UTM – A COMPLEMENTARY SET OF SERVICES TO ATM

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Abstract

Small Unmanned Aircraft Systems (sUAS) operators are continuously exercising new, beneficial applications for sUAS operations, such as goods delivery, infrastructure inspection, search and rescue, and agricultural monitoring. Currently, no established infrastructure manages the widespread expansion of sUAS operations in the National Airspace. A safe and efficient UAS Traffic Management (UTM) system is needed to help ensure this newest entrant into the skies does not compromise safety.

This paper provides an overview of UTM's current state and initial capabilities, operational environment, key objectives in support of the FAA's overall architecture; an overview of proposed data exchanges and the associated data model, and lists UTM has planned activities in Calendar Year (CY) 2018.

Overview: UTM Complements ATM Services

As UAS traffic demand increases in the NAS, it is necessary for the FAA along with NASA and industry partners to develop a means to accommodate these operations in a safe and efficient manner. While many UAS applications operate within Visual Line of Sight (VLOS), a growing number of commercial UAS operators and applications would benefit from missions in which BVLOS operations occur. In order to safely accommodate all manned, VLOS, and BVLOS UAS operations in low-altitude airspace, a systematic approach is needed to accommodate diversity and future demand.

The FAA, in collaboration with NASA and other industry partners, is developing UTM to integrate with existing ATM operations. The FAA has built a framework (Low Altitude Authorization and Notification Capability, LAANC) to allow a limited amount of UAS traffic to operate while meeting current regulations [1]. Concurrent with this effort, NASA has leveraged partnerships with industry to build a prototype system (Flight Information Management System, FIMS) designed to facilitate situational awareness among UAS operators and the FAA.

UTM, like Air Traffic Management (ATM), is the all-encompassing framework for managing sUAS at (currently) 400 feet and below. It encompasses everything from the regulations concerning sUAS operations, including operation rules, registrations, waivers, and performance-based requirements. In addition, UTM is predicated on a community traffic management system, which is managed through private/public partnerships including information sharing from operator to operator, vehicle to vehicle, and ultimately between operator and FAA supported by a UAS Service Supplier (USS), as needed. UTM is more than an infrastructure architecture; it includes multiple applications and complex information interconnected to achieve safe and efficient UAS operations. Figure 1 shows the UTM ecosystem.

In 2005, ICAO published the Global Air Traffic Management Concept Doc 9854-AN/458 [2], which presents the ICAO vision of an integrated, harmonized, and globally interoperable ATM system. The planning horizon is up to and beyond 2025. The following components that are defined as ATM's provision to integrated services are suggested to be aligned to UTM:

- Airspace Organization and Management,
- Demand and Capacity Balancing,
- Airspace User Operations,
- Strategic Conflict Management, and
- Information Services.

Specifically, in ATM's Airspace Management process, the document defines the principles and strategies for airspace reservations; they should be planned in advance with changes made dynamically whenever possible. The system will also accommodate unplanned requirements.

