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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





Highlights of [GAO-10-629](#), a report to congressional committees

Why GAO Did This Study

To prepare for forecasted air traffic growth, the Federal Aviation Administration (FAA), in partnership with other federal agencies and the aviation industry, is planning and implementing the Next Generation Air Transportation System (NextGen), a new satellite-based air traffic management system that will replace the current radar-based system and is expected to enhance the safety and capacity of the air transport system.

GAO was asked to review FAA's metrics for (1) tracking the status of NextGen programs and the implementation of NextGen capabilities, the reliability of those metrics, and any limitations or gaps and (2) measuring the performance and outcomes of NextGen capabilities that are implemented and any limitations. GAO analyzed FAA program progress reports and associated metrics for monitoring. GAO also reviewed agency performance and accountability reports and discussed internal performance reporting methods with FAA officials.

What GAO Recommends

The FAA Administrator should clarify dispute resolution processes within FAA's portfolio management structure, and develop a timeline and action plan to agree with stakeholders on a list of specific goals and outcome-based performance metrics for NextGen. DOT agreed to consider GAO's recommendations and provided technical comments that GAO incorporated as appropriate.

View [GAO-10-629](#) or [key components](#). For more information, contact Gerald Dillingham, Ph.D., at (202) 512-2834 or dillinghamg@gao.gov.

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

What GAO Found

FAA has metrics that allow it to monitor the progress of its programs for acquiring software and hardware. These metrics include Earned Value Management (EVM) measurements that show how well a program is meeting its planned cost and schedule targets for system development. Previous GAO reports have identified issues with FAA's implementation of EVM, which continue to affect the accuracy and reliability of some of FAA's program status reports. For example, for one acquisition program, FAA implemented EVM metrics only for the contractor's performance and not for the government's. As a result, the EVM data did not pick up delays that occurred after the contractor delivered the system and the EVM system did not provide early warnings of delays and potential cost overruns. In addition, GAO's previous work has shown that FAA is not able to report on how slippage in one program's schedule or budget will ultimately affect the implementation of other NextGen acquisition programs or operational capabilities whose progress depends on the completion of the first program. GAO has made recommendations to address these issues, which FAA and the Department of Transportation have begun to implement. FAA has also designated specific positions within the NextGen Integration and Implementation Office—known as solution set coordinators—to monitor and track progress toward implementing a portfolio of operational improvements into the national airspace system. However, the role of the coordinators and the process for resolving any disputes across FAA lines of business have not been clearly defined or delineated and it is uncertain whether the processes in place in this portfolio management structure will strengthen oversight and create a greater likelihood that required activities are completed on time.

FAA has broad goals for NextGen as a whole, such as increasing capacity and reducing noise and emissions, but has not yet developed specific goals and outcome-based performance metrics to track the impact of and benefits realized from the entire NextGen endeavor. The agency has multiple efforts underway to develop such metrics: FAA's Air Traffic Organization (ATO), which manages the air traffic control system, has started to compile and review a set of metrics for measuring outcomes and performance associated with NextGen improvements. These metrics are likely to measure such things as the extent to which improvements increase throughput at airports, reduce emissions, and reduce flight times, but they are in the early stages of development. Recently, FAA also committed to developing performance metrics with industry, but it has no timeline or action plan for completing this effort. Separately, the Joint Planning and Development Office (JPDO), which is responsible for the long-term planning for NextGen and partnering with other federal agencies, has been working to develop a list of potential metrics, which range from fuel consumed per distance flown to curb-to-curb travel time. Without specific goals and metrics for the performance of NextGen as a whole, together with a timeline and action plan for implementation, it is not clear whether NextGen technologies, systems, and capabilities will achieve desired outcomes and be completed within the planned time frames.

