U.S. House of Representatives
Committee on Science, Space, and Technology
Subcommittee on Oversight

HEARING CHARTER

Operating Unmanned Aircraft Systems in the National Airspace System:
Assessing Research and Development Efforts to Ensure Safety

Friday, February 15, 2013
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Purpose

On February 15, 2013, the Subcommittee on Oversight will hold a hearing titled "Operating Unmanned Aircraft Systems in the National Airspace System: Assessing Research and Development Efforts to Ensure Safety." The hearing will examine challenges to integrating Unmanned Aircraft Systems (UAS) safely into the National Airspace System (NAS) and federal research and development (R&D) efforts to ensure the safe operation of UAS in the NAS.

Witnesses

- Dr. Karlin Toner, Director, Joint Program Development Office, Federal Aviation Administration (FAA)
- Dr. Edgar Waggoner, Director, Integrated Systems Research Program Office, National Aeronautics and Space Administration (NASA)
- Dr. Gerald Dillingham, Director, Civil Aviation Issues, Government Accountability Office (GAO)

Background

For most people, the term unmanned aerial vehicle (UAV) is closely associated with the U.S. Air Force's Predator or Global Hawk aircraft. Unmanned aircraft systems (UAS), however, is a more accurate and complete term which includes the aircraft as well as supporting ground, air, and communications infrastructure. UAS come in a variety of shapes and sizes and are viable for a broad range of civilian and commercial uses. Current domestic use of UAS is limited to academic institutions, federal, state, and local government organizations that receive a Certificate of Waiver or Authorization (COA) and private sector entities that receive special airworthiness certificates by the FAA.[1] Typical domestic applications of UAS include border patrol, scientific research, and environmental monitoring. For example, NASA has made extensive use of a myriad of advanced UAS to conduct aeronautics, meteorological, and environmental research over the years; from the Mini-Sniffers of the 1970s to the new high-altitude X-56A Multi-Use

[1] U.S. Department of Transportation, Federal Aviation Administration, "Unmanned Aircraft Systems (UAS) Operational Approval," National Policy Notice, serial N 8900.207 (Washington, DC, 2013).

Technology Testbed, or MUTT.[2] Also, the National Oceanic and Atmospheric Administration (NOAA) operates the RQ-4A Global Hawk platform for climate research, the Customs and Border Patrol (CBP) operates the MQ-1 Predator platform for border patrol, and public universities operate additional systems for academic research purposes.

Though military and civil government will likely dominate in the near term, the UAS market is dynamic and the commercial sector is poised for explosive growth. The Teal Group, an aerospace and defense industry market intelligence firm, forecasts worldwide annual spending on UAS research, development, testing, and evaluation (RDT&E) activities and procurement rising from $6.6 billion in 2013 to $11.4 billion in 2022. Total worldwide spending for the period is forecast to amount to $89.1 billion. Throughout the forecast period, Teal expects the U.S. share of RDT&E to account for 62 percent of worldwide spending, while U.S. procurement will amount to 55 percent of worldwide spending.[3] In 2010, the Association for Unmanned Vehicle Systems International (AUVSI) estimated that over the next 15 years more than 23,000 jobs, totaling $1.6 billion in wages, could be created in the U.S. as a result of UAS integration into the National Airspace System.[4] This does not include the tens of thousands of secondary jobs in sensor manufacturing, software development, and other complementary industries.

To make the most of this opportunity, Congress directed that federal agencies accelerate the integration of UAS into the national airspace. The FAA Modernization and Reform Act of 2012 contains provisions designed to promote and facilitate the use of civilian unmanned aircraft. These included mandates for:

- development of an integration plan that is to commence by the end of FY2015, if not sooner, along with a five-year roadmap for achieving integration objectives;
- selection of six test sites to study UAV integration into the NAS;
- designation of certain permanent areas in the Arctic where small unmanned aircraft may operate 24 hours per day for commercial and research purposes, including flights conducted beyond line-of-sight;
- a simplified process for issuing authorizations for entities seeking to operate public UAS in the NAS;
- incrementally expanding airspace access as technology matures and safety data and analysis become available and to facilitate public agency access to UAS test ranges;
- developing and implementing operational and certification requirements for public UAS by December 31, 2015; and

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[2] Gary Creech, "Introducing the X-56a Mutt: Who Let the Dog Out?" http://www.nasa.gov/topics/aeronautics/features/x-56a_mutt.html (accessed February 8, 2013).