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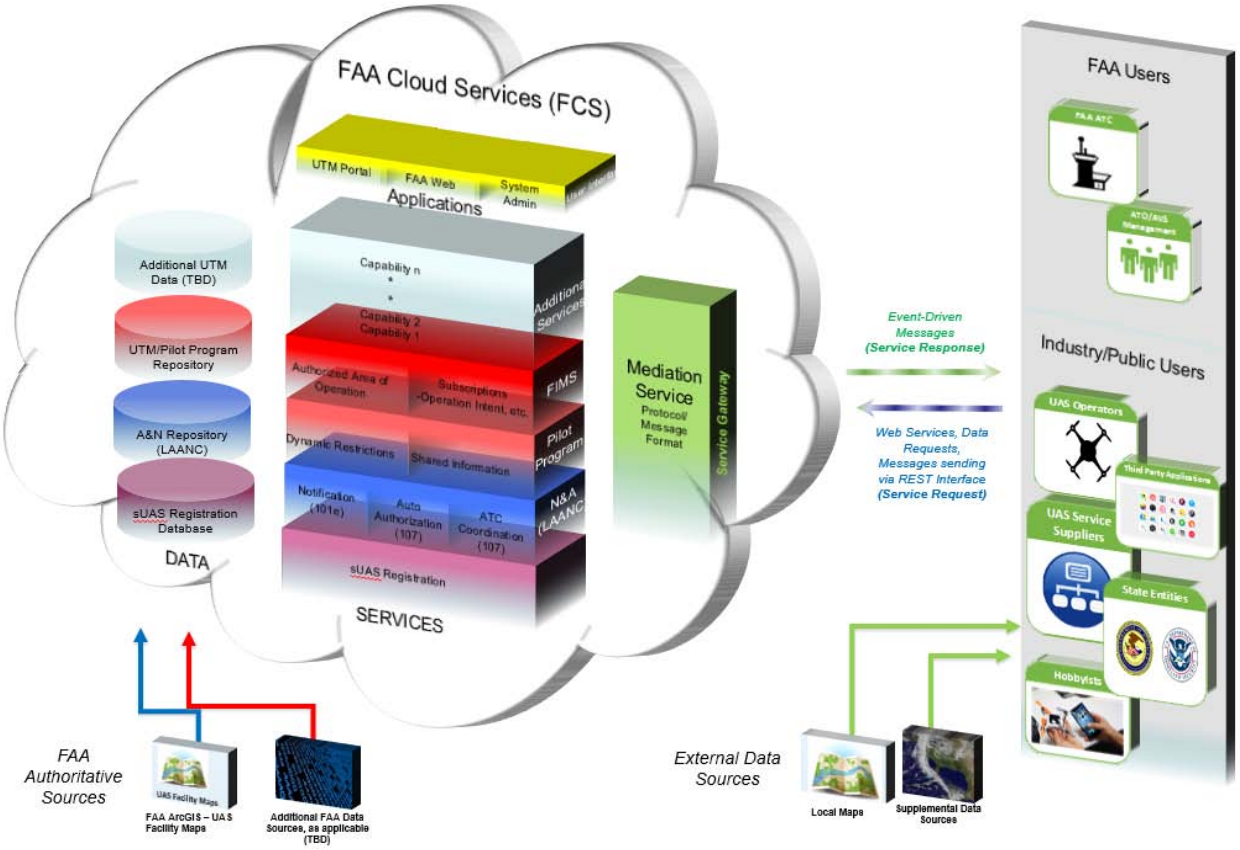

Figure 1. UTM Ecosystem

As part of the UTM ecosystem, NASA has developed the Flight Information Management System (FIMS). FIMS capability is a central component of the overall UTM ecosystem, providing common situational awareness to all UTM stakeholders. The definitions within FIMS describe the submission of operation plans, messages, and position reports to FIMS from a USS. It also defines various subscription endpoints wherein a USS will receive asynchronous updates to the UTM airspace and UTM operation data. This connection functions as a critical mediation service connected to UAS partners and is expected to be facilitated through the FAA's cloud infrastructure and the service gateway to support Beyond Visual Line of Sight (BVLOS) and other operations that extend beyond the current governing Part 107 regulations. This function enables UAS Operators to request access to airspace, inform ATC of unintended deviations in UAS operations that may pose a hazard to controlled airspace, and inform UAS Operators of any flight restrictions imposed by ATC. NASA transitioned the initial FIMS prototype to FAA for further testing and evaluation.

While UTM maturation continues, development and implementation is underway to automate the FAA's sUAS component – Low Altitude Authorization and Notification Capability (LAANC), which will serve as the initial implementation of UTM capabilities. Currently in the beta testing stage, FAA is leading LAANC development in partnership with Industry. When complete, LAANC will provide 14 CFR Parts 101 and 107 operators a streamlined, efficient solution to enable automated sUAS operation notification and authorization.

In addition to capabilities already being developed, tested, and integrated, the FAA will explore a new service that will be available for UTM operations. Dynamic Restrictions represents a UTM airspace constraint as a 4D volume of airspace with associated descriptive data indicating limitations on operations accessing that airspace. These could be

traditional airspace restrictions like TFRs or constraints specific to UTM.

Figure 2 illustrates the notional diagram for Dynamic Restrictions.

As future needs are identified, the FAA will work with NASA and Industry partners to develop concepts with industry and operational input, test the concepts, prototype capabilities, and transfer the mature capabilities to the FAA for deployment into the UTM ecosystem.

