



Unmanned Aircraft Systems (UAS) Traffic Management (UTM)

UTM Pilot Program (UPP) Phase Two (2) Progress Report

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1 Introduction

The Unmanned Aircraft Systems (UAS) Traffic Management (UTM) Pilot Program (UPP) is an important component for defining and expanding the next set of industry and Federal Aviation Administration (FAA) capabilities required to support UTM. In summer 2019, the FAA, National Aeronautics and Space Administration (NASA), and industry partners successfully completed UPP Phase 1 demonstrations. UPP Phase 2 began in spring 2020 and will conclude in early 2021 with the release of the final report.

This document provides an update on the progress for UPP Phase 2 to date.

1.1 Background

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

Operators of small UAS are continuously exercising new, beneficial applications for their operations, including activities such as goods delivery, infrastructure inspection, search and rescue, and agricultural monitoring. Currently, there is only a limited initial infrastructure available to manage the widespread expansion of UAS operations within the National Airspace System (NAS). A safe and efficient UTM environment of expanded services is needed to help ensure that this rapidly growing industry can be incorporated into the NAS safely and efficiently.

Incorporation of small UAS operations in the NAS presents a variety of novel challenges, particularly in low-altitude airspace (below 400 feet Above Ground Level [AGL]). The FAA and NASA have joint interests in identifying innovative and transformative integration solutions that can effectively respond to these challenges without compromising the safety or efficiency of the NAS. In 2015, a UTM Research Transition Team (RTT) was formed between the FAA and NASA to jointly develop and enable UTM framework to manage routine Visual Line of Sight (VLOS) and Beyond Visual Line of Sight (BVLOS) UAS operations in airspace where air traffic services are not provided.

UTM is the manner in which the FAA will support operations for UAS operating in low-altitude airspace. UTM utilizes industry's ability to supply services under FAA's regulatory authority where these services do not currently exist. It is a community-based, cooperative traffic management system in which the operators and entities providing operation support services (i.e., UAS Service Suppliers [USS]) are responsible for the coordination, execution, and management of operations, with rules established by FAA.

UTM development will ultimately identify services, roles and responsibilities, information architecture, data exchange protocols, software functions, infrastructure, and performance requirements for enabling the management of low-altitude UAS operations.

1.1.2 UTM Pilot Program (UPP) Phase 1

The FAA Extension, Safety, and Security Act of 2016 [1] directs the FAA Administrator, in coordination with the Administrator of NASA, to establish the UPP. The UPP was established as

an important component for identifying the next set of FAA and industry capabilities required to support UTM operations.

The primary goal for UPP is to enable the development, testing, and demonstration of a set of UTM capabilities. These capabilities support the sharing of information that promotes situational awareness and deconfliction (i.e., cooperative separation). Some of the UTM capabilities successfully demonstrated in the first phase of UPP included: (1) sharing of operational intent between operators, (2) the ability for a USS to generate a UAS Volume Reservation (UVR), and (3) providing access to FAA Enterprise Services to support shared information (accomplished via the Flight Information Management System [FIMS]).

On January 14, 2019, The Honorable Elaine L. Chao, Secretary of the United States Department of Transportation, announced the FAA's selection of three industry teams to partner with the agency in the UPP:

- The Virginia Tech, Mid-Atlantic Aviation Partnership (VT-MAAP)
- The Northern Plains UAS Test Site (NPUASTS)
- The Nevada Institute for Autonomous Systems (NIAS)

In summer 2019, the FAA, NASA, and their industry partners successfully completed the UPP demonstrations. This consisted of a series of preparation flights and final flight demonstrations, with both live UAS flights and simulated UTM operations at each test site. The flight activities were executed while participating vehicles (live and/or simulated) were connected to FIMS via communication with a USS, and with that USS connected to the UPP demonstration platform. Through the planning and execution of the UPP activities, each of the three UPP partnerships successfully demonstrated all the requisite capabilities. While the specifics of each use case varied between the partnerships, the key UTM capabilities were exercised with success at each site.

1.1.3 Initiation of UPP Phase 2

Recognizing the importance in defining and expanding capabilities needed to support UTM, the FAA Reauthorization Act of 2018 [2] required the UPP to meet additional objectives prior to completion, initiating UPP Phase 2. Objectives for UPP Phase 2 include testing of Remote Identification (RID) tracking technologies and operations with increasing volumes and density. In cooperation with NASA, FAA UAS test sites, industry stakeholders, and UAS Integration Pilot Program (IPP) participants, testing and demonstration activities were conducted to support these objectives.

In April 2020, the FAA selected two FAA UAS test sites (shown in Figure 1) to partner with the agency in UPP Phase 2:

- Virginia Tech, Mid-Atlantic Aviation Partnership (VT-MAAP)
- New York UAS Test Site (NYUASTS)



Figure 1: UPP Phase 2 Test Sites, Locations, and Partners

The UPP results will provide a proof of concept for UTM capabilities and serve as the basis for policy considerations, standards development, and the implementation of a UTM system.

