United States Government Accountability Office

Report to Congressional Committees

January 2021

UNMANNED AIRCRAFT SYSTEMS

FAA Could Strengthen Its Implementation of a Drone Traffic Management System by Improving Communication and Measuring Performance

Accessible Version

GAO@100
A Century of Non-Partisan Fact-Based Work

GAO-21-165

GAO Highlights

Highlights of GAO-21-165, a report to congressional committees

View GAO-21-165. For more information, contact Heather Krause at (202) 512-2834 or krauseh@gao.gov.

Why GAO Did This Study

UAS have potential to provide significant social and economic benefits in the U.S. FAA is tasked with safely integrating UAS into the national airspace. UTM, as planned, will be a traffic management system where UAS operators and service providers are responsible for the coordination and management of operations at low altitudes (below 400 feet), with rules established by FAA.

The FAA Reauthorization Act of 2018 included a provision for GAO to review infrastructure requirements for monitoring UAS at low altitude. This report examines, among other things, the actions FAA has taken to develop UTM and additional steps needed to achieve UTM's implementation.

GAO reviewed relevant statutes, regulations, and agency documents; assessed FAA's efforts against internal controls for communicating quality information and GAO's work on results-oriented practices and performance measures; and interviewed 19 UAS industry and public stakeholders selected to achieve a range of perspectives.

What GAO Recommends

GAO is recommending that FAA: (1) provide stakeholders with additional information on the timing and substance of UTM testing and implementation efforts using FAA's UTM website or other appropriate means, and (2) develop performance goals and measures for its UTM implementation plan. The Department of Transportation generally concurred with these recommendations.

January 2021

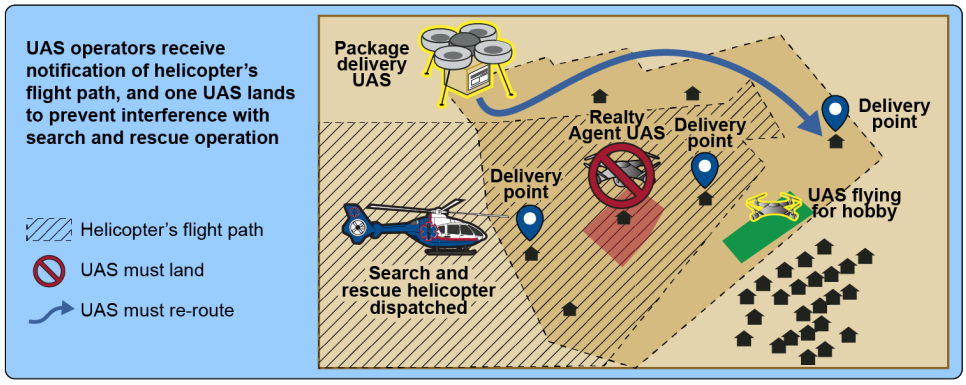
UNMANNED AIRCRAFT SYSTEMS

FAA Could Strengthen Its Implementation of a Drone Traffic Management System by Improving Communication and Measuring Performance

What GAO Found

The Federal Aviation Administration (FAA) is working with industry and public stakeholders to develop a traffic management system for unmanned aircraft systems (UAS), also known as drones. The UAS traffic management ecosystem (referred to as UTM) involves developing a framework of interconnected systems for managing multiple UAS operations. Under UTM, FAA would first establish rules for operating UAS, and UAS-industry service providers and operators would then coordinate the execution of flights. Operators would likely be able to access UTM, for example, through smart phone applications to map routes for UAS flights and check for flight restrictions. FAA began collaborating in 2015 with the National Aeronautics and Space Administration (NASA) to establish and implement a framework to research, develop, and test increasingly complex UTM concepts and capabilities with industry stakeholders. For example, in one scenario tested in Virginia, UAS operators using UTM were alerted to a rescue helicopter, allowing the operators to avoid the area.

Example of a Traffic Management Scenario Simulating a Real-World Situation for an Unmanned Aircraft System (UAS)



Sources: GAO analysis of Virginia Tech Mid Atlantic Aviation Partnership information. | GAO-21-165

To further develop and implement UTM, FAA conducted tests through its UTM pilot program, completed in November 2020, and is working on a UTM implementation plan. However, industry stakeholders said they need more information on the next steps, and it is uncertain whether FAA's plan will include performance goals and measures. FAA has reported that it plans to use results from the pilot program to inform its implementation plan, statutorily required one year after the pilot program concludes. UAS stakeholders generally agreed with FAA's approach for moving UTM toward implementation. However, they said that they face planning challenges because FAA provides limited information on timing and substance of next steps, such as areas of UTM technology that FAA will focus on during testing. In addition, FAA has not indicated whether the implementation plan will include performance goals and measures, instead stating that such metrics are not statutorily required. Providing more data to the UAS industry and public stakeholders in the short term and including goals and metrics in the plan could help stakeholders make informed decisions and better align their activities with FAA plans for UTM testing and implementation.

Contents

Figures

Abbreviations

AIA	Aerospace Industries Association
AMA	Academy of Model Aeronautics
AUVSI	Association for Unmanned Vehicle Systems International
COVID-19	Coronavirus Disease 2019
DAA	detect and avoid technology
DAC	Drone Advisory Committee
DOT	Department of Transportation
DHS	Department of Homeland Security
FAA	Federal Aviation Administration
FIMS	Flight Information Management System
GPRA	Government Performance and Results Act
GPRAMA	GPRA Modernization Act of 2010
LAANC	low-altitude authorization and notification capability
MAAP	Virginia Tech Mid-Atlantic Aviation Partnership
NASA	National Aeronautics and Space Administration
NextGen	Next Generation Air Transportation System
operators	small UAS operators
pilot program	UTM pilot program
Remote ID	remote identification of UAS
RTT	Research Transition Team
UAS	unmanned aircraft systems
USS	UAS service suppliers
UTM	UAS Traffic Management

UVR	UAS Volume Reservations

441 G St. N.W.
Washington, DC 20548

January 28, 2021

Chairman
Ranking Member
Committee on Commerce, Science, and Transportation
United States Senate

The Honorable Peter A. DeFazio
Chairman
The Honorable Sam Graves
Ranking Member
Committee on Transportation and Infrastructure
House of Representatives

The emergence of unmanned aircraft systems (UAS)—commonly referred to as "drones"—has the potential to provide significant social and economic benefits in the United States. In 2020, the Federal Aviation Administration (FAA) forecasted that, by 2024, the small UAS commercial fleet (those operated in connection with a business) will grow from 507,000 to 828,000 and that the UAS recreational fleet (those operated for personal interest and enjoyment) will increase from 1.38 million to 1.48 million.[1] Operators of small UAS must be registered with FAA, which is tasked with safely integrating UAS into the national airspace system—a complex network of airports, aircraft, air-traffic-control facilities, employees, and pilots—through the development of various policies, regulations, and standards.[2] Policy makers and stakeholders face a range of challenges with this integration. Among these is how to manage small UAS traffic operating at low-altitude—set by FAA at below 400 feet—to ensure the safety of the public, as well as ensuring operators' adherence to regulations governing air traffic.

In 2013, the National Aeronautics and Space Administration (NASA) began developing concepts for UAS Traffic Management (UTM) systems

[1]Federal Aviation Administration, *FAA Aerospace Forecast Fiscal Years 2020-2040*. Small UAS are defined as those weighing less than 55 pounds. For the purposes of this report, the term UAS refers to small UAS—those weighing less than 55 pounds.

[2]Operators of small UAS weighing less than 0.55 pounds flying under the exception for limited recreational operations of unmanned aircraft—as explained below—do not need to register with FAA.

for small UAS operating at low-altitude.[3] UTM is the proposed system for providing UAS air navigation services in low-altitude airspace. FAA and NASA formed a UTM research transition team in 2015 to jointly undertake the development and implementation of UTM—with NASA conducting research and development, and then transferring UTM capabilities and technologies to FAA. FAA is expected to use this research to develop and oversee systems, procedures, and policies needed to implement an overall UTM ecosystem (i.e., the network of actors, services, capabilities, information flows, and supporting architecture involved in low-altitude UAS operations).

Among other things, the FAA Reauthorization Act of 2018 included a provision for GAO to review issues related to the infrastructure requirements necessary for monitoring the low-altitude operations of small UAS and enforcing applicable laws.[4] This report discusses UTM and its broad implications for UAS policy development and related infrastructure needs. Specifically, we examine:

- the concept of UTM and the challenges to UTM development and implementation,
- the actions FAA has taken to develop UTM, and
- what additional steps are needed to achieve UTM implementation in the national airspace.

This report focuses on traffic management efforts for small UAS (those weighing less than 55 pounds), operating below 400 feet above ground level.

To address these objectives, we reviewed relevant statutes, regulations, and FAA documents related to developing and implementing UTM and

[3]The concept of operations was required by the FAA Modernization and Reform Act of 2012, Pub. L. No. 112–95, § 208, 126 Stat. 11, 41-43(FMRA) An update to the concept of operations was required by the FAA Reauthorization Act of 2018, Pub. L. No. 115-254, § 342,132 Stat. 3186, 3287-88 (codified at 49 U.S.C. § 44802 note).

[4]Pub. L. No. 115-254, 132 Stat. 3186, 3313. On May 8, 2019, we provided correspondence to the U.S. Senate Committee on Commerce, Science, and Transportation and the Committee on Transportation and Infrastructure of the U.S. House of Representatives. The correspondence related to GAO's review of various UAS-related provisions in Section 373, among other things.

integrating UAS into the national airspace system.[5] These FAA documents included: *Unmanned Aircraft System Traffic Management Concept of Operations*,[6] *Implementation Plan for Integration of Unmanned Aircraft Systems into the National Airspace System*,[7] and *UTM Pilot Program Data Management Plan*.[8] We analyzed documents related to FAA's rulemaking efforts with implications for UTM including proposed rules include notices of proposed rulemaking regarding the remote identification of UAS[9] and operation of small UAS over people,[10] and an advance notice of proposed rulemaking on safe and secure operations of UAS.[11] We also reviewed final rules issued by FAA regarding remote identification of UAS[12] and operations of small UAS over people.[13]

Given NASA's research and development role in UTM, we also reviewed joint NASA and FAA documents and plans, including: *NASA and FAA UAS Traffic Management Research Transition Team Plan,*[14] *FAA and*

[5]We reviewed the FAA Reauthorization Act of 2018, Pub. L. No. 115-254, 132 Stat. at 3186, the FAA Extension, Safety, and Security Act of 2016, Pub. L. No. 114-190, § 2201-13, 130 Stat. 615, 638 (2016) (FESSA), and FMRA, Pub. L. No. 112–954, §§ 331-36, 126 Stat. at 72-78.

[6]Federal Aviation Administration, *Unmanned Aircraft System (UAS) Traffic Management (UTM) Concept of Operations, version 2.0* (Washington, D.C.: Mar. 2, 2020).

[7]Federal Aviation Administration, *Implementation Plan for Integration of Unmanned Aircraft Systems into the National Airspace System: FY2019 Implementation Plan* (Washington, D.C.: March 2019).

[8]Federal Aviation Administration, *UTM Pilot Program (UPP) Data Management Plan* (Washington, D.C.: Mar. 8, 2019).