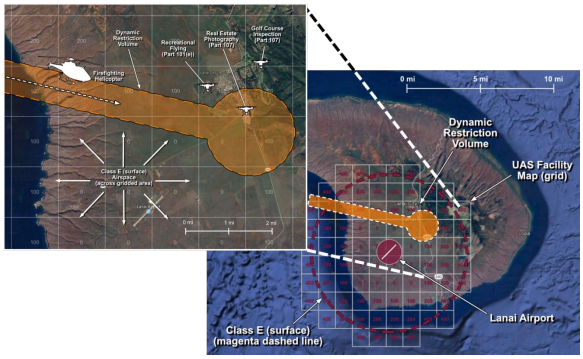

Figure 2. Dynamic Restrictions near VLOS Operations

UTM Operational Environment

UTM will be a separate, but complementary, set of services to the ATM system, based primarily on the information sharing of airspace constraints and operation intent (e.g., Flight Planning). The UTM architecture supports standard web services technologies and related open standards currently under evaluation by the FAA and will use an approved automation platform architecture to facilitate data exchange. Figure 3 depicts a notional UTM system and data architecture, which includes four main entities:

- UAS operators,
- UAS Service Suppliers (USS),
- Regulators/Air Navigation Service Provider (ANSP) – (FAA in the United States), and
- Other stakeholders (e.g., public safety, the public).

UAS operators will be responsible for coordinating, executing, and managing operations, with rules of the road established by FAA. UAS operators will be responsible for ensuring compliance with all FAA regulations. At a high level, a USS will provide [3]:

- A bridge from UAS operators to FIMS,
- Deconfliction support,
- On-Demand information support to authorities, and
- Operational approval support to UAS operators.

In general, these key functions allow a USS network to aid the FAA in managing sUAS without requiring the FAA be involved in a more "hands on" manner. These functions can be considered the USS acting as agents for the FAA for a specific set of responsibilities. The FAA (i.e., ANSP function) will provide a minimum set of data and tools for USS to achieve these delegated responsibilities. Finally, FAA will have on-demand access to information regarding UTM operations, including operation status, vehicle location, and intent information. FAA may require certain data to be logged / archived by operators should the FAA and other federal entities request that information (e.g., safety, security, or post-hoc events-of-interest analysis).

