Supplemental Data Service Provider**
- Inter-USS communication and coordination
- Terrain Weather Surveillance Performance
- Inter-data provider communication and coordination
- Constraints, Directives
- Requests, Decisions
- Operations, Deviations

**UAS Service Supplier**
- Operations
- Constraints
- Modifications
- Notifications
- Information

**Public Safety**
- Public Safety
- FAA Function
- Other Stakeholders

**FAA/Industry Shared Responsibilities**
- Discovery
- Registration Data/Services
- Authentication/Authorization

**NAS Data Source**
- National Airspace System
- NAS state
- NAS impacts

**Flight Information Management System**
- NAS
- UAS
- V2V Comm.
- FAA/Industry Shared Authorization

**Other Stakeholders**
- FAA Development & Deployment
- Industry Development & Deployment
- FAA/Industry Shared Authorization

**Supplemental Data Service Provider**
- FAA Function
- Operator Function
- Other Stakeholders

**NAS Impacts**
- NAS Impacts
- FAA Function
- Other Stakeholders

**Color Key:**
- FAA Function
- Operator Function
- Other Stakeholders

**UAS Service Supplier**
- UAS Comm.
- FAA Function
- FAA Development & Deployment

**FAA/Industry Shared Authorization**
- FAA/Industry Shared Authorization
- FAA Function
- FAA Development & Deployment

**UAS / UAS Operator**
- UAS Comm.
- FAA Function
- FAA Development & Deployment

**Public**
- Public
- FAA Function
- Other Stakeholders

**UAS Service Supplier**
- FAA Function
- FAA Development & Deployment

**Flight Information Management System**
- FAA Function
- FAA Development & Deployment

**Supplemental Data Service Provider**
- FAA Function
- FAA Development & Deployment

**UAS / UAS Operator**
- UAS Comm.
- FAA Function
- FAA Development & Deployment
### Risk-based development and test approach

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<td>Low Traffic Density</td>
<td>Low-Mod Traffic Density</td>
<td>Moderate Traffic Density</td>
<td>High Traffic Density</td>
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<td>Rural Applications</td>
<td>Rural / Industrial Applications</td>
<td>Suburban Applications</td>
<td>Urban Applications</td>
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<td>Multiple VLOS Operations</td>
<td>Multiple BVLOS Operations</td>
<td>Mixed Operations</td>
<td>Dense BVLOS Operations</td>
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<td>Notification-based Operations</td>
<td>Tracking and Operational Procedures</td>
<td>Vehicle to Vehicle Communication</td>
<td>Large Scale Contingency Management</td>
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<td>Public Safety Operations</td>
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Initial UTM Integration with First multi-operation National Campaign RTT Plan signed by TCL 3 Demo Workshop with commercial demo #1 at 6 FAA Test FAA+NASA across 6 FAA Test industry partners Sites Sites

Feb 2014
Nov 2014
Jul 2015
May 2016
Jan 2017
May 2018

FY 2013
Internal seedling Initial prototyping First live flights TCL 1 Demo TCL 2 Demo, NV National Campaign #2 to investigate at 6 FAA Test Sites

May 2014
Aug 2015
Oct 2016
May 2017
Summer 2019

TCL 4 Demo NV+TX

Project Timeline
UTM Partnership

Partnership Strategy
Lead, Leverage & Collaborate
Acceptance of TCLs and UTM

- FAA and Community acceptance of NASA-UTM is demonstrated by:
  - FAA UTM Pilot Program use of NASA-UTM federated architecture and commercial service providers partnered with NASA
  - FAA Low Altitude Authorization and Notification Capability (LAANC) operational system utilizes NASA-UTM construct
  - FAA UTM ConOps, rulemaking, and national implementation plan informed by NASA-UTM
  - Growing market of UAS Service Suppliers (UTM graduates): AirMap, AiRXOS, Amazon, etc.
  - Domestic and international standards groups adopting NASA-UTM and adding further definition
  - DHS/DoD adopting NASA-UTM construct and adapting for their missions