[9]Remote Identification of Unmanned Aircraft Systems, 84 Fed. Reg. 72438 (Dec. 31, 2019).

[10]Operation of Small Unmanned Aircraft Systems Over People, 84 Fed. Reg. 3856 (Feb. 13, 2019) (to be codified at 14 C.F.R. pt. 107).

[11]Safe and Secure Operations of Small Unmanned Aircraft Systems, 84 Fed. Reg. 3732 (Feb. 13, 2019) (to be codified at 14 C.F.R. pt. 107).

[12]Remote Identification of Unmanned Aircraft, 86 Fed. Reg. 4390 (Jan. 15, 2021).

[13]Operation of Small Unmanned Aircraft Systems Over People, 86 Fed. Reg. 4314 (Jan. 15, 2021).

[14]National Aeronautics and Space Administration and Federal Aviation Administration, *UAS Traffic Management (UTM) Research Transition Team (RTT) Plan* (Washington, D.C.: Jan. 31, 2017).

NASA Unmanned Aircraft Systems Traffic Management UTM Pilot Program Summary Report,[15] and documents related to UAS Traffic Management Pilot Program Phase 2. We also reviewed documents from FAA's Drone Advisory Committee—a group of high-level participants from industry, government, airports, and the manned aviation community—that provides advice to FAA on key UAS integration issues. While the UTM pilot program includes actions FAA is taking to develop UTM, we discuss the pilot program effort in relation to additional steps that may be needed to achieve UTM implementation, because this program is critical to this transition.

We determined the following components of internal control in the federal government were significant to this review:[16]

- risk assessment, along with the underlying principle that an entity's management should define objectives in such a way that objectives are clearly understood at all levels of the entity, and
- information and communication, along with the underlying principles that management should communicate externally the necessary quality information to achieve the entity's objectives.

We assessed FAA's documents and actions related to developing and implementing UTM to determine the extent to which FAA set performance goals to clearly define desired program outcomes and develop performance measures that are clearly linked to the performance goals. We assessed FAA's communication with external stakeholders to determine the extent to which FAA communicated with and obtained quality information from those stakeholders so that external parties could help FAA achieve its objectives and address related risks. In addition, we compared FAA's documents and actions to our prior work on results-

[15]Federal Aviation Administration and National Aeronautics and Space Administration, *Unmanned Aircraft Systems (UAS) Traffic Management (UTM) UTM Pilot Program Summary Report (UPP)* (Washington, D.C.: October 2019).

[16]GAO, *Standards for Internal Control in the Federal Government*, GAO-14-704G (Washington, D.C.: September 2014).

oriented organizations and the importance of performance measures to show progress toward achieving program goals.[17]

We interviewed FAA and NASA officials and UAS stakeholders to get their opinions: on the actions FAA has taken to develop and implement UTM, on challenges to developing UTM, and on any additional steps needed to fully develop and implement UTM. For the purposes of this report, we define stakeholders to include UAS manufacturers, UAS service suppliers, recreational and commercial UAS operators, and other interested third party organizations such as universities and state governments involved with UTM research. More specifically, we conducted semi-structured interviews with representatives from a non-generalizable sample of 19 UAS stakeholder groups selected based on their participation in the Federal Aviation Administration (FAA)'s UAS traffic management (UTM) Pilot Program, their participation in FAA's Drone Advisory Committee, and recommendations from other UAS stakeholders, or because they are UAS and aviation stakeholders who were previously identified in our prior work. More information about stakeholder selection and a full list of the stakeholders we interviewed are included in appendix I.

Due to the relatively early stage of UTM development, not all stakeholders had opinions on all topics discussed. Accordingly, we do not enumerate stakeholder responses in the report. Instead, we analyzed the responses and reported on common themes that arose during the stakeholder interviews. Because we selected a non-generalizable sample of stakeholders, their responses should not be used to make inferences about a population. To characterize stakeholders' views in some cases, we defined modifiers (e.g., "several") to quantify stakeholders as follows:

- "several" stakeholders represents stakeholders in 3 to 5 of the interviews,
- "some" stakeholders represents stakeholders in 6 to 11 of the interviews, and

[17]GAO, *Executive Guide: Effectively Implementing the Government Performance and Results Act*, GAO/GGD-96-118 (Washington, D.C.: June 1996); *Veterans Justice Outreach Program: VA Could Improve Management by Establishing Performance Measures and Fully Assessing Risks*, GAO-16-393 (Washington, D.C.: Apr. 28, 2016); *Performance Measurement and Evaluation: Definitions and Relationships*, GAO-11-646SP (Washington, D.C.: May 2, 2011); and *Managing for Results: Enhancing Agency Use of Performance Information for Management Decision Making*, GAO-05-927 (Washington, D.C.: Sept. 9, 2005).

- “many” stakeholders represents stakeholders in 12 or more of the interviews.

We conducted this performance audit from June 2019 to January 2021, in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

Historically, unmanned aircraft systems have been known by many names including: drones, remotely piloted vehicles, unmanned aerial vehicles, and models. Today, the term UAS is generally used to emphasize that separate system components are required to support airborne operations without a pilot onboard the aircraft.[18] Recreational users have flown UAS—largely model aircraft—for years with minimal FAA interaction. More technically advanced UAS are being used in a variety of ways by different types of users. Certain industries are interested in expanding the allowable uses for UAS, such as expanding use of UAS in controlled airspace.[19] Expanding allowable uses would likely require more FAA involvement and regulatory action. UAS operators (operators) generally fall into the following categories:

- Non-recreational users operate UAS for non-recreational purposes. Examples of non-recreational uses include commercial uses, such as wedding or real estate photography, mapping or land surveys, and factory or equipment inspections. These UAS operators must follow the regulatory scheme under Part 107 of Title 14 of the Code of Federal Regulations, otherwise known as “Part 107.” To operate under Part 107, a user must obtain a remote pilot certificate from

[18]For the purposes of this report, the term UAS refers to small UAS—those weighing less than 55 pounds.

[19]Controlled airspace exists around some airports and at certain altitudes where air traffic controllers are actively communicating with, directing, and separating all air traffic. Other airspace is considered uncontrolled in the sense that air traffic controllers are not directing air traffic within its limits. In general, drone operators may only fly in uncontrolled airspace below 400 feet above the ground. 14 C.F.R. § 107.51(b). Drone operators are required to get permission from the FAA before flying in controlled airspace. 14 C.F.R. § 107.45.

FAA.[20] Non-recreational operators must fly within visual-line-of-sight, and register each UAS used for commercial purposes with FAA, among other requirements.

- Recreational fliers—that is operators (previously known as hobbyist or model aircraft operators) of small UAS that are flown strictly for recreational purposes and meet other criteria— may but are not required to follow the Part 107 rules. Instead, recreational fliers may operate UAS without specific FAA certification or authorization if the operation adheres to all UAS "recreational operations" requirements in 49 U.S.C. § 44809. To operate UAS under this statutory exception for limited operations of unmanned aircraft, a user must fly within visual-line-of-sight, fly strictly for recreational purposes, and obtain a certificate of registration from the FAA, among other requirements. The certification constitutes registration for all unmanned aircraft owned by the individual and operated recreationally.
- Public safety and government users operate UAS in a variety of ways to support key activities of their missions. For example, firefighters use UAS to identify a fire's perimeter and areas of intense heat and the Department of the Interior uses UAS to survey national parks. Public safety and government users must operate UAS under Part 107 unless the users' activities qualify the UAS as public aircraft conducting a governmental function, in which case they may operate under a Certificate of Authorization that demonstrates FAA's approval of airspace access.[21] Public safety and government users must register each UAS.[22]

In coordination with government and UAS stakeholders, FAA is conducting a phased approach to incrementally integrate both existing and planned UAS operations safely and routinely into the national airspace system. Safe integration of UAS is important because it creates

[20]14 C.F.R. § 107.12.

[21]The term public aircraft is defined by statute in 49 U.S.C. § 40102(a)(41) and, governmental function is defined in 49 U.S.C. § 40102(a)(2). These entities may apply for a Certificate of Authorization to conduct public aircraft operations for one of the governmental functions listed in the statute. Governmental functions include activities undertaken by a government, such as intelligence missions, search and rescue, aeronautical research, or geological resource management. 49 U.S.C. § 40125(a)(2). See also FAA, Public Aircraft Operations—Manned and Unmanned, Advisory Circular No. 00-1.1B, Sept. 21, 2018.

[22]Public safety and government users may fly a mission either as: (a) a civil operator under 14 C.F.R. part 107 or (b) as a Public Aircraft Operator under a Certificate of Authorization.

a foundation for the development of future economic benefits, including more investment in commercial uses. For example, during the Coronavirus Disease 2019 (COVID-19) pandemic, UAS were used for contactless distribution of personal protective equipment and medical supplies at hospitals. Routine, for-hire UAS package delivery is on the horizon and FAA predicts that growth in the UAS small-package delivery sector could be "phenomenal."[23] Integration of UAS could also result in safety benefits, such as more effective disaster response efforts.

However, a UAS operator may generally not operate beyond the operator's visual-line-of-sight—likely a critical requirement for large-scale commercial UAS delivery. FAA may grant waivers on a case-by-case basis and has done so for some UAS operators—including commercial and government users—to operate beyond visual-line-of-sight or at night for purposes including inspection of hurricane damage and aerial photography. However, FAA will not waive the visual-line-of-sight prohibition in order to allow aircraft to carry the property of another for compensation or hire.[24] A limited number of operators have conducted beyond visual-line-of-sight package deliveries through the UAS Integration Pilot Program.[25]

Pursuant to statute, FAA is the primary agency responsible for facilitating the safe integration of UAS into the national airspace system.[26] FAA's UAS Integration Office, located in the Office of Aviation Safety, seeks to integrate UAS operations into the national airspace system while ensuring the safety of the public and integrity of the airspace. As UAS increasingly enter and operate within the national airspace system, FAA officials told

[23]*FAA Aerospace Forecast, Fiscal Years 2020-2040.*

[24]14 C.F.R. § 107.205(c).

[25]The UAS Integration Pilot Program, authorized in section 351 of the FAA Reauthorization Act of 2018, looked at matters such as expanding UAS operations while maintaining safety, security, and property and privacy rights, and identifying the most effective models of balancing these interests. FAA Reauthorization Act of 2018, Pub. L. No. 115-254, § 351, 132 Stat. at 3301-04. The UAS Integration Pilot Program is distinct from the UTM Pilot program, which is discussed later in this report and is required under FESSA, Pub. L. No. 114-190, § 2208(b), 130 Stat.at 633-34, and section 376(b) of the FAA Reauthorization Act of 2018. FAA Reauthorization Act of 2018, Pub. L. No. 115-254, § 376(b), 132 Stat. at 3314-17.

[26]49 U.S.C. § 44802. In addition, FAA has asserted responsibility for air safety "from the ground up" pursuant to 49 U.S.C. § 40103, which directs FAA to regulate "the use of the navigable airspace . . . to ensure the safety of aircraft and the efficient use of airspace" and declares every "citizen of the United States has a public right of transit through the navigable airspace." 49 U.S.C. §§ 40103(a), (b)(1).

us FAA's responsibility is to plan for and oversee the UTM ecosystem. UTM is intended to enable safe UAS operations in low-altitude airspace (below 400 feet) and facilitate the integration of UAS into the national airspace system. NASA was responsible for the initial research, development, and testing of various technologies that might be included in the UTM ecosystem and subsequently transferred the results of the research to FAA.