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Washington, DC 20548

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Congressional Committees

Air traffic is growing, and with it, congestion and flight delays, which can cause significant economic losses. The Federal Aviation Administration (FAA) predicts that, by 2025, the number of passengers will increase 57 percent—from about 700 million to about 1.1 billion per year—and the number of flights from about 80,000 to more than 95,000 every 24 hours. Today's air transportation system will be strained to meet these air traffic demands, especially on some routes to and from major cities and hubs, but improvements to the national airspace system can mitigate the anticipated increase in flight delays and any resulting decrease in economic productivity. Accordingly, FAA and other federal agencies have worked in partnership to develop a plan for the Next Generation Air Transportation System (NextGen).¹ NextGen involves every aspect of air transportation, from arrival at the airport to departure from the destination airport. NextGen requires the acquisition of new integrated systems (software and hardware), flight procedures, aircraft performance capabilities, and supporting infrastructure to transform the current air transportation system into one that uses satellite-based surveillance and navigation and network-centric operations.² These acquisition programs and their associated improvements are intended to increase the efficiency and capacity of the air transportation system while maintaining its safety so that it can accommodate anticipated future growth. The initial planning for NextGen, starting with Vision 100³ in 2003, focused on implementing improvements through 2025. More recently, FAA has emphasized improvements that can be implemented in the near term and midterm,

¹NextGen was designed as an interagency effort in order to leverage various agencies' expertise and funding to advance NextGen while avoiding duplication. In addition to FAA, federal partner agencies include the Departments of Commerce (particularly its National Oceanic and Atmospheric Administration), Defense, Homeland Security, and Transportation; the National Aeronautics and Space Administration; and the White House Office of Science and Technology Policy.

²GAO, *Next Generation Air Transportation System: Challenges with Partner Agency and FAA Coordination Continue, and Efforts to Integrate Near-, Mid-, and Long-term Activities Are Ongoing*, [GAO-10-649T](#) (Washington, D.C.: Apr. 21, 2010).

³Vision 100—Century of Aviation Reauthorization Act (Pub. L. No. 108-176, 117 Stat. 2490 (2003)).

defined as between 2012 and 2018.⁴ At the same time, stakeholders and Members of Congress have expressed concerns about the pace of FAA's implementation of NextGen, citing the schedule delays that plagued FAA's previous air traffic control modernization efforts and led GAO to place air traffic modernization on its High-Risk List between 1996 through 2008. Additionally, given increasing demands for a more effective, transparent, and accountable federal government, it is important that federal agencies establish meaningful goals for improving performance, monitor progress in achieving their goals, and use information about performance to make decisions that can improve results. Metrics are important for demonstrating progress toward achieving goals and providing information on which to base organizational and management decisions.

In light of the scale and complexity of NextGen implementation and concerns about past modernization efforts and the pace of implementation, you asked us to review the metrics and process FAA uses to monitor the status of NextGen implementation. To do so, we examined (1) FAA's metrics for tracking the status of NextGen acquisition programs and the implementation of NextGen capabilities, the reliability of these metrics and the data underlying them, and any limitations or gaps in FAA's efforts to track the status of NextGen implementation; and (2) how FAA currently measures the performance of NextGen programs and capabilities, FAA's progress in developing a full suite of metrics to measure the outcomes and performance of NextGen capabilities once implemented, and any limitations or gaps in FAA's approach to developing these metrics.

To determine what programmatic metrics FAA has available for monitoring NextGen programs and programs critical to NextGen implementation, we reviewed reports used to justify programs prior to investment, progress reports submitted by program managers, and reports based on the FAA database that houses program information. We also interviewed FAA acquisition and finance officials and selected NextGen

⁴FAA requested that RTCA—a private, not-for-profit corporation that develops consensus-based recommendations on communications, navigation, surveillance, and air traffic management system issues—create a NextGen Midterm Implementation Task Force (the Task Force), composed of industry stakeholders, to reach consensus within the aviation community on the operational improvements that can be implemented between now and 2018. The Task Force provided recommendations to FAA in September 2009 and FAA responded to all of these recommendations in its 2010 NextGen Implementation Plan. FAA is continuing to work with industry through RTCA to address the recommendations as implementation continues.