[3] Teal Group, *World Unmanned Aerial Vehicle Systems: Market Profile and Forecast (Fairfax, 2012)*, cited in U.S. Government Accountability Office, *Unmanned Aircraft Systems: Measuring Progress and Addressing Potential Privacy Concerns Would Facilitate Integration into the National Airspace System,* GAO-12-981 (Washington, DC, 2012).

[4] Association for Unmanned Vehicle Systems International, *Unmanned Aircraft System Integration into the United States National Airspace System: An Assessment of the Impact on Job Creation in the U.S. Aerospace Industry* (Arlington, 2010).

- an exemption from rules and regulations pertaining to the operation of unmanned aircraft for model aircraft weighing 55 pounds or less that are flown within visual line-of-sight strictly for hobby or recreation.[5]

Issues

UAS stakeholders have made progress toward completing the above requirements, but the GAO and Department of Transportation's Office of Inspector General have both assessed that significant technical obstacles and research gaps still exist.[6] Also, *The Washington Post* recently reported that at least nine U.S. UAS crashes occurred near civilian airports overseas as a result of pilot error, mechanical failure, software bugs, or poor coordination with air-traffic controllers.[7] While the operational environment for military UAS overseas is vastly different from UAS use domestically, these incidents are instructive. As UAS are integrated or accommodated into the NAS, several R&D challenges must be addressed.

Vulnerabilities in command and control of UAS operations – Ensuring uninterrupted command and control is critically important to safe integration of UAS into the national airspace. Unprotected data links can be hacked, spoofed or jammed to disrupt or gain control of the aircraft. For example, last summer a University of Texas (UT) at Austin research team demonstrated for the first time that it is possible to electronically hijack a UAV through Global Positioning System (GPS) spoofing. The team created false GPS signals to commandeer a small but sophisticated UAV about one kilometer away.[8] Redundant systems or encrypted communications would mitigate risks, but the costs, weight, and encryption issues make such additional equipage unfeasible for smaller UAS. NASA's five-year UAS Integration in the National Airspace System Project aims to: develop data and rationale to obtain appropriate frequency spectrum allocations to enable safe and efficient operation of UAS in the NAS; develop and validate candidate secure safety-critical command and control system/subsystem test equipment for UAS that complies with UAS international/national frequency regulations, recommended practices and minimum operational and aviation system performance standards for UAS; and perform analysis to support recommendations for integration of safety-critical command and control systems and air traffic control communications to ensure safe and efficient operation of UAS in the NAS.[9]

Homeland Security – In 2008 and again in 2012, the GAO assessed that Transportation Security Administration (TSA), a subordinate agency within the Department of Homeland Security, had

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[5] FAA Modernization and Reform Act of 2012 (PL 112-95)

[6] GAO-12-981, *Unmanned Aircraft Systems*

[7] Craig Witlock, "Drone crashes mount at civilian airports," *The Washington Post*, November 30, 2012, http://www.washingtonpost.com/world/national-security/drone-crashes-mount-at-civilian-airports-overseas/2012/11/30/e75a13e4-3a39-11e2-83f9-fb7ac9b29fad_story.html (accessed February 6, 2013).

[8] Melissa Mixon, "Todd Humphreys' Research Team Demonstrates First Successful Gps Spoofing of Uav," http://www.ae.utexas.edu/news/archive/2012/todd-humphreys-research-team-demonstrates-first-successful-gps-spoofing-of-uav (accessed February 6, 2013).

[9] "Unmanned Aircraft Systems Integration in the National Airspace System," National Aeronautics and Space Administration, http://www.nasa.gov/centers/dryden/news/FactSheets/FS-075-DFRC.html (accessed February 7, 2013).

not properly examined nor identified specific steps to mitigate potential security threats posed by routine UAS access to the national airspace.[10]

Spectrum – The 2012 World Radiocommunication Conference allocated two bands of protected spectrum for UAS command and control.[11] UAS stakeholders continue to develop hardware and standards to operate safely in allocated spectrum, while also working with the National Telecommunications and Information Administration and International Telecommunication Union to identify additional UAS-dedicated spectrum, particularly satellite spectrum, needed to assure continuous communication.