1.2 Document Scope

This report provides a status of UPP Phase 2, including the shakedown activities, which ensured that participants were ready to conduct the final demonstrations. The document includes an overview of UPP Phase 2, descriptions of key UTM elements being examined in UPP Phase 2 activities, details on test sites and other participants, and a summary of UPP Phase 2 progress to date. The progress update includes information from the onboarding and checkout process, shakedown 1, and shakedown 2. To conclude, it provides initial takeaways from UPP Phase 2 activities, as well as next steps. Results of the final demonstrations will be presented in 2021.

2 UPP Phase 2 Overview

This section provides a high-level overview of the UPP Phase 2 project, including a review of the capabilities to be demonstrated, background information on key UTM elements applicable to phase 2, an overview test site partners and supporting actors, and a review of project activities.

2.1 Capabilities for Demonstration

UPP Phase 2 demonstrates the following emerging UTM capabilities that will support BVLOS operations.

- The FAA FIMS prototype and infrastructure, which gives the FAA access to information from industry and other stakeholders.
- New technologies and data to validate the latest standards for RID and support authorized users with specific operator data.
- In-flight separation from other UAS or manned aircraft in high-density airspace to validate recently proposed international UTM standards to help UAS avoid each other.
- UVRs to notify UAS operators of emergencies and make sure other UTM capabilities work properly in these scenarios.
- Secure information exchanges between the FAA, industry, and authorized users to ensure data integrity.

2.2 Key UTM Elements in UPP Phase 2

This section provides background information on key UTM elements that are a focus of UPP Phase 2 and are discussed throughout this report. In general, detailed concepts can be found in the FAA UTM Concept of Operations (ConOps) Version 2.0 [3].

2.2.1 UTM Architecture

Within the UTM ecosystem, the FAA maintains its regulatory and operational authority for airspace and traffic operations; however, the operations are not managed by Air Traffic Control (ATC). Rather, they are organized, coordinated, and managed by a federated set of actors in a distributed network of highly automated systems via Application Programming Interfaces (APIs). Figure 2 depicts a notional UTM architecture that visually identifies, at a high level, the various actors and components, their contextual relationships, and high-level functions and information flows. The gray dashed line represents the demarcation between the FAA and industry for infrastructure, services, and entities that interact as part of UTM. As shown, UTM comprises a sophisticated relationship between the FAA, operator, and various entities providing services and/or demonstrating a demand for services within the UTM ecosystem. The illustration highlights a model, which heavily leverages utilization of third-party service providers (e.g., USSs, Supplementary Data Service Providers [SDSPs]) to support the FAA and the operator in their respective roles and responsibilities.