program managers to understand how program managers develop and report their metrics to internal and external stakeholders and to gain an understanding of the database that houses this information. To learn how FAA plans to monitor and measure progress toward implementing NextGen operational capabilities—beyond the status of acquisition programs—we reviewed documents that outline FAA’s solution set organization and management approach, and interviewed officials involved in coordinating and managing solution sets.⁵ To determine the reliability of these programmatic metrics and to analyze the extent of any gaps or limitations, we reviewed past GAO reports on FAA’s acquisition process and the reliability of the data FAA uses to develop its metrics, as well as the implementation status of prior recommendations. We reviewed program and process reviews from FAA’s acquisition offices to identify key areas of FAA’s internal oversight focus and key findings reached in such reviews about FAA’s acquisition procedures and policies. To determine FAA’s progress in developing metrics for measuring the outcomes of NextGen improvements, we first reviewed how FAA currently reports on its performance, both internally and externally, and how information on the performance of specific NextGen improvements is incorporated into those metrics. We reviewed FAA’s performance and accountability reports and discussed internal performance reporting methods with relevant FAA officials. Specifically, we reviewed FAA’s Flight Plan, Performance and Accountability Report, NextGen Implementation Plans published in 2009 and 2010, Enterprise Architecture, and reports to the Office of Management and Budget (OMB) (known as “Exhibit 300” reports).⁶ To understand FAA’s approach and progress toward developing a suite of NextGen metrics, we interviewed FAA officials with responsibilities for NextGen planning and implementation, particularly officials within the Air Traffic Organization (ATO) and the Joint Planning and Development Office (JPDO) responsible for modeling

⁵The solution set organization is located in the NextGen Integration and Implementation Office and provides a portfolio framework to manage the successful implementation of both immediate improvements and the large-scale integration of NextGen capabilities.

⁶FAA’s Flight Plan is a 5-year strategic plan that outlines agency goals and metrics. FAA’s NextGen Implementation Plan is an annual workplan that defines the midterm operational capabilities the agency plans to deliver between now and 2018. FAA’s Enterprise Architecture provides the structure to relate organizational mission, vision, and goals to business processes and the technical or information technology infrastructure required to execute them. An Exhibit 300—also called a Capital Asset Plan and Business Case—is used to justify resource requests for major investments and is intended to enable an agency to demonstrate to its own management, as well as to OMB, that a major project is well planned.

NextGen benefits and developing NextGen performance metrics. To evaluate metrics that FAA is considering, we compared proposed metrics with key attributes of successful performance metrics that we identified in past GAO work.⁷ We also interviewed several key stakeholders for NextGen, including representatives from airlines, equipment manufacturers, federal partner agencies, and the air traffic controllers union to get their views on the metrics they deem most appropriate to measure the performance of NextGen.

In this report, we discuss two types of metrics: programmatic and performance. Programmatic metrics are used to track the progress of programs or capabilities, and include such things as time, cost, and schedule. For instance, some programs use earned value management (EVM), a technique for showing how well a program is meeting cost and schedule milestones.⁸ In contrast, performance metrics measure the impact or results of a program or activity once it is implemented relative to desired outcomes or goals, such as reductions in delays or fuel consumption and increased throughput at an airport.⁹ Effective performance metrics require baselining, or determining the current status of whatever is being measured, so that targets can then be set. These metrics will, if developed well, measure how well something is progressing toward its intended target.

We conducted this work from June 2009 through July 2010 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the work 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. Appendix I contains more detail information on our objectives, scope, and methodology.

⁷GAO, *Tax Administration: IRS Needs to Further Refine Its Tax Filing Season Performance Measures*, [GAO-03-143](#) (Washington, D.C.: Nov. 22, 2002).

⁸Earned value management compares the actual work performed at certain stages of a job to its actual costs—rather than comparing budgeted and actual costs, the traditional management approach to assessing progress. By measuring the value of the work that has been completed at certain stages in a job, earned value management can alert program managers, contractors, and administrators to potential cost growth and schedule delays before they occur and to problems that need correcting before they worsen.

⁹Performance metrics ensure that project managers are accountable in meeting expected performance goals and that projects are aligned with an agency's strategic goals.

Background

FAA is currently tracking over 30 acquisitions related to modernization and improvement of the national airspace. While not all of these acquisition programs are considered to be “NextGen” programs, several are instrumental to NextGen implementation. Examples of instrumental programs include the En Route Automation Modernization (ERAM); the Airport Surface Detection Equipment-Model X (ASDE-X), which increases runway safety and airport efficiency by putting in place tools to improve operations, surveillance, and data sharing on the airport surface (e.g., runways and taxiways); and the Wide Area Augmentation System (WAAS), which provides aircraft more accurate position information for more direct flight paths and precision approaches to airports. In particular, ERAM, a new system architecture, will replace the current En Route computer system and its backup and is considered to be the backbone that will support NextGen. ERAM is meant to provide all of today’s functionality and add new capabilities needed to support the transformation to NextGen.