“The FAA is already deploying a preliminary version of UTM … it’s the wave of the future and we are using UTM to lead that way.”
- Steve Bradford, Chief Scientist for Architecture, NextGen, FAA
How the Project met the Critical Commitment

Demonstrate the feasibility of highly automated, low altitude UAS traffic management and deliver validated requirements to the FAA and industry

• How we demonstrated the feasibility of highly automated, low altitude UAS traffic management
  – Workshops and working groups develop use cases and scenarios
  – Collaboratively develop data interfaces and protocols to support use cases
  – Demonstrate use cases via collaborative simulations and flight tests
  – Incorporate industry leaders in flight tests to nurture their development and show state of art

• How we delivered validated requirements to the FAA and industry
  – Technical Memos and internal documentation provided in Tech Transfers to FAA and publicly (examples)
    • USS Specification (NASA/TM-2019-220376)
    • Strategic Deconfliction: System Requirements
    • UAS Service Supplier Checkout (NASA/TM–2019–220456)
    • Automated Management of sUAS Comm and Nav Contingency (AIAA 2020)
  – Field-tested Application Programming Interfaces published via GitHub
  – Supporting analysis of test results via TM and conferences
UTM Influence

- FAA UTM RTT
- FIMS Prototype
- USS Checkout Process
- TCL 1-4 CONOPS and Use Cases
- International
- UTM Annex for JARUS SORA
- UTM Architecture for ICAO
- C&N Requirements for GUTMA/3GPP

- ASTM WK69690 Ground Surveillance
  UTM Surveillance API
  TCL DAA Results
  Conflict Management Model

- ASTM WK63418 UTM Services
  USS Specification
  Authorization & Authentication

- CTIA UAS Working Group
  TCL C&N Results
  UTM C&N Model and Requirements

- Unmanned Aircraft Safety Team
  Off-Nominal Reporting
  UTM Hazards Analysis

- DOD / DHS
  Federal USS Prototype

- ASTM WK6540 UAS Remote ID
  TCL Remote ID Results
  Discovery Specification

- IEEE P1920.2 V2V for UAS
  TCL V2V Results
  Conflict Management Model

- ASTM WK62669 Detect & Avoid
  TCL DAA Results
  Conflict Management Model
International Impact of UTM

UTM has directly influenced the regulation and policy, concepts and architectures, and standards across the world for implementing UAS traffic management

**FAA** - “UTM Conops v2.0”
**EASA** – ”High Level regulatory framework for the U-space”

**ICAO** - “UTM - A Common Framework with Core Principles”
**JARUS** – “SORA v2.0 Annex H- UTM Services”

**GUTMA** - “Map of Global UTM Implementations”

**ASTM** - “New Specification for Service provided under UAS Traffic Management”
**ISO** – ” Requirements for UTM services and service providers”
UTM Project Ends but UTM Construct Continues

Adapt the UTM construct and apply lessons learned to mature the concept of operations for managing Urban Air Mobility (UAM) traffic and enabling cooperative operations in Upper Class E airspace

Expand the UTM architecture for testing in National Campaign and performing High-Density UAM operations in R&D

Extend the UTM code base for managing government agency operations with an emphasis on security

FAA uses FIMS part of code base

The UTM concept has been very successful in evolving to new applications and spring boarding projects
In 2015, the small UAS industry was just beginning to accelerate with no clear concept of how this new traffic would be safely managed.

Through partnerships with FAA, industry, and academia, a concept was created and UTM was developed to meet stakeholder’s needs.

A prototype UTM system of federated services was tested through a series of increasingly complex events in realistic environments to prove the concept.

Industry has created business models around providing UTM services and is taking leadership in standards development.

The FAA is embarking on the UTM implementation program that will unleash, in a disciplined way, a multi-billion-dollar industry.

Now in 2020, the UTM concept is the springboard for managing UAS in all airspace domains and will influence the future NAS transformation.