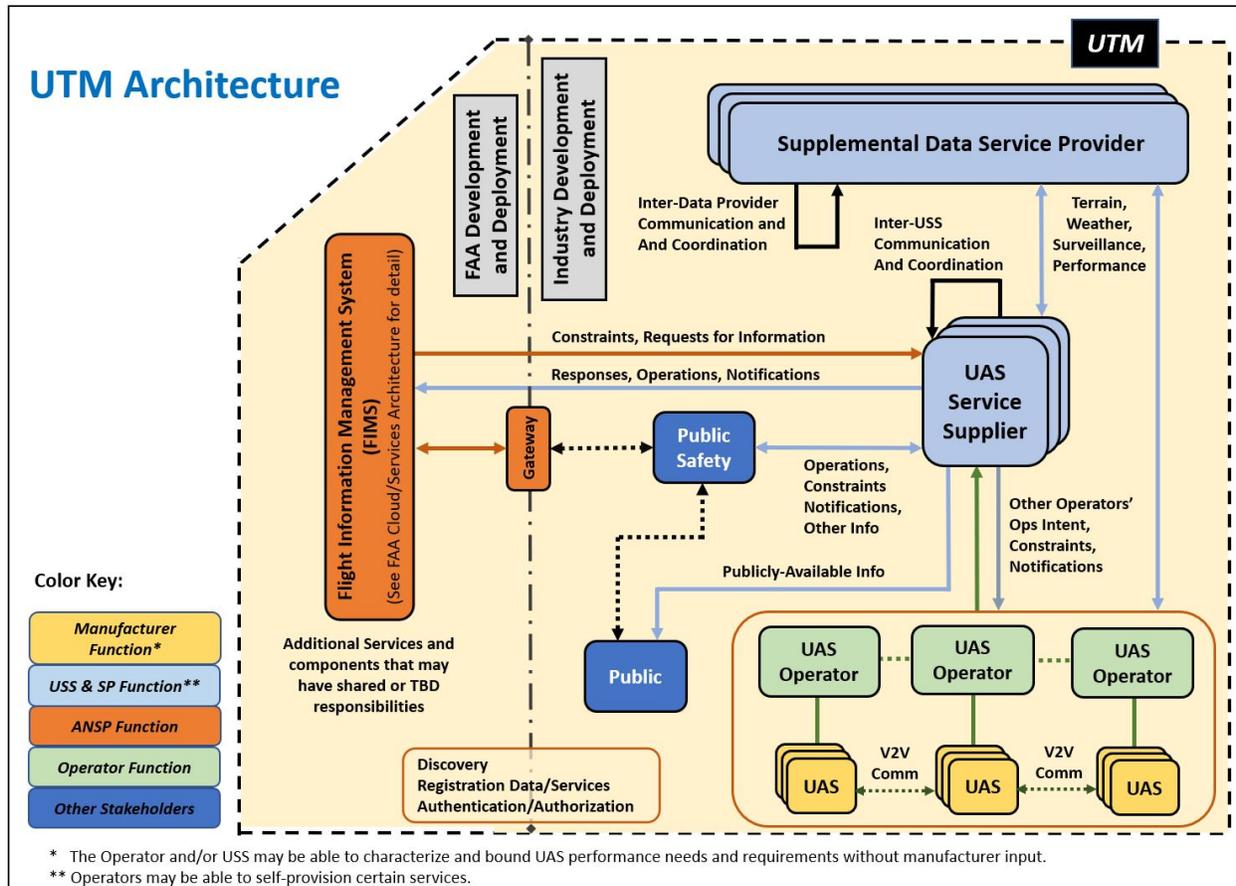


Figure 2: UTM Notional Architecture

2.2.2 UAS Service Supplier (USS)

A USS is an entity that assists UAS operators with meeting UTM operational requirements that enable safe and efficient use of airspace. A USS provides three main functions:

- Acting as a communications bridge between federated UTM actors to support operators' abilities to meet the regulatory and operational requirements for UAS operations.
- Providing the operator with information about planned operations in and around a volume of airspace so that operators can ascertain the ability to conduct the mission safely and efficiently.
- Archiving operations data in historical databases as appropriate for analytics, regulatory, and operator accountability purposes.

In general, these key functions allow for a network of USSs to provide cooperative management of low-altitude operations without direct FAA involvement. The following terms are defined within the context of USSs.

- **USS Network:** The amalgamation of USSs connected to each other, exchanging information on behalf of subscribed operators. USSs share operational intent data, airspace

constraint information, and other relevant details across the network to ensure shared situational awareness for UTM participants. In the UTM construct, multiple USSs can operate in the same geographical area.

- **Discovery and Synchronization Service (DSS):** DSS is utilized by USSs to facilitate automated data exchanges between one another within the USS Network. This capability allows USSs to identify one another and exchange relevant information when the geographical service area of one USS overlaps one or more other USSs.

For UPP Phase 2, participating USS APIs adhered to the New Specification for Service provided under UTM version 0.3.5, currently in development within ASTM Committee F38.02 [4].

2.2.3 Flight Information Management System (FIMS)

The FAA FIMS prototype was implemented by the FAA NextGen Integration and Evaluation Capability (NIEC) Lab at William J. Hughes Technical Center for UPP Phase 1. It remains there and has been updated since Phase 1 to reflect the changes needed for the integration and testing of UPP Phase 2 activities.

In UPP Phase 2, the FAA uses FIMS as an access point for information on active UTM operations. FIMS is an interface for data exchange between FAA systems and UTM participants. FIMS enables the exchange of relevant operations data between the FAA and the USS Network. FIMS also provides a means for approved FAA stakeholders to query and receive limited post-hoc/archived data on UTM operations for the purposes of compliance audits and/or incident or accident investigation. FIMS is managed by the FAA and is a part of the UTM ecosystem.

2.2.4 Remote Identification (RID)

RID provides a means to address public concerns and protect for public safety vulnerabilities associated with low-altitude UAS operations, including privacy and security threats. RID allows electronic identification of an Unmanned Aircraft (UA)/operator through use of a unique identifier (similar in concept to an automobile license plate). RID enables accountability and traceability, particularly for BVLOS operations, where an operator and vehicle are not co-located.

For UPP Phase 2 activities, participants are conducting testing and evaluation of RID technologies developed in accordance with the ASTM International Standard Specification for Remote ID and Tracking version 1.0 [5].

2.2.5 UAS Volume Reservation (UVR)

UVRs are designed to support operational safety during public safety activities (e.g., medical evacuation flights, firefighting) by notifying UTM operators of blocks of airspace in which these activities occur. UVRs may be established when activities on the ground or in the air present a potential risk to UTM safety interests. UVRs are generally short in duration (i.e., hours as opposed to days or weeks), have specified airspace boundaries, and have established start and end times. USSs participating in UPP Phase 2 provided UVR services to designated public safety participants. A UVR that is generated upon request is routed to other USSs to notify affected operators, as well as to the FAA via FIMS.