Besides these three instrumental programs, FAA has identified six major acquisition programs that it considers to be transformational NextGen programs, as follows:

- Automatic Dependent Surveillance Broadcast (ADS-B) is a satellite-based information broadcasting system that is designed, along with GPS-based navigation technologies, to enable more precise control of aircraft during en route flight, approach, and descent.
- System-Wide Information Management (SWIM) is the information management architecture for the national airspace system, acting as its “World Wide Web.” SWIM will manage surveillance, weather, and flight data, as well as aeronautical and system status information, and will provide the information securely to users.
- NextGen Data Communications (Data Comm) is intended to provide a digital communications link for two-way exchanges between controllers and flight crews for air traffic control clearances, instructions, advisories, flight crew requests, and reports.
- NextGen Network Enabled Weather (NNEW) is planned to serve as the core of the NextGen weather support services and provide a common weather picture across the national airspace system.
- National Airspace Voice Switch (NVS) is to replace existing switches and provide the foundation for all air-to-ground and ground-to-ground voice communications in the future air traffic control environment.

- Collaborative Air Traffic Management Technologies (CATMT) encompasses the development of systems to distribute and manage aeronautical information, manage airspace reservations, and manage flight information from preflight to postflight analysis.

Acquisition programs are overseen by program offices within the Air Traffic Organization (ATO) and headed by program managers who are responsible for gathering and reporting programmatic data to FAA’s acquisition tracking database, known as the Simplified Program Information Reporting and Evaluation (SPIRE) tool, which FAA uses to track and report the progress of all approved acquisitions toward its schedule and cost performance targets. Detailed cost, schedule, and EVM metrics are developed, and reporting begins after the Joint Resources Council (JRC) approves a program for funding.¹⁰ As table 1 shows, three NextGen transformational programs, ADS-B, SWIM, and CATM, have received final investment approval and are being reported with EVM and associated metrics, while the three remaining programs, DataComm, Voice Switch, and Weather, have not yet received such approval. For the time being, their progress is being tracked against schedule milestones.

Table 1: Status of NextGen’s Six Transformational Programs

Program	Status of latest investment decision	Date of decision	Next major milestone
ADS-B	Final investment	June 2006	Under deployment at several sites (at and near airports); full deployment of ground-based transceivers expected in FY 2013
SWIM	Final investment	June 2009	Deployment of capabilities expected to start in FY 2010
Collaborative Air Traffic Management Technologies (CATMT)	Final investment	Sept 2008 (Work package 2) Jan. 2010 (Work package 3)	Integration of weather data in 2011
DataComm	Final investment decision Segment 1	September 2011	Deployment schedule not baselined until final investment decision, expected in FY 2016

¹⁰Within FAA, the Joint Resources Council is an executive body consisting of associate and assistant administrators, acquisition executives, the Chief Financial Officer, the Chief Information Officer, and legal counsel. The council makes agency-level decisions, including those that determine whether an acquisition meets a mission need and should proceed. The council also approves changes to a program’s baseline, budget submissions, and the national airspace system’s architecture baseline.

Program	Status of latest investment decision	Date of decision	Next major milestone
NAS Voice Switch (NVS)	Final investment decision Segment 1	August 2012	Market survey of potential contractors scheduled for FY 2010
NextGen Weather	Initial and final investment decision have yet to be scheduled	FY 2012-2015	[TBD]

Source: FAA.

ATO's NextGen and Operations Planning Office is leading near-term (now through 2015) and midterm (2015 through 2018) NextGen planning and implementation efforts.¹¹ These efforts are guided by the NextGen Implementation Plan, which identifies the NextGen capabilities that are to be implemented between 2012 and 2018.¹² NextGen capabilities are defined in portfolios of related operational improvements called solution sets, which together, will bring about the midterm system. FAA currently is managing seven solution sets, described in table 2.

