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NEXT GENERATION AIR TRANSPORTATION SYSTEM

Linking Test Facilities Can Help Leverage Resources and Improve Technology Transfer Efforts

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Chairman Mica, Ranking Member Rahall, and Members of the Committee:

I appreciate the opportunity to testify before you today on the use of test facilities as a means of leveraging public, private, and academic resources to deliver technologies for the Next Generation Air Transportation System (NextGen). NextGen will affect nearly every aspect of air transportation and will transform the way in which the air transportation system operates today. It is a complex undertaking that requires new technologies—including new integrated ground and aircraft systems—as well as new procedures, processes, and supporting infrastructure. The result will be an air transportation system that relies on satellite-based surveillance and navigation, data communications, and improved collaborative decision making. Transforming the nation's air transportation system affects and involves the activities and missions of several federal agencies,[1] though the Federal Aviation Administration (FAA) is the lead implementer. In addition, NextGen was designed and planned to be developed in collaboration with aviation stakeholders—airlines and other airspace users, air traffic controllers, and avionics, aircraft, and automation systems manufacturers—in order to facilitate coordinated research activities, transfer technologies from FAA and partner agencies to the private sector, and take advantage of research and technology developed by the private sector that could meet NextGen needs, as appropriate. Three NextGen test facilities, collectively referred to as the NextGen Test Bed, are designed to foster the research and development of NextGen-related technologies and to evaluate integrated technologies and procedures for nationwide NextGen deployment. These test facilities provide access to the systems currently used in the national air space (NAS) and house various types of hardware, simulators, and other equipment to allow for demonstrations of new technologies. They also provide opportunities for stakeholders—public and private—to collaborate with FAA, academia, and each other.

My statement today discusses (1) the role of the NextGen test facilities in the development of NextGen technologies and how private industry and partner agencies participate in projects at the NextGen test facilities, and (2) our previous findings on NextGen technology transfer and FAA's

[1]Federal partner agencies include the Federal Aviation Administration; the Departments of Commerce, Defense and Homeland Security; and the National Aeronautics and Space Administration.

efforts to improve the transfer and implementation of NextGen-related technologies. This statement is based on our prior NextGen-related reports and testimonies,[2] updated with information we gathered from FAA and test facility officials in October 2011. The GAO reports cited in this statement contain more detailed explanations of the methods used to conduct our work, which we performed in accordance with generally accepted government auditing standards.

In summary, the role of the NextGen Test Bed is to demonstrate the benefits of NextGen initiatives and to do so early in the technology development process. While sharing a common purpose, each of the three facilities that collectively make up the NextGen Test Bed offers different testing capabilities and brings together different participants from different communities. Across the test facilities private and public sector stakeholders contribute personnel, equipment, and funding to develop and integrate technologies. Linking the test facilities to leverage the benefits of each is part of the NextGen Test Bed concept and officials from the test facilities indicated they have made some progress in doing so. In prior work on technology transfer activities, we found that the success of test facilities as a means to leverage private sector resources depends in large part on the extent to which the private sector perceives benefits to its participation. Similarly, collaboration among the NextGen partner agencies depends in part on their seeing outcomes that further their mission and on identifying a common purpose. FAA has taken a number of actions to improve its ability to implement new technologies and increase partner agencies' and private sector participants' involvement in seeing the development of selected technologies through to successful implementation—including restructuring the organization responsible for implementing NextGen and linking the test facilities and improving their capabilities.