2.2.6 Integration of Key UTM Elements in UPP Phase 2

In October 2018, Congress passed an FAA Reauthorization Act that called upon the FAA to address the development and implementation of a UTM environment, as well as assess RID capabilities to safely integrate UAS into the airspace and address public safety and security concerns. The set of UTM elements noted above are key to providing a proof of concept for the integrated UTM environment that includes communication and information sharing between operators, USSs, public safety entities and the FAA. The results from UPP Phase 2 will inform continued research and development and will serve as the basis for implementation of initial UTM capabilities.

2.3 UPP Phase 2 Partners and FAA Support

As noted above, UTM operations are primarily managed by a federated set of actors, including UAS operators and the USSs that support them. Given this, it is critical that UTM demonstration activities include a diverse set of stakeholders to ensure the envisioned capabilities address the various sets of needs and interests. UPP Phase 2 focuses on this need and has brought together various FAA stakeholders, NASA, industry service providers, UAS operators, and public safety stakeholders to support use cases within the integrated test environment.

2.3.1 Test Site Partners

Table 1 provides overviews of the industry partners and other participating stakeholders who are working with VT-MAAP and NYUASTS. The test sites oversee project management for activities executed at their sites; provide infrastructure/services to support USS and UAS operator activities; coordinate with the NIEC lab to provide the integrated test environment; and provide additional support to the FAA, partners, and other stakeholders as needed.

Table 1: Test Site Partners

VT-MAAP Partners	
USS Partners	Other Partners
<ul style="list-style-type: none"> • ANRA Technologies • Airmap • AiRXOS • Wing 	<ul style="list-style-type: none"> • Public Safety: Christiansburg, Blacksburg Police Department, Virginia Tech Police Department, Montgomery County Sheriff’s Department, Virginia Tech Department of Emergency Management, Radford Army Ammunition Plant
NYUASTS Partners	
USS Partners	Other Partners
<ul style="list-style-type: none"> • ANRA Technologies • AX Enterprize • AiRXOS • OneSky 	<ul style="list-style-type: none"> • Public Safety: Syracuse Fire Department, Oneida County Sheriff’s Department, Albany County Sheriff’s Department • Additional Partners: Aerodyne Measure, Johns Hopkins University – Applied Physics Laboratory, TruWeather Solutions, Skyward (a Verizon Company), Flytrex

USSs provide technologies and services to support live and simulated flights of UAS, which may include operating their own simulated and/or live UAS during flight activities. They integrate into the test environment, and ensure supporting technologies and services conform to applicable standards and project requirements.

Public safety partners participate in several ways. This includes operating UAS, using UVR services in simulated public safety conditions, testing RID technologies that conform to the ASTM International Standard Specification for Remote ID and Tracking [5], and coordinating with supporting FAA personnel for information services.

Other partners support in various ways. This includes, but is not limited to, supplementary data services, communications infrastructure, and operating UAS.

2.3.2 FAA NextGen Integration and Evaluation Capability (NIEC) Lab

The FAA NIEC lab provides infrastructure, technologies, and applicable support to enable an integrated test environment for the test sites and their partners. Activities include, but are not limited to, software development, implementation of ASTM International standards, implementation of FAA's UPP message security requirements¹, provision of an administrative portal for related interactions with other participants, connecting USSs into FIMS infrastructure, conducting USS checkout processes to ensure they meet applicable functional requirements, and facilitating data collection and reporting.

3 UPP Phase 2 Status

3.1 Execution Plan Overview

Throughout spring and summer of 2020, VT-MAAP and NYUASTS worked with their partners and the FAA to prepare for the final flight demonstration. This included software development, systems integration, definition of use case test cards, and identifying data capture requirements. As part of the preparation for the demonstrations, the USSs and the NIEC lab conducted numerous checkout tests to validate the required system interactions. The checkout process tested individual interactions between USS and FIMS, USS and USS, and UAS vehicles and USS. This ensured that the individual USSs were able to connect and communicate with the other UTM components prior to beginning the operational tests of the capabilities outlined in section 2.1.

The operational testing of the UPP Phase 2 capabilities in the integrated test environment was conducted through a number of shakedown activities. These activities tested end-to-end systems through the operational use cases. During these pre-demonstration activities, the UPP Phase 2 partners were able to exercise their vehicles and systems to test to the various standards, concepts, and operational requirements. In many cases, this initial test was the first validation of a standard that was tested across different commercial partners in a live environment, revealing a number of challenges previously unknown to the UTM community. The activities conducted prior to the final demonstration allowed the UPP Phase 2 partners to identify and resolve a number of challenges

¹ UPP 2 message security requirements are an FAA-driven research area. Requirements and best-practices identified during UPP activities will be provided to stakeholders to facilitate continued standards development.

with these advanced UTM capabilities that ensured the success of the final demonstration. Figure 3 shows the general timeline of these activities.