Table 2: Description of FAA's NextGen Solution Sets

Solution set	Description of solution set
Initiate Trajectory-Based Operations	This will lead to a shift from current "clearance-based" to "trajectory-based" air traffic control and will enable aircraft to fly negotiated flight paths that take both controller and pilot preferences and optimal airspace system performance into consideration.
Increase Arrivals and Departures at High-Density	Airports will improve arrival and departure capacity for airports with heavily used airspace.
Increase Flexibility in the Terminal Environment	This will increase access and help manage the separation of aircraft in and around airports and allow for improved management of aircraft on the airport surface, as well as improved access to runways in low visibility.
Improve Collaborative Air Traffic Management	This will support a more flexible air traffic system capable of adjustments to routings or altitude to match airspace and airport capacity, and accommodate controller and pilot preferences to the maximum extent possible.
Reduce Weather Impact	This will support integration of a broad range of weather information into air traffic control decision-making.

¹¹ATO is responsible for operating, maintaining, and modernizing the nation's current air traffic control system.

¹²The 2010 NextGen Implementation Plan also identifies how FAA plans to respond to recommendations from the NextGen Midterm Implementation Task Force (the Task Force). FAA requested that RTCA, (see footnote 4) create the Task Force to reach consensus within the aviation community on the operational improvements that can be implemented between now and 2018.

Solution set	Description of solution set
Improve Safety, Security and Environmental Performance	This will deploy an automated system to identify airborne security threats and communicate that information to the appropriate agency.
Transform Facilities	This will support planning for future NextGen facilities. ^a

Source: FAA.

^aThis definition is limited to activities funded for fiscal year 2010.

Each of the solution sets includes or will include numerous acquisition programs and a variety of other activities that will be carried out across offices within ATO, such as the Office of Operations, and several other lines of business across FAA, such as the Office of Aviation Safety, the Office of Airports, and others. For example, implementing the solution set Increase Flexibility in the Terminal Environment requires that ADS-B, DataComm, SWIM, ERAM, NNEW and other programs be implemented; flight procedures be developed by the Flight Procedure Standards Branch; and safety analyses be conducted by ATO, and requirements and standards be developed by the Flight Technology and Procedures Division, among numerous other actions.

FAA has created a new position - solution set coordinator - to coordinate and manage the implementation of each solution set across the agency. While solution set coordinators manage the day-to-day implementation of solution sets, the NextGen Management Board, which includes the heads of ATO and the key agency lines of business, oversees NextGen implementation efforts within FAA and has the authority to force timely resolution of emerging NextGen implementation issues.¹³ The Board's role is to measure the progress of deployments and of key activities that support decision-making; ensure essential resources are available, including reprioritizing resources as necessary; issue policies and guidance; and identify officials—like program managers—within organizations who will be accountable for delivering system changes.