UTM Is Complex and Faces a Variety of Challenges to Develop and Implement

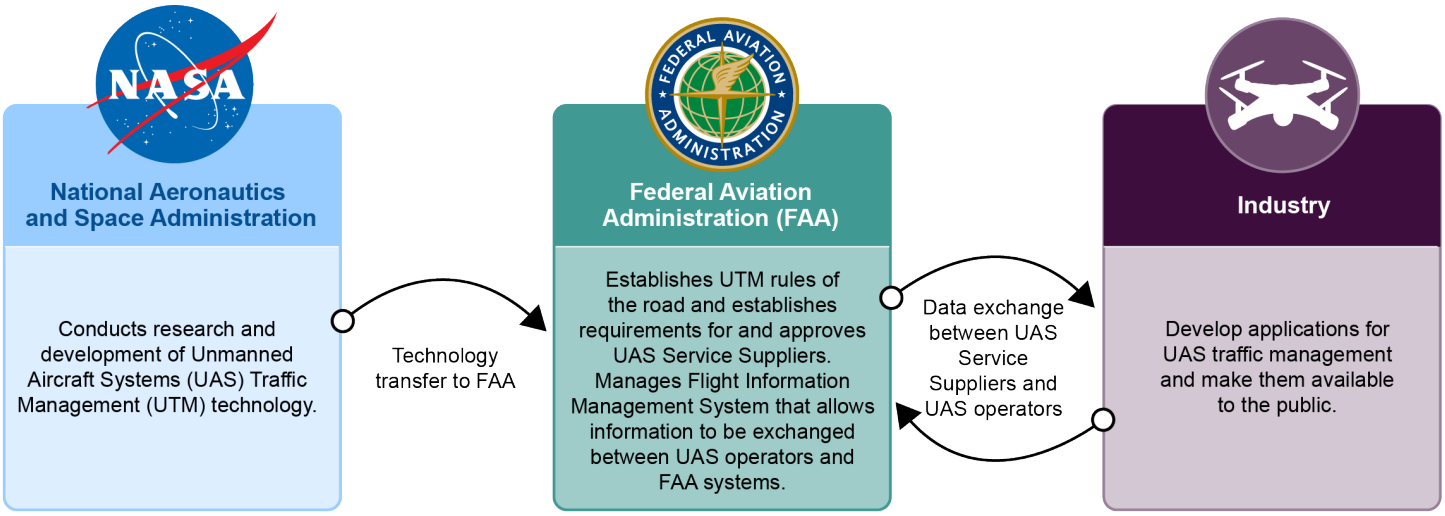
FAA's Concept for UTM

FAA's concept for UTM involves the incremental development of a UTM ecosystem, primarily focused on developing low complexity operations and building in higher complexity operational concepts and requirements over time. This incremental approach, outlined in FAA's *Concept of Operations*, first issued in May 2018, states that UTM is being designed to support the demand and expectations for a broad spectrum of operations with ever-increasing complexity and risk[27]. Each step is designed to advance the UTM ecosystem design and service provided. FAA's *Concept of Operations* also notes that UTM will be a separate, but complementary, traffic management system to the current FAA air-traffic control system.

There is broad consensus among FAA, NASA, and UAS stakeholders that developing and deploying a UTM ecosystem would be a complex undertaking primarily because UTM requires the establishment of regulatory frameworks and the development of operating rules and performance requirements. Further contributing to the complexity, the roles, responsibilities, and activities that will collectively make up the UTM ecosystem are divided among various actors. See figure 1 for additional information on the roles and responsibilities of NASA, FAA, and industry.

[27]Federal Aviation Administration, *Unmanned Aircraft System (UAS) Traffic Management (UTM) Concept of Operations, version 2.0* (Washington, D.C.: Mar. 2, 2020).

Figure 1: Selected Roles and Responsibilities in an Unmanned Aircraft Systems (UAS) Traffic Management Ecosystem



Source: GAO analysis of Federal Aviation Administration information. | GAO-21-165

Text of Figure 1: Selected Roles and Responsibilities in an Unmanned Aircraft Systems (UAS) Traffic Management Ecosystem

1. National Aeronautics and Space Administration: Conducts research and development of Unmanned Aircraft Systems (UAS) Traffic Management (UTM) technology.
2. Technology transfer to FAA
3. Federal Aviation Administration: Establishes UTM rules of the road and establishes requirements for and approves UAS Service Suppliers. Manages Flight Information Management System that allows information to be exchanged between UAS operators and FAA systems.
4. Data exchange between UAS Service Suppliers and UAS operators
5. Industry: Develop applications for UAS traffic management and make them available to the public.

The *Concept of Operations* states that UTM will be a community-based traffic management system, in which operators are responsible for the coordination, execution, and management of operations, with rules of the road established by FAA. The *Concept of Operations* does not prescribe solutions or specific implementation methods. Rather, it describes the essential conceptual and operational elements associated with UTM operations that will inform the development of solutions across the many stakeholders involved in implementing UTM. Furthermore, the *Concept of Operations* supports an approach to implementation where more complex

airspace environments are tested and validated by field demonstrations. According to FAA, UTM will ultimately allow for full integration of unmanned and manned aircraft at low-altitudes.

The current *Concept of Operations* includes the UTM operational concept, which provides the principles around which UTM is based, such as the operational requirements needed to provide a comprehensive set of traffic services. This operational concept envisions UTM as a set of federated services—a group of systems and networks operating in a standard and connected environment—and a framework for managing multiple UAS operations. UTM would encompass all infrastructure, policies, procedures, services, and personnel required to support low-altitude UAS operations. Additionally, UTM is expected to be centered on the sharing of information among operators and UAS service suppliers (USS)[28] via an information exchange framework and airspace constraints set by the FAA.[29] If UAS operators are planning to fly in airspace around airports, the operators must receive an airspace authorization from FAA before they can fly.[30] It is expected that FAA may exchange information with USS—private entities that may be qualified by FAA, as needed—that, in turn, will provide services to small UAS operators.

FAA envisions that USS will be key to this framework by providing services to the operator in meeting UTM operational requirements. USS will coordinate and distribute to appropriate entities, among other things, operator intent and vehicle-tracking data. These data will support numerous services, including terrain and obstacle-clearance-and-detect-and-avoid functions, which are discussed below. Operators will likely be able to access UTM, for example, through smart phone applications to map routes for UAS flights and check for flight restrictions. Moreover, when UTM services are deployed, FAA can use the system to provide directives and make relevant information on operations available to

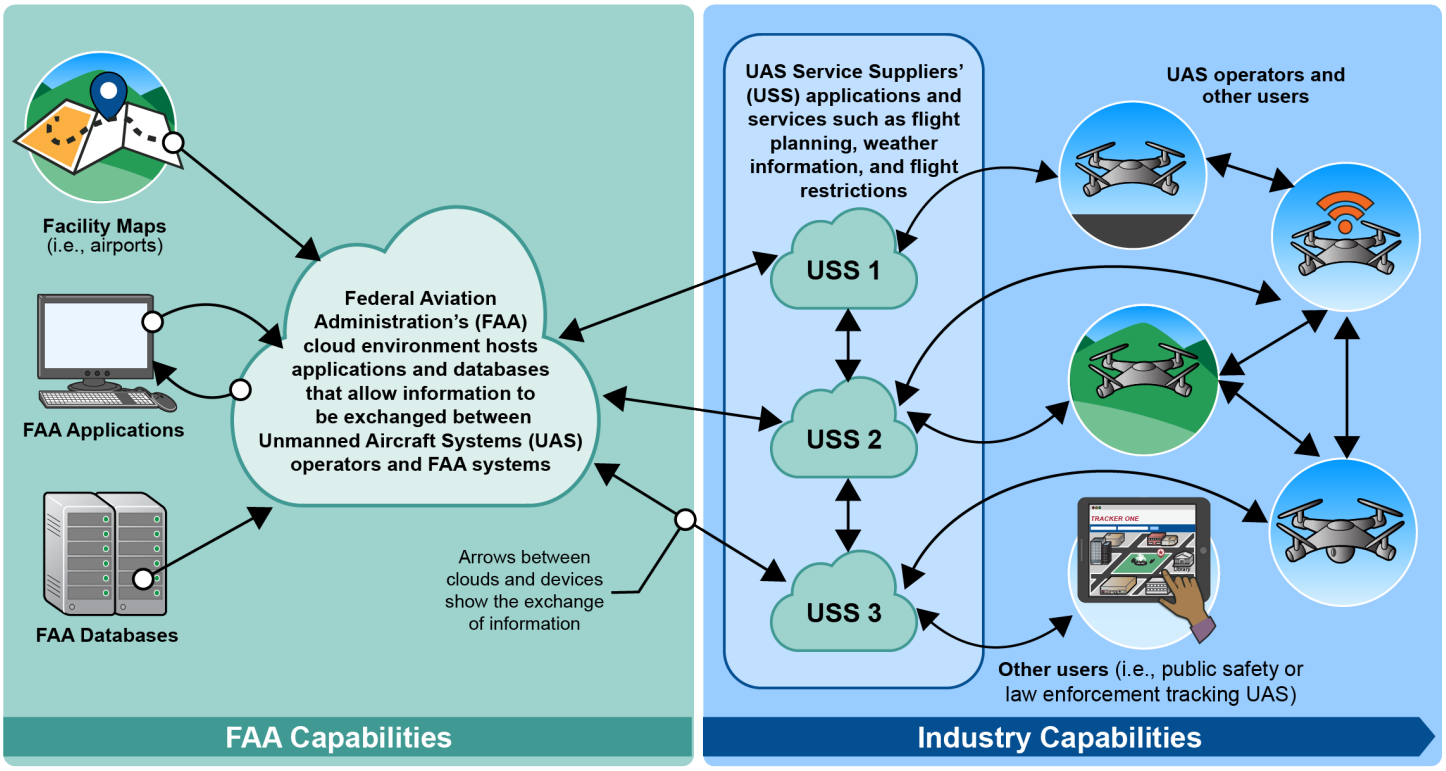
[28]In this report, we are using USS to note the singular and plural use of UAS service suppliers.

[29]This framework is the ability of an unmanned aircraft in flight to provide certain identification and location information that people on the ground and other airspace users can receive. One part of that, remote identification (Remote ID) would provide FAA, law enforcement agencies, and other UAS users with the ability to remotely identify UAS while in flight. FAA issued a final rule regarding remote identification in December 2020 and the rule was published in the Federal Register January 2021. Remote Identification of Unmanned Aircraft, 86 Fed. Reg. at 4390.

[30]FAA's low-altitude authorization and notification capability (LAANC) is a UAS data exchange that allows operators request and receive approval to in controlled airspace.

operators via the UTM ecosystem. According to FAA officials, supplemental data service providers are another UTM service that can work directly with an operator or in conjunction with a USS, to provide additional information that is not provided by FAA before and during a flight. Figure 2 depicts FAA's concept for FAA and industry capabilities in a UTM ecosystem.