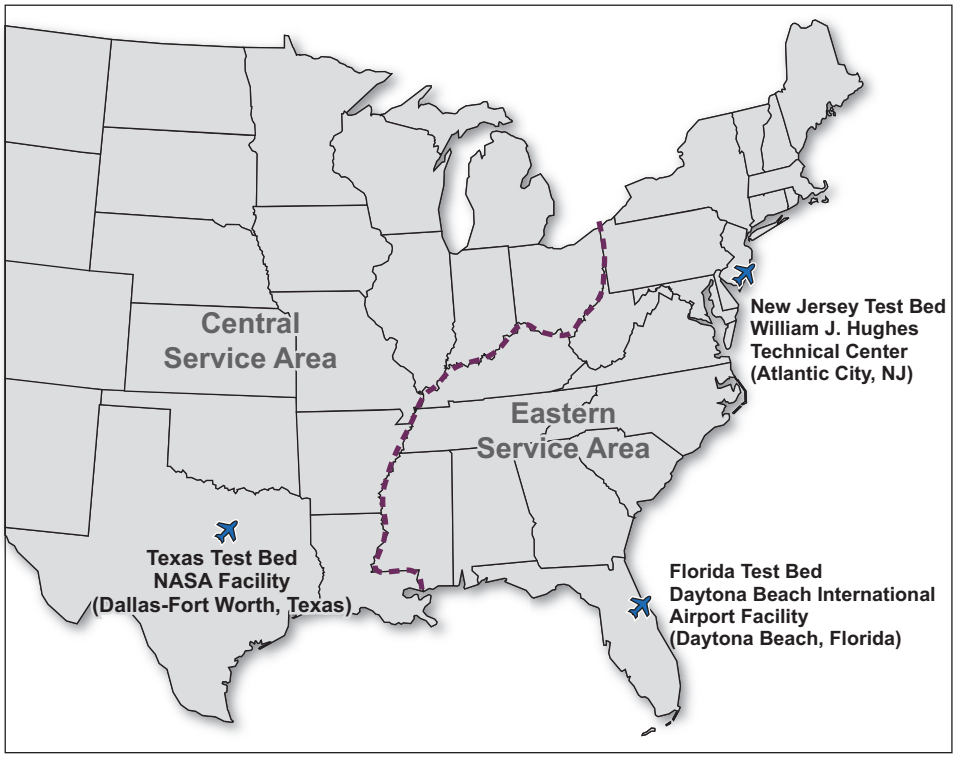
[2]GAO, *Next Generation Air Transportation System: FAA Has Made Progress in Implementation, but Delays Threaten to Impact Costs and Benefits,* GAO-12-141T (Washington, D.C.: Oct. 5, 2011); *Transportation System: Mechanisms for Collaboration and Technology Transfer Could be Enhanced to More Fully Leverage Partner Agency and Industry Resources*, GAO-11-604 (Washington, D.C.: June 30, 2011); *Integration of Current Implementation Efforts with Long-term Planning for the Next Generation Air Transportation System*, GAO-11-132R (Washington, D.C.: Nov. 22, 2010); *Next Generation Air Transportation System: Status of Systems Acquisition and the Transition to the Next Generation Air Transportation System*, GAO-08-1078 (Washington, D.C.: Sept. 11, 2008).

NextGen Test Facilities Share a Purpose but Have Different Capabilities and Participants

The purpose of the NextGen Test Bed is to provide an environment in which laboratory testing and real-world demonstrations help to show the benefits of NextGen technologies. Furthermore, the Test Bed provides access to the systems currently used in the NAS, which allows for testing and evaluating the integration and interoperability of new technologies. The Test Bed is also meant to bring together stakeholders early in the technology development process so participants can understand the benefits of operational improvements, identify potential risks and integration and interoperability issues, and foster partnerships between government and industry. Some test facilities also serve as a forum in which private companies can learn from and partner with each other and eventually enter into technology acquisition agreements with FAA with reduced risk.

Each of the NextGen test facilities that compose the NextGen Test Bed offers different testing capabilities and brings together different participants. The test facilities include: (1) the Florida Test Bed at Daytona Beach International Airport, supported by Embry-Riddle Aeronautical University (Embry-Riddle); (2) the Texas Test Bed, a National Aeronautics and Space Administration (NASA) facility near the Dallas-Fort Worth Airport; and (3) the New Jersey Test Bed located at FAA's William J. Hughes Technical Center near Atlantic City. (See fig. 1). According to FAA, while physically in different locations, the facilities are united in their purpose and will eventually be integrated to share capabilities and information.

Figure 1: Map of the Facilities That Compose the NextGen Test Bed



Sources: FAA and Map Resources.

While sharing a common purpose, each facility offers different testing capabilities and brings together different participants from different communities, as follows:

- The Florida Test Bed is located in a private facility at which companies, including Lockheed Martin and Boeing, come together with academia and FAA to test technologies that fit into the NextGen vision. Private participants contribute financially to research and demonstration projects and collaborate to test concepts and technologies. These activities are guided by memorandums of understanding among all the participants. Embry-Riddle is currently working on a model agreement to govern the contributions of its private partners that will help delineate which components (hardware, software, and infrastructure) will be provided by the government and which by private participants. The model is meant to provide a cost-sharing method and also help engage participants and provide a means for them to have a vested interest in seeing the development

of the technology all the way through to implementation. Currently, FAA pays the operating costs of the Florida Test Bed while Embry-Riddle and participating companies contribute technology and technical staff. Private participants may invest directly in software or hardware support. The facility—which has just undergone an expansion—provides access to the systems currently used in the NAS and to some of the major navigation, surveillance, communications, and weather information programs that are under development. It also has a dedicated area to support demonstrations and a separate space for the participating companies to test integration—where a greater contribution from the private sector is envisioned.

