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

System Architecture and Data Transfers

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Outline

- UTM RTT Data Exchange & Information Architecture Subgroup
- Federated Airspace Management
- System Architecture
- Data and Protocols
- Publication of Research Findings
- Future Evolution
- Summary and Impact
Federated enterprise architecture is a collective set of architectures with the following attributes:

- It operates collaboratively, where governance is divided between a central authority and constituent units, balancing organizational autonomy with enterprise needs.

- The central authority's architecture can focus on the dynamics of economies of scale, standards, and the well-being of the enterprise.

- Constituent units' architectures have the flexibility to pursue autonomous strategies and independent processes.

MITRE Systems Engineering Guide, Architectures Federation
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UTM Architecture

NAS Data Sources

National Airspace System

Flight Information Management System

Supplemental Data Service Provider

UAS Service Supplier

Public Safety

Public

UAS Operator

UAS Operator

UAS Operator

Terrain Weather Surveillance Performance

Inter-data provider communication and coordination

ANSP Function

Operator Function

Other Stakeholders

Start: (red) National Airspace System

Tab for next or to NAS Data Sources for sub

Option 1: (green) tab back to National Airspace System

Option 2: (red) Discovery Registration Data/Services Authentication/Authorization - FAA Development and Deployment - Development and Deployment Industry (tab to next)

Option 1.2: (red) tab to Flight Information and back

Option 2.2: (green) tab back to Flight Information

Option 3.2: (green) Tab to Public Safety or UAS Service back

Option 4.2: (green) tab to next.

Option 5.2: (green) tab to UAS Service

Option 6.2: (green) Terrain Weather Surveillance Performance

Option 7.2: (green) tab to next

Color Key:

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NASA Specification published
ASTM Specification forthcoming

USSs share data for operations that are under their management. Data include intent, updates, requests, position reports, alerts, and other operational messages.

Conceptually designed to be highly automated. In early stages, humans are in the loop for more complex tasks.
Exercised in TCLs and UPPs

NASA tech transfer of initial FIMS code to FAA. FAA further developed to integrate with other systems and further concept development

R+D here may help us to understand future requirements for other non-traditional/new entrant operations beyond small UAS
USS Discovery process highlighted by NASA as key architectural concern. Posed initial solution in TCL2 timeframe. Industry developed improved solution tested in TCL3 and 4. Input from NASA testing and industry collaboration moved discovery to an open source project driven by ASTM and industry (DSS).

Authentication and authorization paper published by NASA with close FAA discussion. Paper summarizes authorization architecture through TCL4 and somewhat beyond. As part of UPP2, industry engaged to further develop security questions and overall requirements/design.
Many SDSP types have been tested: surveillance, weather, vehicle health, static and dynamic risk assessment, conflict avoidance, communication coverage, and others.

Significant opportunity for industry innovation in this aspect of UTM.

Certain SDSPs may require regulatory scrutiny and ANSP support depending on safety criticality, adoption rate, or other concerns.

NASA's major contribution is the architectural context and the demonstration of proof-of-concept services.
Every TCL has touched on public safety, and the UPP activities continue to develop it.

Engagement with government agencies from the local through the national level is vital to maturing this part of the architecture.
1. Operator plans mission
2. Operator submits plan to its supporting USS
3. USS checks plan against other entities in airspace
4. USS writes appropriate op data to DSS, discovering other USSs
5. USS notifies operator of plan submission success
6. USS sends appropriate op data to other USSs as required
7. FIMS used throughout USS-USS and USS-DSS comms for auth services
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Upon commencing operation, the operator would share state data with its USS. Certain changes in the airspace or other operations are pushed to the operator from its supporting USS. Off-nominal conditions are pushed to the USS Network. DSS facilitates USS communications and synchronizing data.

All of these interactions can be summarized into groups of required and optional services of a USS. Defining those services is an effort that has been handed off to the FAA and industry for UTM.
Search GitHub for “utm-apis” to see the NASA APIs for UTM TCL activities

Search GitHub for “astm-utm” to see current ASTM drafts

See the following NASA Technical Memos for the first USS Specification and UTM Authentication and Authorization approach as well as the NASA briefing on strategic deconfliction. These docs are major input and starting points for much of the FAA and standardization work currently on-going:

**UAS Service Supplier Specification**

**UAS Service Supplier Framework for Authentication and Authorization**

**NASA UTM Strategic Deconfliction Final Report**
NASA Ames Research Center, July 31, 2018.
UTM-A Complementary Set of Services to ATM
Raju, Praveen, Federal Aviation Administration; Joseph Rios, NASA Ames Research Center; Addam Jordan, LS Technologies. ICNS 2018, April 10-12, 2018, Herndon, VA.
• Provides an FAA perspective on the UTM service architecture.

UAS Service Network Performance: Results and Analysis from Flight Testing Multiple USS Providers in NASA's TCL4 Demonstration

Strategic Deconfliction Performance: Results and Analysis from the NASA UTM Technical Capability Level 4 Demonstration
• Two papers describing measures of performance for the USS Network within TCL4, helping to inform future USS requirements

UTM UAS Service Supplier Development - Sprint 2 Toward Technical Capability Level 4

UTM UAS Service Supplier Development - Sprint 1 Toward Technical Capability Level 4
• Two papers describing the build-up to TCL4 and outlining a process that may be applicable to future operationalization of USSs.
Future Evolution

The work in NASA UTM laid out initial research questions and a framework for evaluating the architecture. With that work transitioned to industry and the FAA, there is a great deal of effort on standardizing components and protocols that meet both civilian and government/public safety needs.

xTM: eXtensible Traffic Management

- NASA UTM uncovered a previously undiscovered approach to managing airspace in a collaborative manner amongst stakeholders, complementing the conventional Air Traffic Services provided by the FAA. This approach is being generalized by NASA and the FAA to extract the common features that are applicable to several current and future aviation domains.

Advanced Air Mobility and Urban Air Mobility

- The principles of collaborative airspace management and increased automation are critical enabling future mobility concepts.

High-Altitude Traffic Management

- Operations over 60,000ft typically do not receive air navigation services and they can span international boundaries. Also, vehicle performance operating in these altitudes varies greatly, from balloons to hypersonic aircraft. Allowing operators more agency in the management of the airspace with their fellow operators can expand operational opportunities in that environment.

- Concepts related to the provisioning of services and increasing automation may be applicable to the conventional operators in the National Airspace System potentially allowing for safer, lower-cost operations.
The NASA UTM Project along with its partners in the FAA an industry defined a novel, feasible, federated, stakeholder-driven approach to managing the airspace.

The concept of federated airspace management allows for operators to take a key role in the management of the airspace in which they fly.

In a short time, NASA research has spawned numerous international standardization efforts, a new industry for service suppliers, and a path for safe, efficient, scalable, and fair management of the airspace.

The architecture is recognized as a key enabler to other new aviation entrants like air taxis and high-altitude operations.