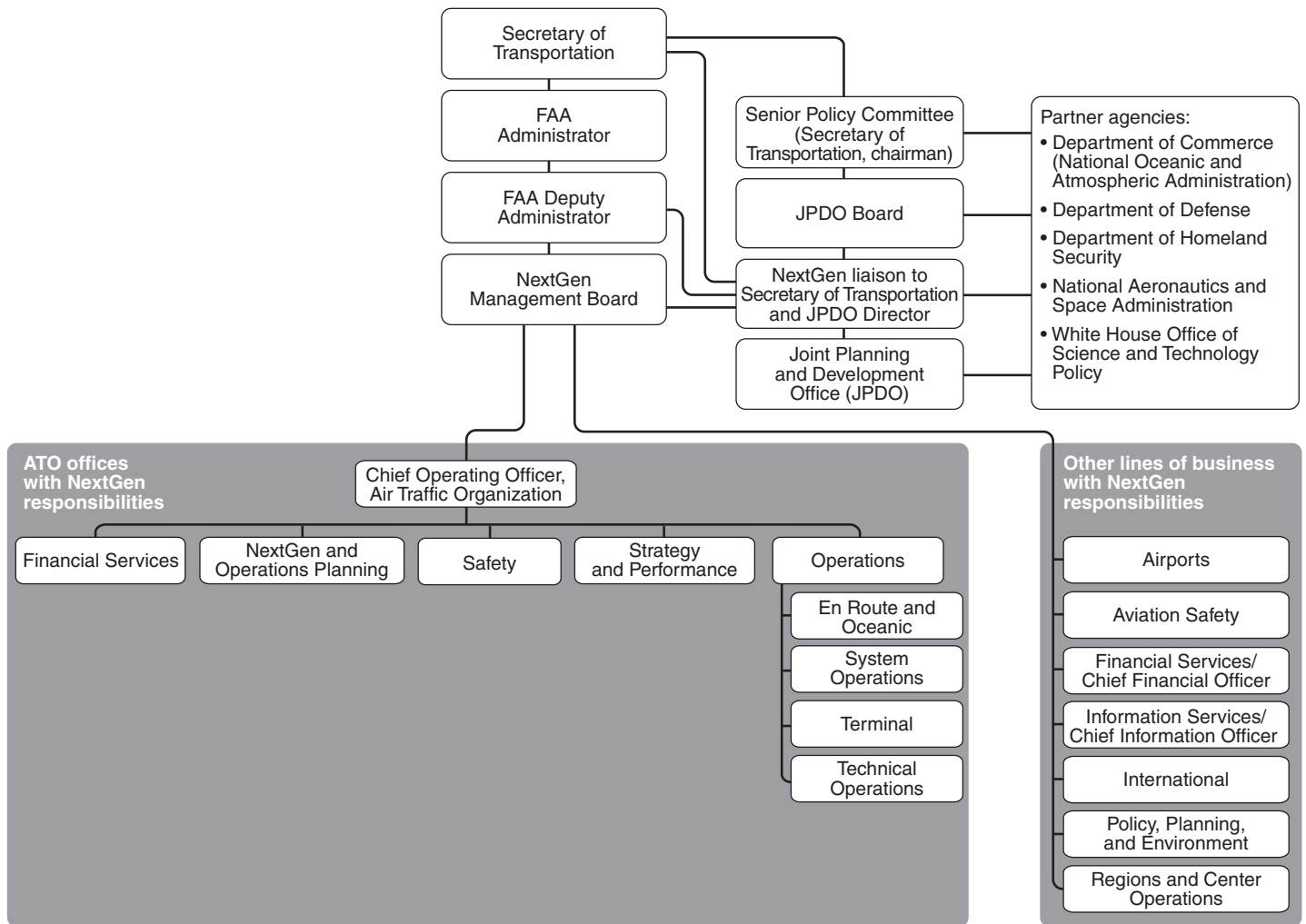
¹³The NextGen Management Board is chaired by the FAA Deputy Administrator and consists of ATO's Chief Operating Officer and direct reports (including all Senior Vice Presidents and Vice Presidents, as well as the Director of the NextGen Integration and Implementation Office), the Associate Administrator for Aviation Safety, the Deputy Associate Administrator for Airports, the Assistant Administrator for Regions and Center Operations, the Assistant Administrator for Financial Services/Chief Financial Officer, the Assistant Associate Administrator for Policy, Planning and Environment, the Director of JPDO, Department of Defense Liaison, and a representative from MITRE. Also on the board are members of other key stakeholder groups, including representatives from the air traffic controller and aviation safety specialist unions. According to FAA, the Board is currently undergoing restructuring.

JPDO is responsible for the long-term planning and development for NextGen and as such, is involved in modeling the costs, benefits, and risks associated with alternative scenarios of NextGen implementation over the long term. Originally chartered in Vision 100¹⁴ to plan and coordinate the transition to NextGen, JPDO began to focus on planning for NextGen beyond 2018 after organizational changes were made in May 2008.¹⁵ JPDO has recently undergone a leadership change, has been repositioned within FAA's organization, and now reports directly to the FAA Deputy Administrator—who is the FAA executive in charge of NextGen. JPDO is also responsible for ensuring and fostering interagency coordination and collaboration and is closely tied to the Senior Policy Committee—the governing body for NextGen chaired by the Secretary of Transportation and made up of cabinet-level officials from the partner agencies. Figure 1 shows the current governmental organization surrounding NextGen activities.

¹⁴Vision 100—Century of Aviation Reauthorization Act (Pub. L. No. 108-176, 117 Stat. 2490 (2003)).

¹⁵2010 NextGen Implementation Plan, March 2010, and GAO, *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).

Figure 1: NextGen Governmental Organizational Structure



Sources: FAA and JPDO.