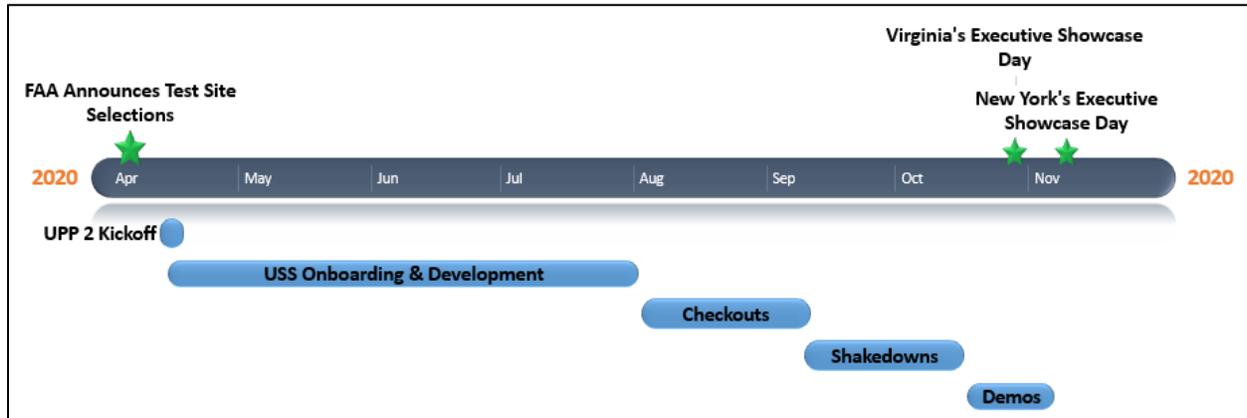


Figure 3: UPP Phase 2 Execution Timeline

Note on the COVID-19 Public Health Crisis: The pandemic caused by COVID-19 created initial concerns in scheduling, collaboration, and execution of activities. However, the FAA, in collaboration with NASA, UAS test sites, the test site partners, and other stakeholders/contributors, has been able to adjust approaches to coordination and development cycles to continue work towards demonstration of the targeted capabilities. Approaches included the use of teleconference tools (e.g., Zoom, GoToMeeting) when previously planned trips were no longer possible, the use of online collaboration software (e.g., Redmine, Slack, Microsoft Teams), and performing simulated flights for some missions that could not currently be supported with live UAS.

3.2 USS Onboarding and Checkout

3.2.1 Purpose

During the onboarding and checkout process, participating USSs were required to complete connectivity tests with the NIEC UTM development environment to verify basic software/data exchange functionality (e.g., with FIMS, with other USSs) so that integrated tests could be performed during the shakedown activities. Functional tests included the ability to get access tokens from FIMS and meet UPP Phase 2 data exchange requirements, which are based on the ASTM RID standard, ASTM UTM draft standard, and FAA FIMS API.

3.2.2 Summary of Checkout Activities

The UPP Phase 2 USS onboarding, development, and checkout processes were performed in three stages during spring and summer of 2020.

- **Stage 1: Message Signing Certificates and Token Access:** Each USS completed an onboarding form with the organizational information necessary to request a signing certificate on their behalf. USSs verified the validity of the certificate by requesting a token from the FIMS Authorization server. During checkouts, most issues were related to the

message that was signed not being identical to the message that was sent; however, this process went smoothly, and most issues were worked out with minor debugging.

- **Stage 2: Automated Tests:** The NIEC supported a suite of automated tests that sent data to partner USSs to verify functionality and test for proper handling of invalid data. The tests were run at the request of a USS when they were ready. Issues that were worked through at this stage were related to USSs receiving and verifying signatures, as this was the first opportunity for USSs to test this functionality.
- **Stage 3: Manual Tests:** Manual checkout tests were also conducted between the NIEC and USSs that tested a series of USS and FIMS capabilities. These tests included:
 - Operation intent sharing via posts to DSS and necessary subscribers
 - Operation state changes (e.g., activated, ended)
 - UVR constraint message posts to DSS and necessary subscribers
 - NIEC RID queries
 - NIEC historical data queries

Testing consisted of one-hour sessions with each USS as they completed stage 2. Some common issues worked through in the testing sessions were incorrect handling of the deletion of operations and constraints, configuration issues related to subscriptions, and the data that should be returned from a historical query.

3.3 Shakedowns

3.3.1 Purpose

Following the checkout process, the shakedowns tested and mitigated any issues relating to supporting the capability goals for UPP Phase 2 (specified in section 2.1 of this report). This was accomplished through various tests to the test site use cases, as well as live and simulated flights conducted in the integrated UPP Phase 2 test environment, including UAS connected to supporting USSs, USS to USS data exchanges, and FIMS to USS data exchanges. UPP Phase 2 participants conducted increasingly complex tests to validate their software and hardware, addressing issues as they were identified. Upon completion of the shakedown and closure of identified actions, final live demonstrations of the use cases can be conducted in a mature integrated UPP Phase 2 test environment.