- The Texas Test Bed is a collaborative effort between NASA and FAA built on the grounds of FAA's Fort Worth Air Route Traffic Control Center. It supports NextGen research through field evaluations, shadow testing, the evaluation of simulations, and data collection and analysis.[3] The researchers at the facility have agreements to receive data feeds from the airlines operating at the Dallas-Fort Worth airport, as well as various data feeds from airport and air traffic control facilities.

- The New Jersey Test Bed, located at FAA's national scientific test base, conducts research and development for new NextGen systems. In June 2010, this facility opened the NextGen Integration and Evaluation Capability area where scientists use real-time simulation to explore, integrate, and evaluate NextGen concepts, such as area navigation, trajectory-based operations, and unmanned aircraft system operations in the NAS. In addition, in 2008, FAA entered into a lease to build the Next Generation Research and Technology Park (the Park) adjacent to the New Jersey Test Bed. The Park is a partnership intended to engage industry in a broad spectrum of research projects, with access to state-of-the-art federal laboratories. The Park's establishment is meant to encourage the transfer of scientific and technical information, data, and know-how to and from the private sector and is consistent with FAA's technology transfer goals. (See table 1 for examples of past and planned activities at NextGen test facilities.)

[3]Field evaluations include tests or trials in an operational (i.e. field) environment, as opposed to a laboratory setting. Shadow testing refers to evaluating a concept or technology using live data rather than simulated or recorded data. It can be performed in a laboratory or in the field.

Table 1: Select Projects at NextGen Test Facilities

Facility	Project	Description	Purpose	Participants
Florida Test Bed	Flight Data Object (FDO) Preparation	A flight's unique characteristics, data elements collected from disparate sources and merged into a cohesive picture, are its "Flight Object." Identifying these characteristics throughout the phases of flight in domestic and international automation systems is part of the process of developing four-dimensional trajectory planning that considers both space and time.	Perform research, analysis, and demonstration of Flight Data Object exchange as a means for capturing and sharing up-to-date information on any flight.	Lockheed Martin, Harris Corporation, Sensis Corporation, Mosaic ATM, Adacel, NavPortugal, NATS UK, and Embry-Riddle
	4-Dimensional Weather Cube Demonstration	The 4-Dimensional Weather Cube is continuously updated information on weather conditions, including convection, turbulence, icing, wind, visibility, clouds, volcanic ash, and space weather. The information is suitable for use by human or machine aviation decision-making procedures and processes.	Small demonstration of the 4-Dimensional weather cube.	Massachusetts Institute of Technology Lincoln Laboratory, NCAR, Embry-Riddle
	Oceanic Conflict Advisory Trial (OCAT) Flight Trial	OCAT is a year-long FAA operational trial designed to help airlines fly more of their preferred oceanic routings while reducing air traffic controller and pilot workloads.	Trial to allow airlines to access Advanced Technologies and Oceanic Procedures (ATOP) conflict probe results. ATOP is an integrated oceanic air traffic control automation system that includes an enhanced probe to detect conflicts between aircraft.	Lockheed Martin, Boeing, Embry-Riddle
Texas Test Bed	Precision Departure Release Capability (PDRC)	PDRC is software that links Traffic Management Advisor to other information to better plan flight departures by minimizing delays once passengers have boarded. Traffic Management Advisor uses graphical displays and alerts to increase situational awareness for air traffic controllers and traffic management coordinators.	Live-data, engineering shadow evaluation to verify integrated performance, refine concept of operations, and develop plan for operational evaluation.	NASA, FAA