Figure 2: Federal Aviation Administration's (FAA) Concept for FAA and Industry Capabilities in Unmanned-Aircraft- Systems Traffic Management Ecosystem



Source: GAO analysis of FAA documentation. | GAO-21-165

Text of Figure 2: Federal Aviation Administration's (FAA) Concept for FAA and Industry Capabilities in Unmanned-Aircraft-Systems Traffic Management Ecosystem

FAA Capabilities	Industry Capabilities
Federal Aviation Administration's (FAA) cloud environment hosts applications and databases that allow information to be exchanged between Unmanned Aircraft Systems (UAS) operators and FAA systems	UAS Service Suppliers' (USS) applications and services such as flight planning, weather information, and flight restrictions

Note: According to FAA officials, supplemental data service providers are another UTM service that can work directly with an operator or in conjunction with a USS, to provide additional information that is not provided by FAA before and during a flight.

Many UAS stakeholders told us that FAA's *Concept of Operations* effectively outlines the public-private partnership and shows how industry will be providing most UTM services while FAA regulates and oversees safety. FAA is targeting a release date of an updated version of the concept of operations in 2021, and future versions will continue to be developed as needed. According to FAA, additional versions are needed to reflect the progress of research and continued concept maturation resulting from collaboration among FAA, NASA, and UAS stakeholders.

Technology, Public Policy, and Regulatory Challenges

In addition to the multiple components needed for UTM to come together, FAA faces broader issues with the safe integration of UAS technology that also affects UTM development and implementation. Specifically, in its *2018 UAS Integration Roadmap,* FAA outlined key technology and public policy challenges to the safe and efficient integration of UAS into the national airspace system. FAA officials said these challenges also apply to developing UTM, particularly for low-altitude operations.[31] Additionally, FAA officials said developing a regulatory framework and having the necessary rules in place are challenges to both UAS integration and UTM development and implementation.

Technology Challenges

The following technology challenges related to more routine UAS operations also affect UTM implementation.

- **Detect and Avoid (DAA).** DAA technology, sometimes referred to as see and avoid, is intended to ensure UAS maintain a safe distance from other aircraft, both manned and unmanned, and prevent mid-air collisions. FAA said that developing detect and avoid operating requirements is one of the key challenges to implementing UTM and integrating UAS into the national airspace. According to FAA, in order to develop DAA operating requirements, minimum performance standards need to be developed for UAS operating beyond visual line of sight. In its *2018 UAS Integration Roadmap,* FAA stated that it is researching specific challenges related to DAA, including assessing DAA multi-sensor use and other technologies and determining the minimum amount of information required for collision avoidance maneuvering. FAA officials told us in September 2020, that there are

[31]FAA, *Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap: Second Edition* (July 2018).

several efforts under way within standards bodies to develop industry standards for DAA, and FAA is funding research into various aspects of minimum performance requirements.

- **Command and Control (C2).** The command and control communication link between a UAS and its operator is critical to enable the operator to maintain control of the UAS during normal operations, as well as to avoid bad weather or other obstacles. According to FAA, some specific challenges associated with UAS command and control include developing requirements for radio spectrum, which requires working with the Federal Communications Commission and the National Telecommunications and Information Administration, and determining which of many possible network approaches (terrestrial, satellite-based, or airborne radios) should be used to sustain the UAS command and control system.[32]

Public Policy Challenges

Public policy challenges related to expanded UAS use and integration will also affect UTM implementation.

- **Privacy.** According to FAA, the increased availability of UAS technology and proliferation of UAS operations across the national airspace increases the potential use of UAS for illegal activity such as the unlawful invasion of privacy.[33] FAA has reported that it lacks authority to issue regulations to address privacy concerns raised by UAS operations.[34] As FAA explained in 2016 when issuing the Part 107 UAS rules, FAA regulates the safe and efficient operation of aircraft within the national airspace system, and in particular, the FAA Modernization and Reform Act of 2012, which directed FAA to integrate civil UAS into the national airspace system, did not direct FAA to consider privacy issues.[35]

[32]These are the possible communication systems that will allow operators to maintain command and control of their UAS.

[33]Remote Identification of Unmanned Aircraft Systems, 84 Fed. Reg. at 72,494.

[34]See, e.g., Operation of Small Unmanned Aircraft Systems Over People, 84 Fed. Reg at 3893.

[35]Operation and Certification of Small Unmanned Aircraft Systems, 81 Fed. Reg. 42064, 42190-91 (June 28, 2016).

Although FAA believes it lacks authority to regulate UAS privacy, it nonetheless recognizes that unique characteristics and capabilities of UAS may pose risks with regard to individual privacy.[36] FAA has included privacy-related terms and conditions in its agreements with lead participants in the UAS Integration Pilot Program. In addition, FAA acknowledges the public's concerns regarding the use of small UAS to collect information about individuals.[37] FAA, has reported taking steps to help address these concerns through engagement and collaboration with the public, stakeholders, and other agencies with authority and subject matter expertise in privacy law and policy. According to FAA officials, some privacy challenges could be addressed by UTM and the ability of individuals or law enforcement to remotely identify and track UAS engaging in careless or dangerous behavior.

According to UAS stakeholders and FAA, there are also privacy concerns related to UTM. For example, representatives from several UAS stakeholder groups stated that UTM could potentially allow competing business interests to have access to proprietary information, such as the number of deliveries and routes. Additionally, a representative of another UAS stakeholder group expressed privacy-related concerns about UTM, such as how personally identifiable information will be handled, including the information about an operator that is available to members of the public and to law enforcement.

- **Security.** Cybersecurity is a broader issue for UAS integration. According to FAA officials, potential cyberattacks could exploit design and implementation weaknesses in UTM software, hardware, or interfaces. Examples include exploiting wired and wireless network protocols for unauthorized access, and software bugs for malware. FAA is working with industry partners and federal stakeholders to identify and address the cyber security risks associated with the overall national airspace system. These efforts include identifying the security issues, defining the security requirements, and determining security mitigations for risks associated with systems specific to UAS, for example command and control links between unmanned aircraft and their operators.

[36]For additional information on this topic, see: GAO, *Unmanned Aircraft Systems: Current Jurisdictional, Property, and Privacy Legal Issues Regarding the Commercial and Recreational Use of Drones*, B-330570 (Washington, D.C.: Sept. 16, 2020).

[37]Operation of Small Unmanned Aircraft Systems Over People, 84 Fed. Reg. at 3893

FAA has also stated the increased availability of UAS technology increases the potential use of UAS for illegal activity such as sabotaging critical infrastructure.[38] FAA officials said they are concerned about UAS potentially threatening physical security, as well as the need for UTM to mitigate these concerns. One of FAA's concerns regarding physical security involves potential rogue UAS operators intending to cause physical harm, to inflict property damage, or otherwise to disrupt lives of members of the public. According to FAA, in the event of UAS-related threats, UTM will provide relevant information and assistance to responsible authorities. In the *2018 UAS Integration Roadmap,* FAA stated that it is working extensively with other federal agencies to address these concerns. For example, in December 2015, the Department of Homeland Security (DHS) and FAA signed a memorandum of understanding related to security. This memorandum set forth terms by which DHS and FAA will cooperate on various activities that support UAS integration into the national airspace system, with an emphasis on enhancing both aviation safety and security through broad research and concept exploration projects.

Regulatory Challenges

FAA's rulemaking efforts to allow more complex UAS operations are, according to some stakeholders we spoke with, essential to implementing UTM. These rulemaking efforts include how to remotely identify UAS, operate UAS over people, and identify other UAS performance requirements. These efforts may help to address broader UAS integration challenges related to privacy and security as previously noted. According to FAA officials, such efforts could enhance an operator's ability to fly UAS safely in the national airspace by providing greater awareness of all aircraft and support more routine operations over people—which UTM also aims to support. FAA officials told us they anticipate future rulemakings related to UTM, such as a rule on beyond visual line-of-sight UAS operations.

- **Remote identification of UAS (Remote ID).** FAA issued a final rule in December 2020 that was published in the Federal Register in January 2021. The rule establishes requirements related to the ability of a UAS in flight to provide identification information that can be

[38]Remote Identification of Unmanned Aircraft Systems, 84 Fed. Reg. at 72,455, 72,494.

received by other parties.[39] The rule states that Remote ID is necessary to ensure public safety and the safety and efficiency of the airspace. Additionally, the rule states that a Remote ID system that provides for immediate awareness of unmanned aircraft in the widest variety of settings will be adequate to support the phased, incremental approach, while allowing the UAS industry additional time to continue developing the network-based UTM ecosystem. Stakeholders we spoke with also said Remote ID is fundamental to the development of a mature UAS regulatory framework and that the technology would address safety, security, and privacy concerns. The rule states that operators must comply with the rule's requirements in 30 months after the rule goes into effect.

- **Other rulemakings.** FAA has additional rulemakings that are related to integrating UAS into the national airspace and that could affect UTM implementation. For example, FAA issued a final rule in December 2020 that was published in the Federal Register published a final rule in January 2021. This final rule allows expanded routine operations of UAS over people without a waiver or exemption in certain conditions, operations that UTM also aims to support.[40] Additionally, in February 2019 FAA released an advance notice of proposed rulemaking to seek public comment on whether FAA should begin a new rulemaking related to, for instance, additional operating and performance requirements for UAS.[41] The notice seeks comment from the public on, among other things, how additional information can be shared via UTM to help reduce risks to public safety and national security.

FAA officials said that UTM could inform how to address the challenges discussed above. According to FAA's *Concept of Operations,* FAA expects that UTM would involve industry's developing standards, innovating, and developing solutions that will help address technology challenges, and assisting in the management of increasing numbers of UAS operations now and into the future.[42] UTM allows FAA to maintain its authority over the airspace, while allowing industry to manage operations in areas authorized for low altitude UAS flights. As such, UAS

[39]Remote Identification of Unmanned Aircraft, 86 Fed. Reg. at 4390.

[40]Operation of Small Unmanned Aircraft Systems Over People, 86 Fed. Reg. at 4314.

[41]Safe and Secure Operations of Small Unmanned Aircraft Systems, 84 Fed. Reg. at 3732.

[42]For example, FAA officials told us that industry was responsible for developing standards on USS-to-USS data exchange.

stakeholders have been working with NASA and FAA to test various UTM technologies to help address these challenges, which we describe in greater detail later in the report.

FAA Has Collaborated with NASA and UAS Stakeholders on a Range of Actions to Develop UTM

FAA and NASA Established and Implemented a Framework to Research, Develop, and Test UTM Concepts and Capabilities with UAS Stakeholders

FAA and NASA worked together to create *The Research Transition Team (RTT) Plan* that describes the agencies' collaborative efforts to develop UTM to be conducted through September 2020.[43] FAA and NASA formed the *RTT Plan* in 2015 to jointly identify, quantify, conduct, and transfer UTM capabilities and technologies to FAA as the implementing agency and to provide guidance and information to UTM stakeholders. According to NASA officials, they will continue to conduct UTM research and will transfer it to FAA on an ongoing basis.

The *RTT Plan* contains NASA's UTM Research Platform, which outlined the research that NASA intended to do. From 2016 through 2019, NASA led research, development, and testing of various technologies that could be included in the UTM ecosystem and then transferred the results of this research to FAA. This research and development resulted in, among other things, the software prototype for the flight information management system (discussed below) and technical documentation to support additional research on detect and avoid technology and communications and guidance. Additionally, the *RTT Plan* produced *FAA's Concept of Operations* (discussed previously).