3.3.2 Shakedown 1

3.3.2.1 VT-MAAP

Shakedown 1 at VT-MAAP was a simulated exercise conducted September 14-18, 2020. During this shakedown, all use cases planned for the demonstration flights were conducted remotely due to COVID-19 restrictions. Hardware-in-the-Loop (HITL) and Software-in-the-Loop (SITL) simulation was used as a stand in for actual UAS flights. Figure 4 provides a summary of the number of operations (a total of 247) conducted by the USSs throughout this activity.

During shakedown 1, VT-MAAP and its partners were able to successfully test a number of the functionalities needed to support the targeted demonstration capabilities, including:

- Sharing operation intent pre-flight
- Changes to operation intent while in flight
- Strategic deconfliction between operators
- USS data/message exchanges (e.g., intent, notifications)
- Discovery and synchronization service
- UVR request and processing
- RID technologies²
- Contingent UAS data exchanges
- FAA historical data queries

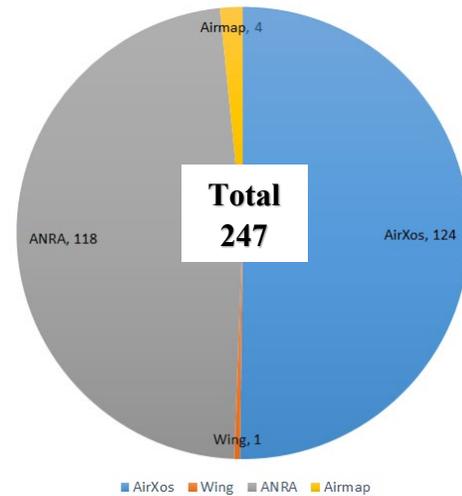


Figure 4: VT-MAAP Operations – Shakedown 1

While the testing was limited by the virtual environment in shakedown 1 at VT-MAAP, several key lessons learned were identified during testing. One key focus area for UPP Phase 2 is the ability of operators to access and view information to support strategic deconfliction. For some of the USSs, there was limited capability for the operator to deconflict if there was a conflict with an operator of a different organization. Additional issues pertaining to historical queries and data capture were discovered that could not be addressed during the shakedown activities and were added to an issue tracking list for addressing prior to the final demonstration.

By the end of VT-MAAP’s shakedown 1, the basic UTM functionality was in place and working as defined in the ASTM-proposed New Specification for Service provided under UTM; the system could support most desired data points.

3.3.2.2 NYUASTS

Shakedown 1 for NYUASTS was conducted at the Griffiss International Airport and a park in the City of Rome, New York from August 31-September 4, 2020. Due to COVID-19-related travel restrictions, some partners were unable to attend in person and instead participated remotely. The Northeast UAS Airspace Integration Research (NUAIR) (who manages activities at NYUASTS) and AX Enterprize staff filled onsite roles to support this activity, assisted by pilots from the Oneida County Sheriff’s Department. Operations consisted of both live and simulated UAS flights. Figure 5 provides a summary of the number of operations (a total of 172) conducted by the USSs throughout the shakedown activities.

During shakedown 1, NYUASTS and its partners were able to also successfully test several functionalities needed to support the targeted demonstration capabilities, including:

² Broadcast RID was not tested during shakedown 1 at VT-MAAP due to the use of simulated UAS only.

- USS data/message exchanges (e.g., intent, notifications)
- RID technologies, including broadcast and network RID
- DSS use per current ASTM standard
- Strategic deconfliction between operations
- Off-nominal situation reporting
- Mobile radar
- Simultaneous operations, including live and simulated UAS
- Long Term Evolution (LTE) spectrum data collection
- True BVLOS flights

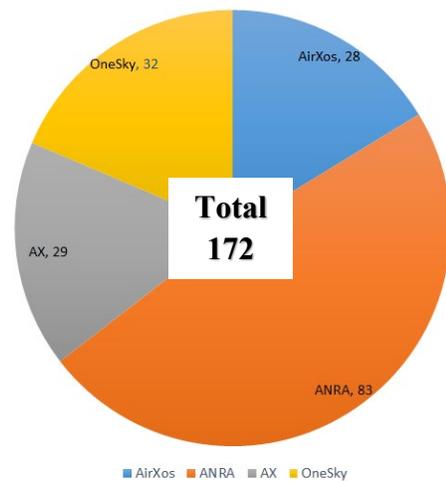


Figure 5: NYUASTS Operations – Shakedown 1

Similar to VT-MAAP, shakedown 1, this activity at NYUASTS represented the first opportunity for a number of the USS partners to test some functionalities, including those implemented in accordance with recently developed ASTM standards. Each USS also implemented various capabilities in different ways that identified new interoperability challenges when operating together in a collaborative UTM ecosystem. For example, each USS participating in shakedown 1 defined the buffer for the operational intent differently, which, when integrated together in an operational use case, caused unnecessary strategic deconfliction events.