The participation of industry and other stakeholders is critically important to the success of NextGen’s implementation. Numerous venues exist for stakeholders to participate, although our prior work has shown that industry stakeholders, the air traffic controller and aviation safety specialist unions, and the partner agencies have participated unevenly for a variety of reasons.¹⁶ The NextGen Institute, a JPDO mechanism designed

¹⁶GAO-08-1078 and GAO-10-649T.

to involve private-sector expertise, tools, and facilities in the development and implementation of NextGen, has been leaderless since March 2010 when the head of the NextGen Institute resigned, and a replacement has yet to be named. Last year, FAA requested that RTCA create a NextGen Midterm Implementation Task Force to reach consensus within the aviation community on the operational improvements that can be implemented by 2018 and would be most beneficial to users.¹⁷ The Task Force focused on maximizing benefits in the near term and paid particular attention to aligning its recommendations with how aircraft operators decide to invest in aircraft equipment. On September 9, 2009, the Task Force issued its final report, which contained a list of recommendations for FAA. FAA agreed with the Task Force recommendations and worked with the Task Force to incorporate and address their recommendations in FAA's plans. In January 2010, FAA released its response to the task force, which outlines FAA's specific responses, including an action plan detailing when certain tasks will be completed. A key recommendation of the Task Force was for FAA to work with industry to develop performance metrics to show the progress and benefits of NextGen.

FAA Has Metrics to Report on Program Status but Does Not Have Metrics to Measure Overall Implementation of NextGen Capabilities

¹⁷Organized in 1935 and once called the Radio Technical Commission for Aeronautics, RTCA is today known just by its acronym, RTCA. RTCA is a private, not-for-profit corporation that develops consensus-based performance standards for air traffic control systems. RTCA serves as a federal advisory committee, and its recommendations are the basis for a number of FAA's policy, program, and regulatory decisions.

FAA Uses Programmatic Metrics to Provide Updates on Program Status, but Additional Information and Context Could Help Observers and Overseers Understand Problems


FAA's SPIRE tool can organize information provided by program managers into various reports that give high-level indications of a program's status. For example, figures 2 and 3 show the program assessment reports for ERAM and ADS-B, respectively. These reports use a color-coded chart to summarize program managers' assessments of performance for cost and schedule indicators, with green signifying that the program is on target, yellow that there are potential issues with meeting targets, and red that there is significant risk that the target will not be met. These reports also contain space for the program managers to clarify the status of the program, implementation concerns, and information on any other issues deemed necessary to highlight, such as problems, issues, and corrective actions for ensuring that milestones and costs are maintained within the established targets.

Figure 2: Program Assessment Report for ERAM as of June 2010

Program Phase: Deployment

June 2010

Program assessment					
Financial	Schedule	Technical	Resources	External interest	Program manager
G	R	Y	G	Y	Y

Supporting indicators			
Financial	Measure of cost performance	Technical	Measure of cost performance
Cost Performance Index (CPI)	1.02	Requirements stability	G
To Complete Performance Index (TCPI)	TCPI = 0.85	System defects	Y
Cost Variance At Completion (CVAC)	G	Test results	Y
Obligation rate		Deployment	Y
		Cumulative mitigated risk impact	R
Schedule	Measure of schedule performance	Performance Variance At Completion (PVAC)	G
		Resources	Measure of appropriated funding
Schedule Performance Index (SPI)	1.00	Funding	G
Schedule Variance At Completion (SVAC)	R	External interest	External review activity
APB standard level 1 milestones	R	Under review by DOT, IG, GAO, or other	Y
Fiscal year schedule goals	R		

Program manager comments

The approved 2003 schedule for the ERAM program was to reach full operational status at the first operational site, the Salt Lake City (ZLC) Air Route Traffic Control Center by the end of December 2009. However, continuing resolution of PRs needed for the key site to transition to continuous operations continues to delay this milestone. These PRs could not have been discovered in the Technical Center Laboratory environment and only became evident when the system was tested operationally at the key sites. The Salt Lake City key site has run on ERAM operationally three separate times for periods of seven days from late January through March 2010. During these periods there were no delays, separation violations, safety impacts, or catastrophic failures of ERAM. However, there were issues noted which required work-arounds in operational procedures and required additional staffing to conduct operations. While this was workable for short durations of up to a week, these issues precluded sustained continuous operations due to the impact on staffing.