Specifically, NASA's UTM research included testing UTM capabilities and technologies in different real-world environments. NASA's UTM research was divided into four phases called technical capability levels, each with specific technical goals. NASA selected six test sites— Alaska, Nevada,

[43]FAA and NASA *UAS Traffic Management (UTM) Research Transition Team (RTT)*, (January 2017).

New York, North Dakota, Texas, and Virginia— from FAA's designated list of seven UAS test sites to participate, to varying degrees, in the different phases.[44] In addition to using the FAA designated UAS test sites, NASA managed two major flight tests using the UTM system and multiple individual on-board technology experiments to characterize communication, navigation, and detect and avoid equipment's performance. The scenarios tested during each demonstration were designed to mirror real world scenarios and entailed collaborating with as many as 35 industry partners to conduct controlled flight demonstrations and prototype tests in staged UTM environments. Each demonstration built on the capabilities tested during the previous demonstrations. According to NASA officials, the agency completed all four of its technical capability levels within their projected timeframes.

- Technical capability level 1 was completed in May 2016. NASA conducted a 1-day demonstration at the six test sites of the initial UTM system capabilities. This followed a NASA-managed flight test of UTM at Crows Landing, in the Central Valley of California, in August 2015. This technical capability level demonstrated management of airspace in lower risk (rural) environments and multiple visual line of sight UAS operations. The Crows Landing location was selected because it was remote and mostly unpopulated.
- Technical capability level 2 was completed in May 2017. NASA conducted demonstrations at the six test sites of the second version of the UTM system. This testing followed a NASA-managed flight test of UTM at the Reno Stead Airport in Nevada in October 2016. This technical capability level demonstrated management of airspace in complex multiple beyond-visual-line-of-sight UAS operations in lower risk (rural and industrial) environments. The Nevada location was selected because it was sparsely populated.
- Technical capability level 3 was completed in May 2018 with flight demonstration tests conducted at the six test sites. This technical capability level demonstrated technologies needed for beyond-visual-line-of-sight UAS operations over populated (suburban) areas and near airports.
- Technical capability level 4 was completed in August 2019 at Reno, Nevada, and Corpus Christi, Texas. This technical capability level

[44]FAA initially designated six test sites: North Dakota Department of Commerce, State of Nevada, University of Alaska Fairbanks, Texas A&M University at Corpus Christi, Virginia Polytechnic Institute & State University, and Griffiss International Airport (New York). In 2016, FAA designated New Mexico State University as a seventh test site.

demonstrated simultaneous UAS flight operations of multiple beyond-visual-line-of-sight operations over complex urban environments and dealing with contingency.

According to NASA officials, as part of its research, NASA developed technology to support data exchange needed for UTM and transferred the research and technology to FAA for further development and deployment. This technology was the Flight Information Management System (FIMS) prototype. According to FAA's *Concept of Operations,* FIMS is an interface for data exchange between FAA systems and UTM stakeholders (operators, other government agencies, and FAA). FIMS is managed by FAA and is a central component of the UTM ecosystem.[45]

FAA Continues to Work with UAS Stakeholders to Develop UTM

According to FAA, it relies on relationships across government and UAS stakeholders to ensure that its UAS integration efforts are consistent and, accordingly, continues to work with stakeholders to develop UTM. For example, UAS stakeholders continue to conduct flights and demonstrations at FAA designated test sites to help develop UTM. These activities are designed to test concepts and technologies, such as detect and avoid technologies and flying UAS beyond the operator's visual line of sight, among other things. According to FAA, the concepts and technologies identified in table 1 below are being tested at FAA designated sites.

Table 1: Unmanned Aircraft Systems (UAS) Traffic Management (UTM) Technologies and Concepts Being Tested at the Federal Aviation Administration's (FAA) Designated Test Sites

Technologies and concepts	Description
Command and Control	The command and control link or communication link between a UAS and its operator allows the operator to control the UAS, including maintaining control during various scenarios, such as avoiding bad weather or other obstacles.
Detect and Avoid (DAA)	This technology is intended to enable a UAS to detect and avoid other manned or unmanned aircraft. UAS operators desiring to operate in areas with high-density traffic may be required to equip with DAA technologies to meet these responsibilities.

[45]FAA also uses this interface as an access point for information on active UTM operations in the UTM pilot program.

Technologies and concepts	Description
Beyond Visual Line of Sight	This means that UAS fly beyond the visual line of sight of the operator. Beyond-visual-line-of-sight UAS operators are not able to visually separate from other UAS and manned aircraft. Accordingly, the operators are reliant on various technologies to safely operate in the national airspace system. The tests included package deliveries while flying beyond the visual line of sight.

Source: GAO review of FAA and National Aeronautics and Space Administration documents. | GAO-21-165

Industry and FAA are also collaborating to develop a UAS data exchange, which UAS stakeholders and FAA consider a key building block toward UTM. The low-altitude authorization and notification capability (LAANC) provides UAS operators wanting to fly near certain controlled airspace, such as participating airports, the ability to apply for and receive authorization from FAA to do so. Although LAANC is not intended to inform data exchange for UTM, FAA and stakeholders consider LAANC to be an important step toward UTM, as it provides nearly real-time authorization to operate in certain controlled airspace, through the use of USS. In comparison, as previously discussed, UTM, as conceived, would rely on USS for the provision of certain services, such as vehicle-tracking data. FAA also provides data on temporary flight restrictions, notices, and airspace maps of participating facilities through LAANC. According to FAA, as of November 2020, LAANC is currently provided through 17 different USS and allows operators access to fly in controlled airspace near 726 participating airports.

Additionally, FAA established a Drone Advisory Committee (DAC)—made up of high-level participants from various companies, state and local governments, airports, and the manned aviation community—to provide FAA with advice on key UAS integration issues. In October 2019, the DAC established a sub-group (a “task group”) focused on UTM. At a June 2020 DAC meeting, the UTM task group provided comments, at FAA’s request, on the second version of the *Concept of Operations,* including identifying areas where the group fully supports the concept of operations and 12 areas requiring more discussion (see table 2). For those areas requiring more discussion, in October 2020, FAA stated that it would collaborate with UAS stakeholders on these issues prior to publishing a third version of the *Concept of Operations* in 2021. FAA also announced in October that it was working with NASA to create a mechanism to collaborate on those areas needing discussion and would include industry associations in discussions to expand industry engagement.

Table 2: Drone Advisory Committee's (DAC) June 2020 Comments on the Federal Aviation Administration's (FAA) Unmanned Traffic Management (UTM) Concept of Operations

Areas of full support	
1.	The *Concept of Operation's* description of the federated UTM system.
2.	Recognition of the benefits of the low-altitude authorization and notification capability and the clear need for the UTM system.
3.	Understanding that some of the technologies referenced in the document are not fully developed yet, but will be necessary to maintain the safety of the National Airspace.
4.	Specification of performance rules governing unmanned aircraft systems (UAS) service suppliers and certain UTM services.
5.	Recognition of standards development organizations and their contributions to UTM and overall National Airspace System safety.
6.	Notion of government-qualified services and/or service providers.
Areas requiring more discussion	
1.	Role of Flight Information Management System (FIMS): the *Concept of Operations* should provide more clarity around the specific functions that FIMS will serve, the separation of the roles of FIMS and UAS service suppliers, as well as how FIMS can provide information to the legacy Air Traffic Control system.
2.	Participation of UAS within UTM: discussion is needed around participation within UTM, in terms of "all UAS" should participate in UTM versus "at some level" of participation in UTM.
3.	Role of "UAS Volume Reservations" (UVR). UVR refers to areas that impose restrictions on allowable UAS operations. Decisions will need to be made about whether UVR will be available to public safety entities only or will UVR also be available to commercial entities.
4.	Manned aircraft operators participation: More discussion is needed on responsibilities of manned operators in UTM.
5.	Benefits of UTM: additional benefits of UTM including, • a safe and stable environment for operators to operate through shared situational awareness and an operational framework consisting of standards, regulations, and common protocols that reduce risk. • a construct that allows FAA to maintain its authority over airspace, while allowing industry to manage operations in areas authorized for low altitude UAS flight; and • UTM provides a framework wherein an integrated suite of services can be used to increase situational awareness of the operating environment and mitigate operational risk.
6.	Role of performance authorizations: More information is needed about the specific type of performance linked to an authorization. For example, decisions need to be made about whether authorization could be linked to geographic location instead of airspace.
7.	Networked remote Identification (Remote ID): More clarity is needed on specifics tied to Remote ID and the UTM architecture.
8.	The ability for technology to take the place of certain UTM services.
9.	The accuracy of the scenarios: scenarios that are more complex may be needed to address future realities of the National Airspace System.
10.	Data protection: USS should meet international data protection standards in order to ensure that customer, government, and peer services are secured for the continued and safe operation of the UTM network. For example, to provide UTM services, USS may need to collect and use personal information from UAS operators; therefore, USS should use international standards for data privacy in how it collects personal data and prevents unauthorized use or disclosure.
11.	Volume-based versus trajectory-based strategic de-confliction Seeking clarity from the FAA on whether a trajectory-based approach, which is more aligned to evolving ATM system for legacy traffic, would be effective as UAS operations evolve into the future.
12.	Roles and responsibilities of the operator and USS: FAA must clearly define who or what entity is responsible for an individual piece of the UTM ecosystem and clearly define the roles and responsibilities for the operator and the USS platform.

Source: GAO review of FAA Drone Advisory Committee document. | GAO-21-165

FAA Continues a Phased Approach toward UTM Implementation but Lacks Information on How Progress Will Be Measured

Analyzing Results from the Pilot Program and Issuing a Final Report Is the Next Step in Implementing UTM

FAA concluded a statutorily mandated UTM Pilot Program (pilot program) in November 2020 that, according to FAA officials, will be used to evaluate FAA and NASA's UTM research technologies and further develop and demonstrate services that will support UTM implementation.[46] In April 2017, FAA established the pilot program and used it to demonstrate how to integrate a variety of operations within UTM, such as the sharing of operational intent among operators and the creation and dissemination of notifications to operators regarding air and ground activities. FAA divided the pilot program into two phases—phase 1, which was completed in August 2019, and phase 2, which was completed in November 2020. According to FAA officials, they are planning to issue a final report on the pilot program in the spring of 2021. FAA plans to use results from phase 2 of the pilot program to help develop a UTM implementation plan, which is described in greater detail later in the report.