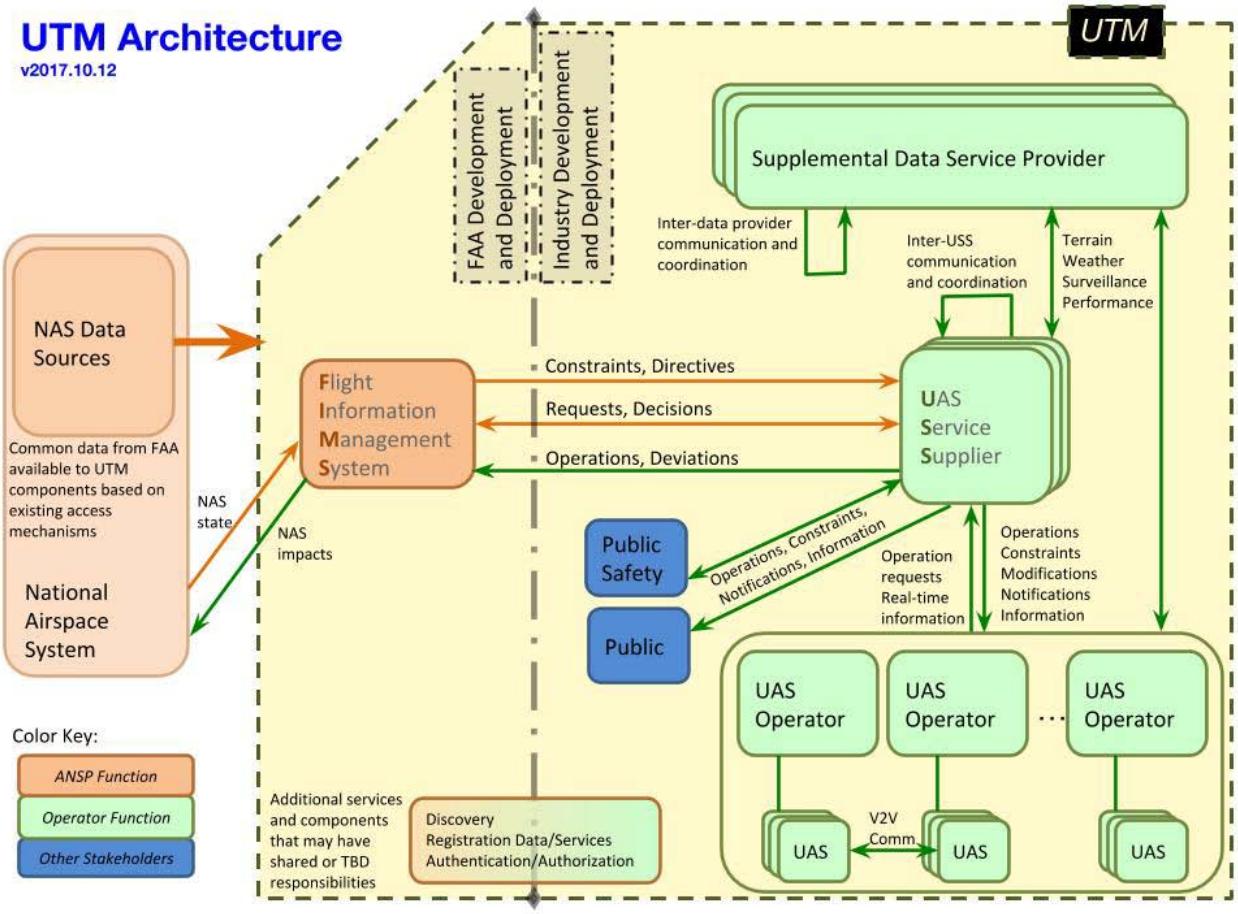

Figure 3. UTM Architecture

Given that USS have a key role within the UTM System, it is not difficult to imagine a subset of those USS aiding in the generating and distributing UTM airspace constraints. This is a role that may not immediately available to every USS as it has additional requirements beyond the scope of the minimum required USS responsibilities.

This additional USS role would allow a USS to vet other entities as being allowed to introduce UTM Airspace Constraints into the UTM System. These entities could be any level of municipality (state, county, city, tribal, community, etc.) or agency (fire, police, ambulance, etc.). The accepted approaches and data exchanges used elsewhere in the UTM ecosystem will by employed for this functionality.

The FAA would mandate the appropriate level, and the USS applying for the role would need to demonstrate meeting that level of assurance. After a USS has obtained this role within the UTM System, it would have the authority to operate as a constraint manager within UTM. This would allow that USS to manage and announce constraints on behalf of authorized entities (vetted and managed via the processes described in NIST 800-63-3).

UTM Data Model Description

The FAA, NASA, and Industry partners have collaborated in developing information exchange models and APIs to simplify data exchange in support of the UTM "ecosystem". An information exchange model is characterized by unambiguously defined terminology acceptable to all stakeholders (standardized data measures and units) and by organizing information into groupings that enable modularity, flexibility, and extensibility. The UTM architecture described above supports web services technologies based on XML, JSON, and related open standards currently under evaluation by the FAA and

will use an approved automation platform architecture to facilitate data exchange. The FAA uses internationally interoperable standards, which assist in standardization and global electronic distribution of data including aeronautical data, flight data, and weather data. The use of these global information exchange models supports UTM data exchange requirements and are used to form the conceptual UTM model. These global standards include:

- Aeronautical Information Exchange Model (AIXM) [4] and
- Flight Information Exchange Model (FIXM) [5].

In developing a data model, a hierarchical approach is taken, in which different layers of the model represent different aspects of the data. Figure 4 depicts a high-level representation of a generic data model, showing the Conceptual, Logical, and Physical model layers for UTM. An example of a physical model for UTM's operation plan capability is depicted Figure 5.