In addition to identifying these opportunities for improvement prior to final demonstration, shakedown 1 also provided the opportunity to successfully test a number of new technologies, such as RID based on the ASTM International Standard Specification for Remote ID and Tracking [5].

3.3.3 Shakedown 2

3.3.3.1 VT-MAAP

VT-MAAP’s shakedown 2 was performed October 12-16, 2020. During this shakedown, all use cases planned for final demonstration flights were conducted. This shakedown utilized the same aircraft, flight crews, and test plans as the demonstration flights that would follow. During shakedown 2, VT-MAAP conducted 193 flights—191 live and 2 simulated—logging a total of 34.9 flight hours. Of the 193 flights, 155 flights were conducted as BVLOS flights, including actual, pseudo³, and simulated BVLOS operations.

As shakedown 2 was conducted with live flights, capabilities such as broadcast RID were able to be successfully tested. Additionally, this allowed the testing of information exchanges supporting RID, including exchanges of experimental Temporary Flight Restriction (TFR) compliance

³ Pseudo BVLOS flights are filed within the UPP 2 test environment as BVLOS but are flown VLOS or with visual observers (e.g., in accordance with a waiver that has been granted to a participating operator).

details. This testing identified a potential issue with the use of extended RID details that may have caused interoperability issues with other providers.

Based on the lessons learned in shakedown 1, USSs in shakedown 2 provided additional information to the operator to support strategic deconfliction, such as lateral bounds and geographical boundaries of the other conflicting operations. This enabled the operators to better plan their UTM operations and will further support BVLOS operations in the future.

3.3.3.2 NYUASTS

NYUASTS's shakedown 2 was executed October 5-9, 2020. The testing was conducted at the Griffiss International Airport, with flights occurring in Downtown Rome, New York, and at a park in the City of Rome. Operations were supported from the operations center at the NYUASTS and from the test site's mobile operations center located in Downtown Rome during the shakedown activities. During testing, up to 16 aircraft (13 live and 3 simulated) were flown at a time. This has been noted as one of the highest-density operations tested in an urban environment using UTM capabilities targeted by this program. During shakedown 2, NYUASTS integrated a number of capabilities to form a more complete picture of future UTM operations. NYUASTS and its partners were able to test a query for additional details after receiving broadcast RID. A newly developed FAA capability successfully provided authorized users with additional UAS and operator details based on the initial information those users received via RID broadcast. These types of integrations and live tests are key to taking concepts and standards towards implementation and use in the operational environment.

3.4 Final Demonstrations

The final step in the UPP execution plan is a series of demonstration flights. The goal is to demonstrate and verify services that will support implementation of initial UTM operations in a live and simulated manner. Participating UAS operations include live and simulated flights supporting demonstration of the specified capabilities for UPP Phase 2.

At the time of the release of this progress report, the final demonstration activities have been completed (fall 2020), and included executive demo days where various FAA stakeholders, federal partners, and industry stakeholders were presented to via digital presentations over teleconferences. Videos from these events are being released through FAA media channels as a series of use cases for each test site.

Data obtained from the checkout, shakedown and final demonstrations will be incorporated into a final report from the FAA and will inform FAA implementation of UTM services and capabilities.

4 Key Takeaways

The activities detailed in this progress report resulted in several key takeaways, highlighted in this section. These takeaways provide insight to the areas of focus as the UPP Phase 2 project comes to its completion, and the resultant expansion of UTM capabilities.

4.1 Initial Cybersecurity Findings

Cybersecurity is of paramount importance in the domain today, especially in the future of the UTM ecosystem. UPP Phase 2 incorporated a layered message security approach using digital certificates and message signatures to improve the integrity and security of the information exchanges. Both of these security measures were applied to the onboarding and shakedown activities.

4.1.1 Onboarding and Checkout Activities

At the onset of the onboarding activities, digital certificates for UPP Phase 2 were obtained from the FAA's International Aviation Trust Framework (IATF) prototype Certificate Authority. To enable UPP Phase 2 participants to request and receive IATF certificates, the FAA developed a semi-automated workflow with feedback from UPP Phase 2 partners. During this collaboration, technical details such as certificate formatting discrepancies and key exchange were resolved to successfully obtain certificates.

After obtaining a certificate, the relevant USSs were then required to demonstrate the ability to sign and validate messages using IATF certificates during the checkout processes. During the onboarding and checkout processes, the USSs and FAA NIEC lab also worked to resolve specific technical issues related to message signing and validation (e.g., formatting and encoding differences). The ensuing discussions resulted in a final protocol that successfully enabled the use of message signing and validation among USSs and between the USS and FIMS. The lessons learned from this collaborative process will improve the specifications for message signing and validation for future activities.