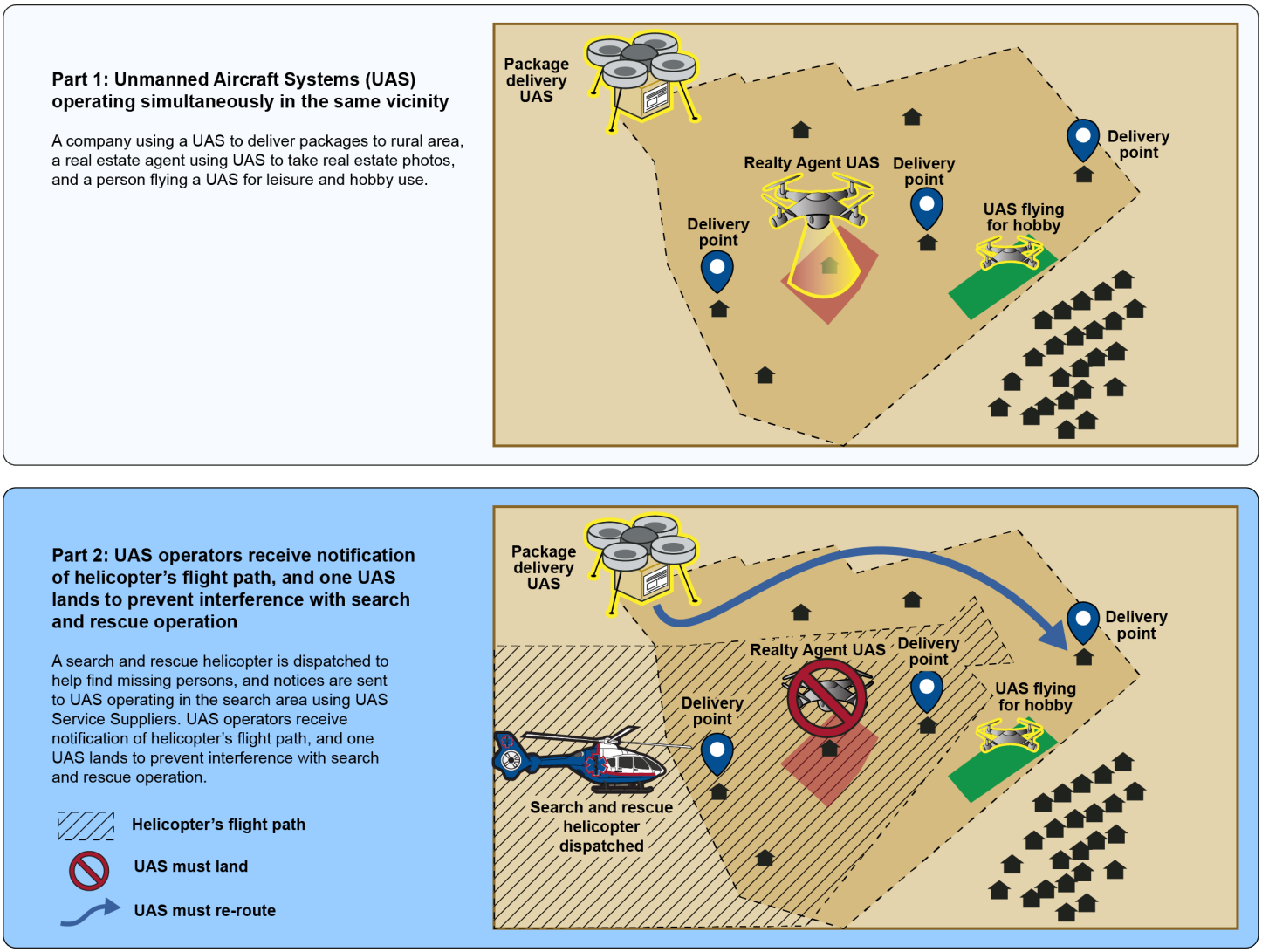
During phase 1, each test site location developed three use cases or scenarios to test different UAS interactions.[47] These interactions were intended to simulate real-world situations. For example, one scenario at the Virginia site demonstrated how three UAS being used for different activities would respond during an unplanned event. In part 1 of this scenario, a commercial operator was using UAS for package delivery, while a real estate agent was using a second UAS to photograph a house and surrounding property, and a nearby recreational operator was operating UAS without USS support. In part 2 of this scenario, a search and rescue helicopter was called in to help find missing persons while the

[46]FESSA, Pub. L. No. 114-190, § 2208(b), 130 Stat. at 633-34.

[47]FAA initially selected three sites to participate in the pilot program for phase 1: Nevada Institute for Autonomous Systems; Northern Plains UAS Test Site; and Virginia Tech Mid-Atlantic Aviation Partnership. In April 2020, FAA selected two test sites to participate in phase 2 of the pilot program: Virginia Tech, Mid-Atlantic Aviation Partnership; and Griffiss International Airport in New York.

three simultaneous flights were under way. The operators each received notification of the helicopter's flight area via their respective USS. The scenario examined how the operators responded, such as making decisions to reroute or to land their UAS and not to interfere with the helicopter's mission. See figure 3 for additional information on this scenario.

Figure 3: Example of a Pilot Program Scenario Simulating Unmanned Aircraft Systems Operating in Real-World Situations



Sources: GAO analysis of Virginia Tech Mid Atlantic Aviation Partnership information. | GAO-21-165

Text of Figure 3: Example of a Pilot Program Scenario Simulating Unmanned Aircraft Systems Operating in Real-World Situations

- **Part 1: Unmanned Aircraft Systems (UAS) operating simultaneously in the same vicinity:** A company using a UAS to deliver packages to rural area, a real estate agent using UAS to take real estate photos, and a person flying a UAS for leisure and hobby use.
- **Part 2: UAS operators receive notification of helicopter's flight path, and one UAS lands to prevent interference with search and rescue operation:** A search and rescue helicopter is dispatched to help find missing persons, and notices are sent to UAS operating in the search area using UAS Service Suppliers. UAS operators receive notification of helicopter's flight path, and one UAS lands to prevent interference with search and rescue operation.

After completing phase 1 of the pilot program, FAA and NASA issued a summary report in October 2019 regarding UTM capabilities, outcomes, and lessons learned.[48] According to this report, phase 1 demonstrated how several fundamental capabilities can work together to provide UTM services, including operation planning for participating UAS operators, shared situational awareness, and automated UAS volume reservations and their effect on UAS operations.[49]

According to the phase 1 summary report, FAA and NASA determined that future demonstrations in phase 2 should explore real-world scenarios in which there are multiple UAS operations occurring simultaneously using only UTM to maintain separation among the UAS. Stakeholders agreed more real world scenarios are needed because the phase 1 tests were highly staged, that is, there were only a few actual UAS operating with the vast majority of flights being simulated by computer programs. They noted the need to test multiple scenarios at one time, such as operating UAS at night or over people. Accordingly, FAA officials told us that more real world scenarios would be demonstrated during phase 2. According to a joint 2019 FAA NASA presentation for industry on phase 2 of the pilot program, phase 2 testing will include: remote ID and tracking

[48]FAA and NASA, *Unmanned Aircraft Systems' (UAS) Traffic Management (UTM) Pilot Program (UPP) Summary Report* (October 2019).

[49]UAS volume reservations, or UVR, are designed to support safe flying conditions for aircraft involved in flights supporting activities, such as police activity, emergency response, or public safety. UVRs notify UTM operators of blocks of airspace where these activities are occurring and are generally short in duration (hours, as opposed to days or weeks); have specified airspace boundaries; and have an established start and end times

services, and operation planning and changes of in-flight intent by operators in high-density airspace.

FAA Has Provided Information to Stakeholders but Not Enough Detail on the Timing and Substance of Next Steps for UTM Implementation

FAA has provided information on its efforts to develop and implement UTM to UAS stakeholders in several ways. For example, FAA's *Concept of Operations,* originally released in 2018, was updated in 2020 to show the continued maturation of UTM and share FAA's vision with government and industry stakeholders.[50] Updates to the document described plans to expand testing scenarios to include increasingly complex operations in denser airspace. FAA has also provided information on its plans for phase 2 of the pilot program and additional updates to the *Concept of Operations* in the FAA-NASA pilot program's summary report, at DAC meetings, and at a 2019 FAA-NASA industry workshop.

Many UAS stakeholders whom we interviewed generally agreed with FAA's overall approach to developing and implementing UTM. However, representatives from all but one USS we spoke with that participated in the UTM pilot program told us in September and October 2020 that additional planning and information from FAA is needed. Stakeholders said that FAA has provided limited information on the timing and details of the next steps and how UTM will ultimately come together. For example, representatives from one USS told us that even though phase 2 of the pilot program was under way, FAA had not provided a timeline, including commitments for UTM elements FAA was responsible for providing. Additionally, some stakeholders told us they are unclear about what FAA plans to do with UTM-related technology developed by and research conducted by NASA. Representatives from one UAS stakeholder group noted that FAA has not provided comprehensive information on how UTM will be implemented and will work together with other air traffic systems.

Our review of planning documents and reports related to the pilot program, as well as of DAC meeting minutes, confirmed that FAA has provided limited information about a timetable and minimal explanation of the next steps for implementing UTM. In October 2019, members of the DAC noted that FAA and industry should work together to identify

[50]Federal Aviation Administration, *Unmanned Aircraft System (UAS) Traffic Management (UTM) Concept of Operations, version 2.0* (Washington, D.C.: Mar. 2, 2020).

priorities for UTM development and deployment and to make a plan for safely rolling out UTM. Furthermore, our review of subsequent DAC meeting minutes and materials from February and June 2020 did not show that there was any additional information from FAA on such a plan. FAA's UTM website provides general information to stakeholders and the public on, among other things, the status of actions taken thus far to develop UTM, including collaborating with industry on LAANC, the *NASA and FAA UAS Traffic Management Research Transition Team Plan,* and the pilot program. However, as of November 2020, the website did not provide information on the timing and substance of the next steps for the pilot program or UTM implementation in general.

Some UAS stakeholders we interviewed said that more information from FAA on the next steps would be helpful for stakeholders to make informed decisions regarding UTM development as a whole. These stakeholders said that not having this information makes it difficult for them to plan for the future and conduct additional testing, which ultimately could increase the time needed to bring certain services to market and implement UTM. For example, several stakeholders said FAA provides limited information on timing and substance of the next steps such as what areas of UTM technology FAA will focus on next. Additionally, one UAS stakeholder we spoke with who participated in the pilot program phase 1 told us there was a disconnect between what FAA outlined in the pilot program's data analysis plan and what FAA ended up doing with the information collected. Given the lack of clarity about FAA's desired outcome for the pilot program phase 2 and related UTM efforts, this company was hesitant to participate further in the pilot program. A key NASA official involved with UAS told us in November 2020 that it would be helpful if FAA provided a roadmap of impending UAS rulemakings and UTM implementation.

In June 2020, FAA officials told us they acknowledged industry's need for additional details on UTM development, and at the October 2020 DAC meeting, they stated that FAA was working on an updated *Concept of Operations* and concurrently developing a UTM implementation plan. FAA did not provide any additional details on its plans for the next steps in developing the UTM implementation plan or on how ongoing activities support the development and implementation of this plan. *Standards for Internal Control in the Federal Government* state that entities should externally communicate the necessary quality information to achieve the

entity's objectives.[51] In particular, open two-way communication allows for quality information, and receiving input from external parties helps ensure effective agency operations. Improved communication with industry in the near term and using existing channels such as the DAC could help industry see the path to implementation and contribute needed technologies and capabilities as appropriate.

Similarly, in 2013, we found that stakeholders expressed the need for timely and reliable information from FAA to make investment decisions for another complex, long-term initiative to modernize the U.S. air-traffic management system—the Next Generation Air Transportation System (NextGen).[52] In that report, we recommended FAA ensure that stakeholders have needed information. FAA subsequently took steps in 2016 to provide stakeholders with information on the implementation status of other key operational improvements. As a result of these actions, the aviation industry had planning information that enabled it to make better-informed decisions about investments on NextGen technology.