Facility	Project	Description	Purpose	Participants
	Boeing Direct Routes	Boeing Direct Routes is a service that uses advanced software algorithms developed by NASA to automatically alert an airline's operations centers and flight crew when a simple, more fuel-efficient path is available, permitting the operations center to propose those routes to FAA controllers for approval.	Evaluate the performance and operational utility of decision support tool for air carrier use.	NASA, FAA, Boeing, Southwest Airlines, Continental Airlines
New Jersey Test Bed	Conflict Resolution Advisories Demonstration Project	Conflict Resolution Advisories is meant to ease en route controller workload and eliminate controller tasks associated with determining conflict resolution. Instead of the controller monitoring the sector airspace display to predict potential problems and mentally calculate problem resolutions, the technology will predict the problem and determine the best solution.	A series of experiments will assess the utility and operational acceptability of the automated resolutions proposed. The experiments will also provide data for the benefits and safety assessments of the operational improvement.	MITRE-Center for Advanced Aviation System Development, FAA
	D-AIRWOLF: DataComm Weather Demonstration	The Automatic Identification of Risk Weather Objects in Line of Flight (AIRWOLF) is a support tool that detects conflicts between aircraft and hazardous weather, alerts the controller, and generates automatic weather advisories. Data Communications (DataComm) is the first phase in the transition from the current analog voice systems to digital communication.	Simulation examines the combination of DataComm and the AIRWOLF weather advisory. Purpose is a demonstration of automated weather advisories being sent from the controller workstation to the pilot over a DataComm interface.	FAA

Source: GAO analysis of FAA and NASA information.

According to officials from the test facilities, they have made some progress in their plans to link the NextGen test facilities to integrate capabilities and share information. Linking the test facilities to leverage the benefits of each is part of the NextGen Test Bed concept. According to an FAA official, in June 2011, the Florida and New Jersey Test Beds established data integration capabilities when they were connected with FAA's NextGen Research and Development computer network. During the summer, they used the integrated capabilities to participate in a demonstration of the Oceanic Conflict Advisory Trial (OCAT) system.[4] In

[4]OCAT is a year-long FAA operational trial designed to help airlines fly more of their preferred oceanic routings while reducing air traffic controller and pilot workloads.

addition, the Texas Test Bed is in the final stages of being connected to FAA's NextGen Research and Development computer network. According to officials at the Texas Test Bed, in the past year, FAA and NASA collaborated on a NextGen Test Bed capabilities analysis and developed an interagency agreement to support NextGen Test Bed collaboration. This increased level of coordination is expected to continue.

Stakeholders Must See Tangible Results to Participate in NextGen Technology Development, and FAA Has Taken Steps to Improve Technology Transfer and Implementation

In prior work on technology transfer activities, we found that the success of test facilities as a means to leverage private sector resources depends in large part on the extent to which the private sector perceives benefits to its participation.[5] Representatives of firms participating in test facility activities told us that tangible results—that is, the implementation of technologies they helped to develop—were important to maintain the private sector's interest. However, they said it was not always clear what happened to technologies that were successfully tested at these sites. In some cases, it was not apparent whether the technology being tested had a clear path to implementation, or whether that technology had a clear place in FAA's NAS Enterprise Architecture Infrastructure Roadmaps.[6] As a result, a successfully tested technology would not move to implementation in the NAS. We also found that FAA has had difficulty advancing technologies that cut across programs and offices at FAA, when there is no clear "home" or "champion" within FAA for the technology.

FAA's expansion of the Test Bed concept—linking together its testing facilities, expanding the Florida Test Bed, and building a Research and Technology Park adjacent to the New Jersey Test Bed to complement the capabilities at Embry-Riddle—is a positive step that should help to address some of these issues, allowing private sector participants to remain more involved throughout the process, with a vested interest in seeing the development of selected technologies through to successful implementation. In addition, to improve its ability to implement new technologies, FAA has begun to restructure its Air Traffic Organization (ATO), which is responsible for moving air traffic safely and efficiently, as well as for implementing NextGen. We have previously reported on problems with FAA's management structure and oversight of NextGen

[5]GAO-11-604.

[6]NAS Enterprise Architecture Infrastructure Roadmaps describe the strategy for transitioning from the current NAS to the future NAS environment.

acquisitions and implementation and made recommendations designed to improve FAA's ability to manage portfolios of capabilities across program offices. To address these issues, FAA made the Deputy Administrator responsible for the NextGen organization and created a new head of program management for NextGen-related programs to ensure improved oversight of NextGen implementation. Furthermore, the ATO is in the process of being divided into two branches: operations and NextGen program management. Operations will focus on the day-to-day management of the NAS and the program management branch will be responsible for developing and implementing programs while working with operations to ensure proper integration. While a focus on accountability for NextGen implementation is a positive step and can help address issues with respect to finding the right "home" for technologies and creating a clearer path to implementation, it is too early to tell whether this reorganization will produce the desired results.