4.1.2 Shakedowns

After working through several technical challenges during the onboarding and checkout processes, USSs did not experience any technical issues with the certificate or message signing and validation processes during the shakedowns. It should be noted that the message signing and validation processes were optional for RID messages as well as messages without Hypertext Transfer Protocol (HTTP) bodies (i.e., GET and DEL) due to the lack of a clear conceptual need for RID signing and prioritization of other technical challenges, respectively. This resulted in a non-uniform message signing approach that allowed the demonstration to move forward. However, this should not be viewed as a long-term strategy. The potential impacts on security must be addressed and future activities may consider further evaluation of signing and validation to ensure both interoperability and security. In addition, the USSs provided general feedback after the shakedowns about reevaluating the message signing approach based on the increased proportion of messages without bodies in the ASTM standard. There was also feedback on the need for specific protocols or standards for error responses or actions taken when receiving invalid messages.

4.1.3 Industry Threat Assessment

In addition to directly supporting the UPP Phase 2 demonstration, an industry-led effort was undertaken to evaluate security as it relates to the ASTM standard. The UPP Phase 2 Security

Working Group included representatives from the USSs, NASA, and the FAA. The effort began with a list of protection needs previously identified by NASA to inform the agency's USS Framework for Authentication and Authorization. The UPP Phase 2 Security Working Group evaluated the protection needs based on consideration from FAA and IATF security policies to assess whether the current ASTM standard covered the protection needs. To determine this, the group performed a preliminary risk assessment assuming a certain level of attacker for specified use cases to outline the likelihood and potential impacts of each of the protection needs. In addition to the protection needs analysis, the group outlined several reference architectures, which included descriptions of the security and its mitigated risks. The overall effort is aimed at informing the ASTM standard group as it further matures the security measures in the standard.

4.2 Value of Testing New Standards

The shakedowns demonstrated the FAA's capability to query participating USSs using the RID endpoints in line with the ASTM standard. During the onboarding phase of the program, there were challenges with the new message security implementations as part of updated ASTM standard, which were subsequently resolved by the team. These challenges can provide input to future updates to the ASTM standard. There were also message formatting issues on the exchange of historical queries RID messages. The team worked diligently throughout both shakedowns to test the telemetry and data messaging elements to resolve the interoperability challenges. These tests have helped to shed light on the new ASTM standard API and how it affects UTM in a real-world environment.

5 Summary and Next Steps

The FAA will utilize data, lessons learned, surveys, and other artifacts to generate a final report, which will be published in 2021. The final report will inform the UTM Implementation Plan to expand UTM operations in accordance with the FAA Reauthorization Act of 2018 [2].

Appendix A References

- [1] Federal Aviation Administration (FAA) Extension, Safety, and Security Act of 2016. Public Law 114-90, Title II, Subtitle B – UAS Safety. July 2016. Retrieved from: https://www.faa.gov/uas/resources/policy_library/media/Pages-from-PLAW-114publ190.pdf
- [2] FAA Reauthorization Act of 2018. Public Law 115-254, H.R. 302 SEC. 376(b). October 2018. Retrieved from: <https://www.congress.gov/bill/115th-congress/house-bill/302/>
- [3] FAA, Unmanned Aircraft System (UAS) Traffic Management (UTM) Concept of Operations (ConOps) Version 2.0. March 2, 2020. Retrieved from: https://www.faa.gov/uas/research_development/traffic_management/media/UTM_ConOps_v2.pdf
- [4] “Subcommittee F38.02 on Flight Operations.” ASTM International. <https://www.astm.org/COMMIT/SUBCOMMIT/F3802.htm> (accessed November 17, 2020).
- [5] ASTM F3411-19, Standard Specification for Remote ID and Tracking. Retrieved from: <https://www.astm.org/Standards/F3411.htm>

Appendix B Acronyms

All acronyms used throughout this document are provided in Table 2.

Table 2: Acronyms

Acronym	Definition
AGL	Above Ground Level
API	Application Programming Interface
ATC	Air Traffic Control
ATM	Air Traffic Management
BVLOS	Beyond Visual Line of Sight
COVID-19	Coronavirus Disease 2019
DSS	Discovery and Synchronization Service
FAA	Federal Aviation Administration
FIMS	Flight Information Management System
HITL	Hardware-in-the-Loop
HTTP	Hypertext Transfer Protocol
IATF	International Aviation Trust Framework
IPP	UAS Integration Pilot Program
LTE	Long Term Evolution
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NIEC	NextGen Integration and Evaluation Capability
NUAIR	Northeast UAS Airspace Integration Research
NYUASTS	New York UAS Test Site
RID	Remote Identification
RTT	Research Transition Team
SDSP	Supplemental Data Service Provider
SITL	Software-in-the-Loop
TFR	Temporary Flight Restriction
UA	Unmanned Aircraft
UAS	Unmanned Aircraft Systems

Acronym	Definition
UPP	UTM Pilot Program
USS	UAS Service Supplier
UTM	UAS Traffic Management
UVR	UAS Volume Reservation
VLOS	Visual Line of Sight
VT-MAAP	Virginia Tech, Mid-Atlantic Aviation Partnership

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Final Audit Report

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