Goals and Performance Measures Could Strengthen the UTM Implementation Plan

The FAA Reauthorization Act of 2018 required FAA to develop a plan for the implementation of UTM services that expands operations beyond visual line of sight, has full operational capability, and ensures the safety and security of all aircraft and the public.[53] This UTM implementation plan must include:

- safety standards to permit, authorize, or allow the use of UTM services;
- roles and responsibilities of industry and government in establishing UTM services that allow applicants to conduct commercial and noncommercial operations; and
- an assessment of various components required for risk reduction and mitigation in relation to the use of UTM services, including: remote ID, maintaining separation among UAS, how FAA will conduct oversight,

[51]GAO-14-704G.

[52]GAO-13-264.

[53]Pub. L. No. 115-254, § 376, 132 Stat. at 3314.

the need for additional technologies to detect aircraft, and cybersecurity protections and data integrity, among other things.

According to FAA officials, FAA is developing the implementation plan that is due one year after completion of the pilot program, which is scheduled to conclude in the spring of 2021. In discussing the implementation plan efforts, FAA officials stated the FAA Reauthorization Act of 2018 does not require performance measures. As such, these officials did not commit to including performance measures and goals in the implementation plan.

We have previously found that results-oriented organizations set performance goals to clearly define desired program outcomes and develop performance measures that are clearly linked to the performance goals.[54] The Government Performance and Results Act (GPRA), as enhanced by the GPRA Modernization Act of 2010 (GPRAMA), states that performance goals should be objective, quantifiable, and measurable.[55] Although GPRAMA's requirements apply at the departmental level (e.g., Department of Transportation), we have previously stated that they can serve as leading practices at other organizational levels, such as component agencies, offices, programs, and projects.[56]

Similarly, in 2010, we found that FAA had not developed specific goals and outcome-based metrics to track the effect of and benefits realized from NextGen.[57] We found that, without specific goals and metrics, together with a timeline and action plan for implementation, it was not clear whether NextGen technologies, systems, and capabilities would achieve desired outcomes within the planned time frames. In that report, we recommended FAA develop a timeline and action plan with performance metrics and goals. FAA subsequently took steps in 2012 to

[54]GAO/GGD-96-118; GAO-16-393; GAO-11-646SP; GAO-05-927.

[55]Pub. L. No. 103-62, 107 Stat. 285 (1993), as enhanced by Pub. L. No. 111-352, § 3, 124 Stat. 3866, 3867 (2011) (codified at 31 U.S.C. § 1115(b)(2), (6)). See also, GAO, *Agencies' Strategic Plans under GPRA: Key Questions to Facilitate Congressional Review*, GAO/GGD-10.1.16 (Washington, D.C.: May 1997) and GAO/GGD-96-118.

[56]*See,* for example, GAO*, Environmental Justice: EPA Needs to Take Additional Actions to Help Ensure Effective Implementation*, GAO-12-77 (Washington, D.C.: Oct. 6, 2011). See also, GAO/GGD-10.1.16 and GAO/GGD-96-118.

[57]GAO, *NextGen Air Transportation System: FAA's Metrics Can Be Used to Report on Status of Individual Programs, but Not of Overall NextGen Implementation or Outcomes*, GAO-10-629 (Washington, D.C.: July 27, 2010).

develop performance metrics and goals. As a result of these actions, stakeholders, interested parties, Congress, and the American people have a clearer picture of where implementation stands at any given time, and whether the technologies, capabilities, and operational improvements that are being implemented are resulting in positive outcomes and improved performance for operators and passengers.

Identifying performance goals and related measures as FAA develops the UTM implementation plan could help FAA, NASA, and industry ensure that the steps identified in the plan align to support implementation. Performance measurement also gives managers crucial information to identify gaps in program performance and plan any needed improvements. Additionally, goals and measures could signal industry what FAA will ultimately consider needed before allowing widespread integration of UTM into the national airspace system, thereby improving transparency.

Conclusions

FAA is responsible for managing the safe integration of UAS into the national airspace system. In this role, FAA continues its statutory obligation to ensure the safety of aviation while overseeing greater use of UAS for commerce and personal enjoyment. As FAA proceeds with its plans to implement a traffic management system for low-altitude UAS flights, providing more information to stakeholders about timelines and upcoming steps is critical to the success of this complex initiative. Stakeholders told us they need such information to be able to plan and align their activities with FAA's incremental rollout of capabilities, but the information FAA has provided thus far has been limited. Until FAA releases its statutorily mandated UTM implementation plan, providing additional information through existing communication channels on the timing and substance of next steps could help FAA and stakeholders continue to make progress in UTM activities. As FAA develops its implementation plan, developing appropriate goals and measures could help FAA and stakeholders, including Congress, gauge progress and measure outcomes as government and industry work toward widespread integration of UAS into the national airspace system.

Recommendations for Executive Action

We are making the following two recommendations to FAA:

The Administrator of the Federal Aviation Administration should provide stakeholders with additional information on the timing and substance of future UTM testing and implementation efforts, using FAA's UTM website or other appropriate means. (Recommendation 1)

The Administrator of the Federal Aviation Administration should develop performance goals and measures for its UTM implementation plan. (Recommendation 2)

Agency Comments

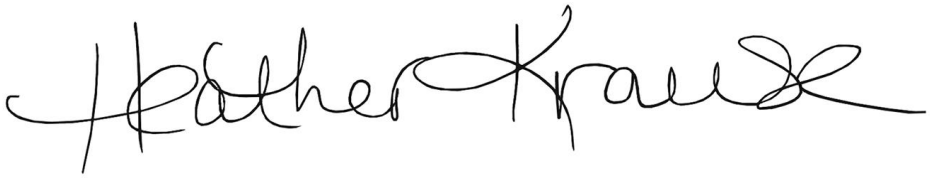
We provided a draft of this report to DOT and NASA for review and comment. In its written comments, reproduced in appendix II, DOT agreed with the first recommendation and partially agreed with the second recommendation. DOT also provided technical comments, which we incorporated as appropriate. NASA officials provided technical comments, which we incorporated as appropriate.

DOT agreed with our first recommendation to provide stakeholders with additional information on the timing and substance of future UTM testing and implementation efforts. DOT stated it regularly briefs industry on UTM efforts through several means, but that it could streamline its communication efforts by centralizing the information in one location to make it quickly retrievable for individuals who search for information on UTM.

DOT partially agreed with our second recommendation. In our draft report, our second recommendation stated that FAA should incorporate performance goals and measures into its UTM implementation plan. DOT agreed that it should develop appropriate performance goals and measures. However, to ensure this does not create delays for completion of the UTM implementation plan, DOT stated it will consider an alternative vehicle for the performance goals and measures, such as a standalone document published on the FAA website or in a planned UAS implementation tracking tool. The UTM implementation plan would seem to be the most appropriate vehicle for identifying goals and measures. However if FAA chooses to identify goals and measures elsewhere for the reasons DOT cited, such an approach would still meet the intent of our recommendation. As such, based on DOT's comments, we have slightly modified our recommendation to state that DOT develop performance goals and measures for its UTM implementation plan.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Transportation, the Administrator of the FAA, the Administrator of NASA, and other interested parties. In addition, the report is available at no charge on the GAO website at http://www.gao.gov.

If you or your staff have any questions about this report, please contact me at (202) 512-2834 or krauseh@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix III.



Heather Krause
Director, Physical Infrastructure Issues

Appendix I: Stakeholders Contacted During the Course of This Review

We interviewed representatives from: a non-generalizable sample of 19 unmanned aircraft systems' (UAS) stakeholder groups, selected based on their participation in the Federal Aviation Administration's (FAA) UAS traffic management (UTM) Pilot Program, and FAA's Drone Advisory Committee, based on recommendations from UAS stakeholders or UAS and aviation stakeholders we identified in our prior work. In September and October 2020, we followed up with UAS stakeholders via email to confirm the information they provided during our initial interviews was accurate and still represented their views. Due to the relatively early stage of UTM development, some stakeholders generally felt it was too early to know how ongoing rulemakings would affect developing and implementing UTM, and accordingly, not all stakeholders had opinions on all topics discussed. Accordingly, we do not enumerate stakeholder responses in the report. Instead, we analyzed the responses and reported on common themes that arose during the stakeholder interviews. Because we selected a non-generalizable sample of stakeholders, their responses should not be used to make inferences about a population. To characterize stakeholders' views in some cases, we defined modifiers (e.g., "several") to quantify stakeholders as follows:

- "several" stakeholders represents stakeholders in 3 to 5 of the interviews
- "some" stakeholders represents stakeholders in 6 to 11 of the interviews
- "many" stakeholders represents stakeholders in 12 or more of the interviews.

See table 3 for list of stakeholders we interviewed. Stakeholders were selected to achieve a range of perspectives including UAS manufacturers, UAS service suppliers, recreational and commercial UAS operators, other interested third-party organizations such as universities, and state governments involved with UTM research, and international stakeholders

Table 3: List of Stakeholders Interviewed

Entity	Description
Academy of Model Aeronautics (AMA)	AMA is a model aviation association, representing a membership of more than 175,000 recreational model aircraft operators. Their purpose is to promote the development of model aviation.
Aerospace Industries Association (AIA)	AIA works as an advocate for nearly 340 member companies to strengthen the industry's ability to effectively support America's national security and economy, with a focus on global competitiveness and innovation, the future of regulation, aerospace and defense investment, and the 21st century workforce.
AirMap	AirMap is an airspace management platform for unmanned aircraft systems (UAS) and has participated in FAA's UAS traffic management (UTM) pilot program. Industry developers, UAS operators, and airspace managers use AirMap's airspace intelligence and services to fly and communicate in low-altitude airspace. AirMap is developing technology solutions for UAS traffic management that are intended to enable safe and responsible UAS operations at scale.
AiRXOS	AiRXOS works to deliver a digital UAS ecosystem designed for the next generation of air traffic management. AiRXOS has participated in FAA's UTM pilot program and helps organizations, cities, states, and local governments meet the increasing demand for UTM capabilities and safe, efficient UAS operations between manned and unmanned traffic.
Amazon Prime Air	Amazon Prime Air is working to develop a future delivery system that is safe, environmentally sound, and enhances Amazons' existing delivery services.
ANRA Technologies	Since 2015, ANRA Technologies has been developing UTM technological solutions. ANRA's software platform aims to support a myriad of UAS through a cloud-based architecture to enable real time flight planning, airspace management, traffic management, strategic deconfliction, compliance, and fleet management while supporting stakeholder interfaces and integrations. ANRA Technologies has participated in FAA's UTM pilot program.
Association for Unmanned Vehicle Systems International (AUVSI)	AUVSI advocates for the advancement of unmanned systems and robotics and represents corporations and professionals from more than 60 countries involved in industry, government, and academia.
Australian Civil Aviation Safety Authority (CASA)	CASA is the government body that regulates Australian aviation safety. CASA licenses pilots, registers aircraft, and oversees and promotes safety.
Collins Aerospace	Collins Aerospace is working to provide access to commercial airspace for UAS operations and participated in the FAA's UTM pilot program with the Northern Plains UAS Test Site. Collins, now a Raytheon Technologies company, provides flight-enabling technologies both on and off the aircraft, to include enhanced situational awareness, surveillance, navigation, and communications.
Commercial Drone Alliance	The Commercial Drone Alliance advocates for the commercial use of drones by working with policymakers to reduce barriers to enable drone technology, and educates end users and the public on the benefits of drone technology.
DJI Technology	DJI is a manufacturer of UAS for both recreational and commercial use.
Virginia Tech Mid-Atlantic Aviation Partnership (MAAP)	MAAP is an FAA-designated test site for UAS and has participated in both phases of the UTM pilot program. MAAP works with regulating authorities and industry partners on studies to inform evidence-based policies and standards.
MITRE Center for Advanced Aviation System Development	MITRE is a non-governmental, not-for-profit entity that operates multiple federally funded research and development centers and conducts work with FAA intended to meet the evolving needs of the nation's airspace.