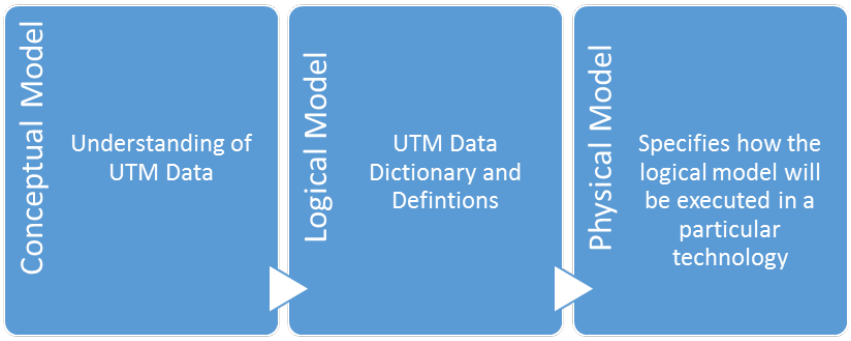

Figure 4. UTM Data Modeling Overview

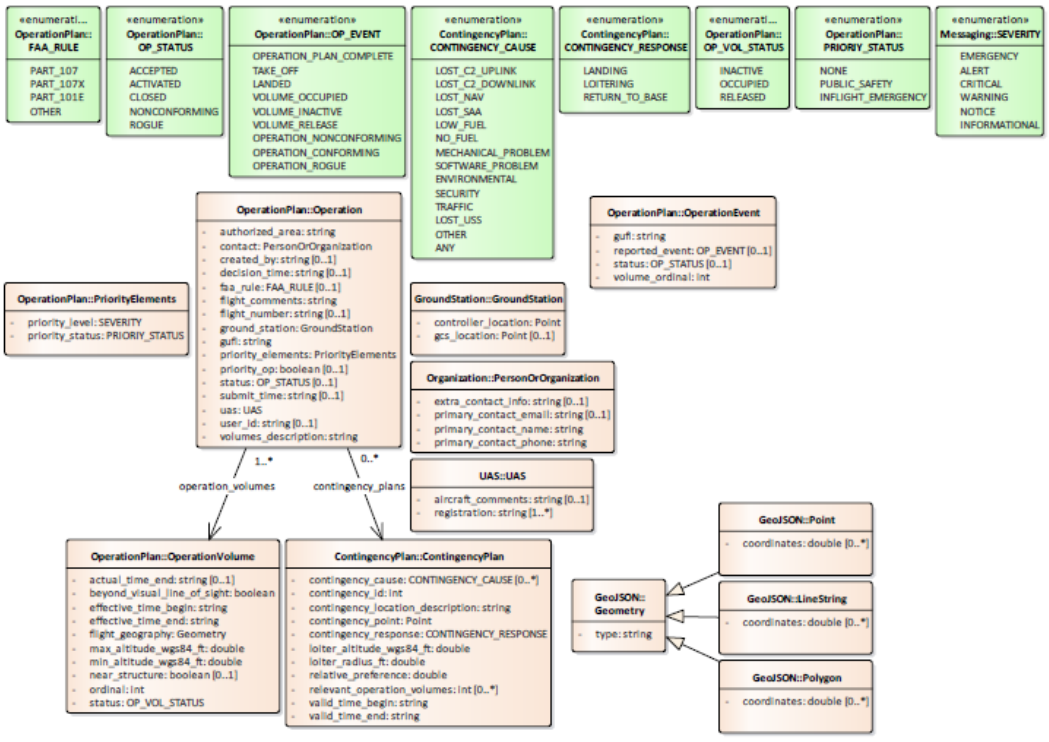

Figure 5. Physical Model for Operation Plan

UTM Pilot Program (UPP) Demonstration

The FAA Extension, Safety, and Security Act of 2016 Pub. L. 114-190 § 2208 (July 15, 2016) directs coordination/collaboration, development, and publication of a UTM Research Plan and establishment of a UTM System Pilot Program (UPP). The primary goal of the UPP is to develop, demonstrate, and provide an enterprise service to support initial UTM operations [6]. The UPP will be an important component of the initial transfer of NASA's UTM research technologies to FAA and a demonstration of the partnership with industry. This enterprise service will be used for sharing of intent and situational awareness information amongst UTM participants. The UPP will explore six capabilities areas in early 2019 (see Figure 6) [6].

The UPP will demonstrate NASA and FAA end-to-end capabilities leveraging various technologies and frameworks including the FIMS prototype, LAANC framework, and additional sUAS capabilities to support initial UTM operations. New UTM capabilities and services will evolve as UTM operational concepts and data exchange requirements mature. The following will be explored in the demonstration:

- Ability to receive information from subscribing UAS operators,
- Ability to receive Part 107 authorization requests,
- Ability to receive and translate UAS facility map information,
- Allow UAS operators to create Part 101(e) notifications,
- Enable information sharing between FAA, UAS operators, and multiple USSs, as applicable,
- Ability to issue and communicate a dynamic restriction,
- Connectivity to the FAA service gateway for mediation services,
- USS tracking of subscribing BVLOS UAS real-time position data, and
- Establish and manage the interface with UAS Operator(s).