Collaboration among the NextGen partner agencies also depends, in part, on their perceiving positive outcomes. NASA has historically been FAA's primary source of long-term air traffic management research and continues to lead research and development activities for many key elements of NextGen. However, past technology transfer efforts between NASA and FAA faced challenges at the transfer point between invention and acquisition, referred to as the "valley of death." At this point in the process, NASA has limited funding at times to continue beyond fundamental research, but the technology was not matured to a level for FAA to assume the risks of investing in a technology that had not yet been demonstrated with a prototype or similar evidence. FAA and NASA officials are both working to address this issue through interagency agreements that specify a commitment to a more advanced level of technological maturity of research that NASA has conducted in the past. Using an interagency agreement, as well as test facility demonstrations, NASA developed and successfully transferred the Traffic Management Advisor—a program that uses graphical displays and alerts to increase situational awareness for air traffic controllers and traffic management coordinators—to FAA. Through the agreement, the two agencies established the necessary data feeds and two-way computer interfaces to support the program. NASA demonstrated the system's capabilities at the Texas Test Bed, where it also conducted operational evaluations and transferred the program to FAA, which, after reengineering it for operational use, deployed it throughout the United States.

FAA has also used research transition teams to coordinate research and transfer technologies from NASA and overcome technology transfer

challenges.[7] As we have previously reported, the design of these teams is consistent with several key practices of interagency coordination we have identified.[8] These teams identify common outcomes, establish a joint strategy to achieve that outcome, and define each agency's role and responsibilities, allowing FAA and NASA to overcome differences in agency missions, cultures, and established ways of doing business.

Differences in mission priorities, however, particularly between FAA and the Department of Homeland Security (DHS), and between FAA and the Department of Defense (DOD), pose a challenge to coordination with those agencies. DHS's diverse set of mission priorities, ranging from aviation security to border protection, affects its level of involvement in NextGen activities. Agency officials also have stated that although different offices within DHS are involved in related NextGen activities, such as security issues, the fact that NextGen implementation is not a formalized mission in DHS can affect its level of participation in NextGen activities. NextGen stakeholders reported that FAA could more effectively engage partner agencies in long-term planning by aligning implementation activities to agency mission priorities and by obtaining agency buy-in for actions required to transform the NAS.

In addition, we have reported that FAA's mechanisms for collaborating on research and technology development efforts with DOD and DHS do not ensure that resources are fully leveraged. For example, FAA and DOD have yet to fully identify what DOD research, technology, or expertise could support NextGen activities. DOD has not completed an inventory of its research and development portfolio related to NextGen, impeding FAA's ability to identify and leverage potentially useful research, technology, or expertise from DOD. In addition, DHS's collaboration with FAA and its NextGen planning unit, the Joint Planning and Development Office has been limited in certain areas of NextGen research, and the agencies have yet to fully determine what can be leveraged. Lack of

[7]Research transition teams cover approximately half of all research and development activities conducted by NASA's Airspace Systems Program—a group assigned to directly address fundamental NextGen needs. Each team addresses a specific issue area that (1) is considered a high priority, (2) has defined projects and deliverables, and (3) requires the coordination of multiple offices within FAA or NASA.

[8]GAO-11-604. See also GAO, *Results Oriented Government: Practices That Can Enhance and Sustain Collaboration among Federal Agencies*, GAO-06-15 (Washington, D.C.: Oct. 21, 2005).

coordination between FAA and DOD and FAA and DHS could result in duplicative research and inefficient use of resources at both agencies. We previously recommended that these agencies develop mechanisms to further clarify NextGen interagency collaborative priorities and enhance technology transfer between the agencies.

Chairman Mica, Ranking Member Rahall, and Members of the Committee, this concludes my prepared statement. I would be pleased to answer any questions that you may have at this time.

GAO Contact and Staff Acknowledgments

For further information on this testimony, please contact Gerald L. Dillingham, Ph.D., at (202) 512-2834 or dillinghamg@gao.gov. In addition, contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this statement. Individuals making key contributions to this testimony include Andrew Von Ah (Assistant Director), Kevin Egan, Elizabeth Eisenstadt, Richard Hung, Bert Japikse, Kieran McCarthy, and Jessica Wintfeld.