Entity	Description
Northern Plains UAS Test Site	The Northern Plains UAS Test Site in North Dakota is a designated UAS test site and participated in phase 1 of the UTM pilot program. Northern Plains UAS Test Site conducts research into the certification and operational requirements necessary to safely integrate UAS into the national airspace system.
PrecisionHawk	PrecisionHawk provides remote sensing applications and data-processing services for UAS in energy, agriculture, and telecom.
Project Wing	Project Wing is an autonomous delivery UAS service and is developing an unmanned traffic management platform intended to allow unmanned aircraft to navigate around other UAS, manned aircraft, and other obstacles.
Simulyze	Simulyze provides UAS operators with a platform for real-time data access for complex mission operations. Simulyze has participated in FAA's UTM pilot program and provides operators with customizable graphical interface suitable for a wide range of operations, such as aerial photography and surveying, agriculture, construction, and infrastructure and utilities inspection.
Small UAV Coalition	The Small Unmanned Aerial Vehicles Coalition is a partnership of leading commercial technology companies that advocates for U.S. leadership in the research, development, and implementation of a UAS regulatory framework that will safely allow ubiquitous UAS operations beyond visual line of sight and over people, with varying degrees of autonomy.
Swiss Federal Office of Civil Aviation	The Federal Office of Civil Aviation (FOCA) is responsible for aviation development and the supervision of civil aviation activities in Switzerland. The FOCA is part of the Federal Department of the Environment, Transport, Energy and Communications and is charged with ensuring that the high safety standards in civil aviation in Switzerland.

Source: GAO. | GAO 21-165

Appendix II: Comments from the Department of Transportation

U.S. Department of Transportation
Office of the Secretary of Transportation

Assistant Secretary for Administration

1200 New Jersey Avenue, SE
Washington, DC 20590

December 22, 2020

Heather Krause
Director, Physical Infrastructure
U.S. Government Accountability Office
441 G Street NW
Washington, DC 20548

Dear Ms. Krause:

The Federal Aviation Administration (FAA) is working diligently to support the development of an ecosystem for Unmanned Aircraft Systems Traffic Management (UTM). The FAA recognized early on the need to engage with industry in considering the development and deployment of UTM. The FAA collaborated with industry and the National Aeronautics and Space Administration to research, develop, and test increasingly complex UTM concepts and capabilities. The FAA is collaborating with industry through participation in standards workgroups as well as through the BEYOND program[1] and the post-Integration Pilot Program, which will push for more advanced testing of UTM capabilities. The FAA leveraged the Drone Advisory Committee (DAC) to collect industry input on the UTM Concept of Operation (ConOps), and will collaborate with industry on the next iteration of the document.

The FAA offers the following comments in response to issues GAO raised in its draft report:

- The FAA regularly briefs industry on UTM efforts through the DAC, ASTM International[2] work groups, and the Global UTM Association. For example, in the October 22, 2020, DAC meeting, the FAA shared a timeline of its efforts to publish the next iteration of the UTM ConOps. However, the FAA agrees that there is an opportunity to streamline its communication efforts by centralizing the information in one location. While the information on that timeline was presented to the DAC and is available in the materials on the FAA page for the drone advisory committee[3], it may not be quickly retrievable for individuals who search for information on UTM.
- Concerning performance goals and metrics, UTM is not necessarily comparable to NextGen. However, as UTM is a federated system[4], the FAA understands the importance of having a common understanding with industry on the performance goals of UTM, and having appropriate performance measures to validate success.

The FAA concurs with recommendation 1 to provide stakeholders with additional information. We

[1] The BEYOND program is designed to further investigate and resolve the challenge of UAS BVLOS flight in three particular environments (Rural, Suburban, and Urban) using three different Concepts of Operations (Infrastructure Inspection, Public Operations and Small Package Delivery).

[2] Formerly known as American Society for Testing and Materials, ASTM International is an international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services.

[3] https://www.faa.gov/uas/programs_partnerships/drone_advisory_committee/media/Public_Ebook_10222020_Final.pdf - p. 102

[4] A group of systems and networks operating in a standard and connected environment.

partially concur with recommendation 2 as we do not agree to incorporate performance goals and measures in the UTM Implementation Plan. We will develop appropriate performance goals and metrics, but to ensure we do not create delays for completion of the Implementation Plan, we will consider an alternative vehicle for the performance goals and metrics. Potential vehicles under consideration to house performance goals and metrics are:

- In a standalone document published on our FAA Web site;
- In our dashboard which tracks safety metrics and quality objectives;
- In our planned UAS implementation tracking tool; or,
- Other appropriately determined location.

We will provide a detailed response to each recommendation within 180 days of the final report's issuance.

We appreciate the opportunity to offer additional perspective on the GAO draft report. Please contact Madeline Chulumovich, Audit Relations and Program Improvement, at (202) 366-6512 with any questions or if GAO would like to obtain additional details about these comments.

Sincerely,

Deputy Assistant Secretary for Administration

Text of Appendix II: Comments from the Department of Transportation

Page 1

December 22, 2020 Heather Krause

Director, Physical Infrastructure

U.S. Government Accountability Office

441 G Street NW

Washington, DC 20548

Dear Ms. Krause:

The Federal Aviation Administration (FAA) is working diligently to support the development of an ecosystem for Unmanned Aircraft Systems Traffic Management (UTM). The FAA recognized early on the need to engage with industry in considering the development and deployment of UTM. The FAA collaborated with industry and the National Aeronautics and Space Administration to research, develop, and test increasingly complex UTM concepts and capabilities. The FAA is collaborating with industry through participation in standards workgroups as well as through the BEYOND program[1] and the post- Integration Pilot Program, which will push for more advanced testing of UTM capabilities. The FAA leveraged the Drone Advisory Committee (DAC) to collect industry input on the UTM Concept of Operation (ConOps), and will collaborate with industry on the next iteration of the document.

The FAA offers the following comments in response to issues GAO raised in its draft report:

[1] The BEYOND program is designed to further investigate and resolve the challenge of UAS BVLOS flight in three particular environments (Rural, Suburban, and Urban) using three different Concepts of Operations (Infrastructure Inspection, Public Operations and Small Package Delivery).

- The FAA regularly briefs industry on UTM efforts through the DAC, ASTM International[2] work groups, and the Global UTM Association. For example, in the October 22, 2020, DAC meeting, the FAA shared a timeline of its efforts to publish the next iteration of the UTM ConOps. However, the FAA agrees that there is an opportunity to streamline its communication efforts by centralizing the information in one location. While the information on that timeline was presented to the DAC and is available in the materials on the FAA page for the drone advisory committee[3], it may not be quickly retrievable for individuals who search for information on UTM.
- Concerning performance goals and metrics, UTM is not necessarily comparable to NextGen. However, as UTM is a federated system[4], the FAA understands the importance of having a common understanding with industry on the performance goals of UTM, and having appropriate performance measures to validate success.

The FAA concurs with recommendation 1 to provide stakeholders with additional information. We

Page 2

partially concur with recommendation 2 as we do not agree to incorporate performance goals and measures in the UTM Implementation Plan. We will develop appropriate performance goals and metrics, but to ensure we do not create delays for completion of the Implementation Plan, we will consider an alternative vehicle for the performance goals and metrics. Potential vehicles under consideration to house performance goals and metrics are:

- In a standalone document published on our FAA Web site;
- In our dashboard which tracks safety metrics and quality objectives;
- In our planned UAS implementation tracking tool; or,
- Other appropriately determined location.

[2] Formerly known as American Society for Testing and Materials, ASTM International is an international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services.

[3] https://www.faa.gov/uas/programs_partnerships/drone_advisory_committee/media/Public_Ebook_10222020_Final.pdf - p. 102

[4] A group of systems and networks operating in a standard and connected environment.

We will provide a detailed response to each recommendation within 180 days of the final report's issuance.

We appreciate the opportunity to offer additional perspective on the GAO draft report. Please contact Madeline Chulumovich, Audit Relations and Program Improvement, at (202) 366-6512 with any questions or if GAO would like to obtain additional details about these comments.

Sincerely,

Keith Washington

Deputy Assistant Secretary for Administration

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

Heather Krause at (202) 512-2834 or KrauseH@gao.gov.

Staff Acknowledgments

In addition to the contact named above, the following individuals made important contributions to this report: David Sausville, Assistant Director; Aaron Kaminsky, Analyst-In-Charge; Oluwaseun Ajayi; Melissa Bodeau; Dwayne Curry; Richard Hung; Jasmine Latiolais; Malika Rice; Kelly Rubin; and Janet Temko-Blinder.

GAO's Mission

The Government Accountability Office, the audit, evaluation, and investigative arm of Congress, exists to support Congress in meeting its constitutional responsibilities and to help improve the performance and accountability of the federal government for the American people. GAO examines the use of public funds; evaluates federal programs and policies; and provides analyses, recommendations, and other assistance to help Congress make informed oversight, policy, and funding decisions. GAO's commitment to good government is reflected in its core values of accountability, integrity, and reliability.

Obtaining Copies of GAO Reports and Testimony

The fastest and easiest way to obtain copies of GAO documents at no cost is through our website. Each weekday afternoon, GAO posts on its website newly released reports, testimony, and correspondence. You can also subscribe to GAO's email updates to receive notification of newly posted products.

Order by Phone

The price of each GAO publication reflects GAO's actual cost of production and distribution and depends on the number of pages in the publication and whether the publication is printed in color or black and white. Pricing and ordering information is posted on GAO's website, https://www.gao.gov/ordering.htm.

Place orders by calling (202) 512-6000, toll free (866) 801-7077, or TDD (202) 512-2537.

Orders may be paid for using American Express, Discover Card, MasterCard, Visa, check, or money order. Call for additional information.

Connect with GAO

Connect with GAO on Facebook, Flickr, Twitter, and YouTube.
Subscribe to our RSS Feeds or Email Updates. Listen to our Podcasts.
Visit GAO on the web at https://www.gao.gov.

To Report Fraud, Waste, and Abuse in Federal Programs

Contact FraudNet:

Website: https://www.gao.gov/fraudnet/fraudnet.htm

Automated answering system: (800) 424-5454 or (202) 512-7700

Congressional Relations

Orice Williams Brown, Managing Director, WilliamsO@gao.gov, (202) 512-4400,
U.S. Government Accountability Office, 441 G Street NW, Room 7125,
Washington, DC 20548

Public Affairs

Chuck Young, Managing Director, youngc1@gao.gov, (202) 512-4800
U.S. Government Accountability Office, 441 G Street NW, Room 7149
Washington, DC 20548

Strategic Planning and External Liaison

Stephen J. Sanford, Acting Managing Director, spel@gao.gov, (202) 512-4707
U.S. Government Accountability Office, 441 G Street NW, Room 7814,
Washington, DC 20548