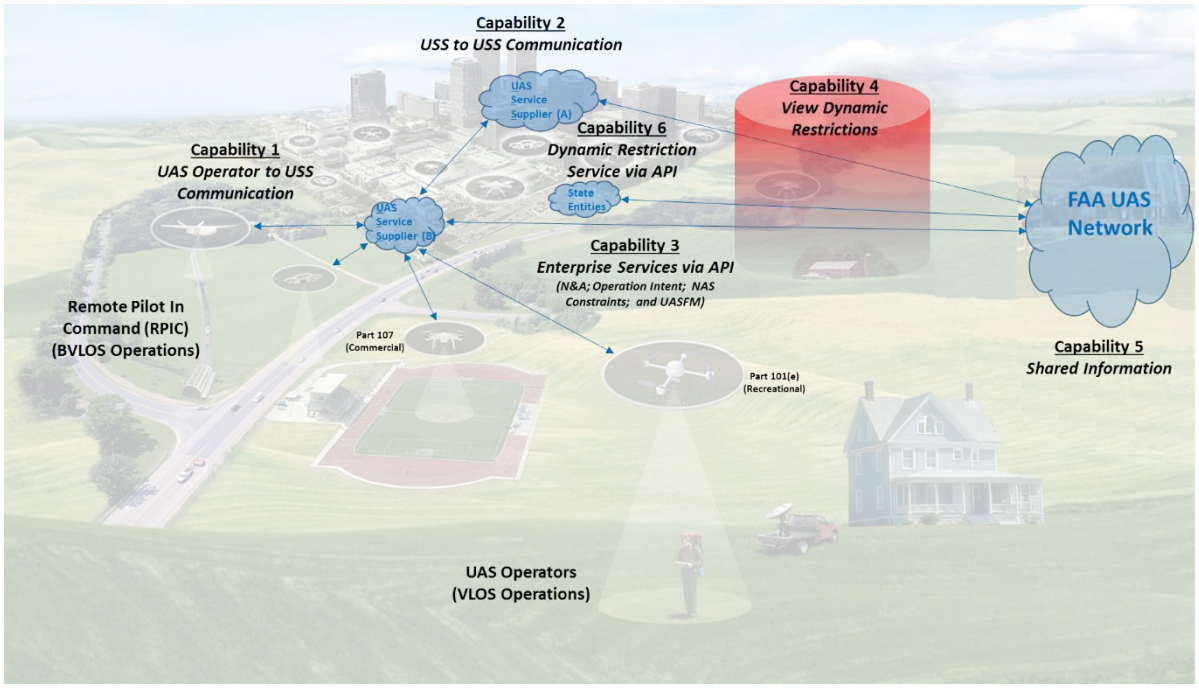

Figure 6. UTM Pilot Program Demonstration

Next Steps in CY 2018

- LAANC Beta Evaluation - FAA continue partnerships with LAANC services and coordinate collaborative tests for implementation with USS for information supplied nationwide
- UPP Demonstration – demo the initial integrated UTM ecosystem, including an ability to dynamically restrict airspace to support UTM operations. The UPP will serve as the foundation for the UTM implementation and support additional capabilities in accordance with the UAS regulatory framework for safe low altitude airspace for UAS operations
- Conduct activities to support UTM Heterogeneous Operations
- Begin examining scope of concepts to support UTM Urban Operations

Conclusion

Given that the UAS industry is growing rapidly, there is a need to quickly develop an infrastructure to manage UAS in uncontrolled airspace without placing a burden on the ATM system. UTM is a "traffic management" ecosystem for uncontrolled operations that is separate but complementary to the ATM system. UTM utilizes industry's ability to supply services under the FAA regulatory authority where these services do not exist. It is an operator-centric concept with layered procedures, services, and responsibilities that will support the separation of UAS from one another and manned aircraft. Data exchanges using standard languages and techniques will be used to build these systems. The core UTM principles are as follows:

- UASs have legitimate commercial applications, including replacing some high-risk manned aircraft operations.
- FAA maintains federal authority over operations in all airspace.
- FAA maintains regulatory control and oversight authority over commercial operations.
- Safety of manned aircraft and people on the ground is the highest priority.
- Risk-based assessments of UAS operations regarding the protection of property on the ground will need to be completed.

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