Inability to detect, sense, and avoid other aircraft – No suitable technology exists that would provide UAS with the capability to "sense and avoid" other aircraft and airborne objects in compliance with FAA regulations.[12,13] Most UAS, particularly small UAS, do not carry onboard systems to transmit and receive electronic identification signals. Solutions such as ground-based sense and avoid (GBSAA)[14] may offer a technical alternative to maintaining a human line-of-sight in the near-term before ultimately transitioning to Automatic Dependent Surveillance-Broadcast (ADS-B) and the satellite-based Next Generation Air Transportation System (NextGen). NextGen is due for implementation across the United States in stages between 2012 and 2025.

FAA's NextGen Integration Office and Joint Planning Development Office (JPDO) are working together to provide UAS stakeholders with a framework to collaborate and coordinate their UAS and NextGen R&D efforts. NASA is assessing how NextGen separation assurance systems, with different functional allocations, perform in real-world settings. For instance, in 2012 NASA researchers at Dryden Flight Research Center successfully tested an ADS-B transponder system on a UAS.[15, 16] Also, NASA, in collaboration with the FAA and U.S. Air Force Research Lab, is considering a two-tier, $1.5 million challenge – part of NASA's Centennial Challenge series – to develop reliable sense-and-avoid techniques to fly safely in congested airspace.[17]

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[10] GAO-12-981, *Unmanned Aircraft Systems*

[11] Julie Zoller, "NTIA Spotlight: Meeting Spectrum Needs At Home Takes Work Abroad," http://www.ntia.doc.gov/blog/2012/ntia-spotlight-meeting-spectrum-needs-home-takes-work-abroad (accessed February 7, 2013).

[12] Ibid.

[13] The FAA regulations include 14 C.F.R. § 91.111, "Operating near other aircraft," with reference to "create a collision hazard," and 14 C.F.R. § 91.113, "Right of way rules."

[14] GBSAA is an air surveillance radar that provides positional information via a display of traffic information to the UAS flight crew.

[15] GAO-12-981, *Unmanned Aircraft Systems*

[16] ADS-B transponder system uses GPS signals along with aircraft avionics to transmit the aircraft's location to ground receivers. The ground receivers then transmit that information to controller screens and cockpit displays on aircraft equipped with automatic dependent surveillance-broadcast transponder system avionics.

[17] "REQUEST FOR INFORMATION - CENTENNIAL CHALLENGES UNMANNED AIRCRAFT SYSTEMAIRSPACE OPERATIONS CHALLENGE," https://www.fbo.gov/?s=opportunity&mode=form&id=426438809b8348c157fa5b7120c18a45&tab=core&_cview=1 (accessed February 7, 2013)

Human Factors – Unmanned aircraft systems is a misnomer. Skilled human operators are critical to safe UAS operations. FAA defines human factors as the examination of interactions between people, machines, and the environment for the purpose of improving performance and reducing error.[18] UAS stakeholders are examining ways to incorporate additional technical safeguards and regulations to mitigate the risks associated with remotely piloted aircraft, but according to a September GAO report, several issues remain: how pilots or air traffic controllers respond to the lag in communication of information from the UAS; the skill set and medical qualifications required for UAS operators; and UAS operator training requirements.[19] NASA is working to develop a research test bed and database to provide data and proof of concept for ground control station (GCS) and will coordinate with standards organizations, such as RTCA SC-203,[20] to develop human-factors guidelines for GCS operation in the NAS.[21]

Lack of technological standards – Minimum aviation system performance standards (MASPS) and minimum operational performance standards (MOPS) are needed in the areas of: operational and navigational performance; command and control communications; and sense and avoid capabilities. The complexity of the issues and the lack of data have hindered the standards development process. That said, according to the GAO, the FAA had not made the most of the data it possessed to develop such standards, according to a report issued in September 2012.[22] For instance, the FAA had not analyzed information collected as part of the COA process, nor had it used the seven years of operational and safety data provided by the Department of Defense because it lacked sufficient detail to be of much value. FAA officials have since more clearly defined and communicated data requirements, and the agency contracted with MITRE to address remaining data challenges. However, it remains to be seen if this will result in useful information.[23]

[18] GAO-12-981, *Unmanned Aircraft Systems*
[19] Ibid.
[20] RTCA is a private, not-for-profit organization consisting of industry experts. SC 203 is responsible for developing consensus-based recommendations and standards regarding UAS communications, navigation, surveillance and air traffic management system issues.
[21] "Unmanned Aircraft Systems Integration in the National Airspace System," NASA
[22] Ibid.
[23] Ibid.