The Western Service Center has developed a list (the NAS Operations List or NOL) containing PRs that are needed in order to sustain continuous operations at the ZLC key site. These PRs are being fixed and packaged in three incremental software releases. The initial two releases have been delivered to the key sites and both Salt Lake City and Seattle have run for 4 hours on the midshift on the first software release with no new critical issues identified. The key sites are expected to conduct operational runs on the 2nd release in early August and the last software release is planned to be delivered during August as well. Once enough operational experience is gained on these releases the schedule to an In-Service Decision (ISD), including conduct of independent operational test and evaluation, and the resultant waterfall deployment schedule will be determined. The key sites are expected to come up on a continuous operational basis on ERAM by November. The current projection for an In-Service Decision is the 2nd quarter of FY 2011.

The program office is currently assessing the cost impact to the program baseline as a result of the schedule delay in achieving ISD and the waterfall deployment at all ARTCCs.

- Metric indicates no issues
- Metric indicates some issues
- Metric indicates serious issues


Source: FAA.

Figure 3: Program Assessment Report for ADS-B as of June 2010



Program Phase: Production

June 2010

Program assessment					
Financial	Schedule	Technical	Resources	External interest	Program manager
G	G	G	G	Y	G

Supporting indicators			
Financial	Measure of cost performance	Technical	Measure of cost performance
Cost Performance Index (CPI)	1.04	Requirements stability	G
To Complete Performance Index (TCPI)	TCPI = 0.97	System defects	n/a
Cost Variance At Completion (CVAC)	G	Test results	G
Obligation rate		Deployment	G
		Cumulative mitigated risk impact	G
		Performance Variance At Completion (PVAC)	G
Schedule	Measure of schedule performance	Resources	Measure of appropriated funding
Schedule Performance Index (SPI)	0.98	Funding	G
Schedule Variance At Completion (SVAC)	G	External interest	External review activity
APB standard level 1 milestones	Y	Under review by DOT, IG, GAO, or other	Y
Fiscal year schedule goals	G		

Program manager comments
<p>External Interest is yellow because the Program has on-going OIG and GAO audits.</p> <p>Juneau IOC was achieved on 04/28/2010. Philadelphia IOC was achieved on March 28. Louisville IOC was achieved on November 19, 2009. Gulf of Mexico IOC was achieved on December 17, 2009.</p> <p>The Final rule was published in the Federal Register on 5/28/10.</p> <p>ISD due in September and is on track. ISR checklist is 61% complete. Some automation issues are being worked.</p>

-  Metric indicates no issues
-  Metric indicates some issues

Source: FAA.

As figures 2 and 3 show, FAA data and reports can indicate potential problems, and the program manager’s comment box can provide additional information on their nature. For example, the report on ERAM in figure 2 shows schedule performance in red, specifically, the program is behind in meeting key milestones and technical performance in yellow, including system defects that need to be dealt with and could affect the cumulative risk and the level 1 milestones associated with the program. The program manager comment box provides more detailed information on the nature of the defects and problems associated with the program—in this case, interruptions in flight data processor software. These reports also indicate how well the program is performing from an EVM

perspective; that is, they show how well the program is meeting its planned cost and schedule targets for system development. In these reports, the information on the left side of the chart indicates performance relative to EVM. “CPI” values of greater than 1 on the chart indicate that the program is performing well, in that for every dollar spent, more than a dollar of value is received, whereas a “CPI” less than 1 would indicate less than a dollar of value is received for every dollar spent. Similarly, a “SPI” value of 1.00 indicates that work is being accomplished at the planned rate, while a “SPI” value of less than 1 indicates that work is behind schedule to some degree.

While we did not specifically review the validity of EVM metrics for these programs as part of this engagement, we have previously reported issues with FAA’s implementation of EVM. Our review of FAA’s reports and interviews with program managers and other officials indicates that these issues continue to affect the accuracy and reliability of some of FAA’s program status reports. For example, in 2008, we reported that FAA did not apply sound earned value techniques to the full ERAM program baseline.¹⁸ In particular, FAA had rigorous EVM processes to govern contractor deliverables for ERAM, but it did not have the same processes in place for government work. As a result, FAA could not ensure that the earned value data reported for the total program were reliable. The consequences of this risk can be seen in figure 2. While the figure shows that milestones for the ERAM program as a whole are being met, the EVM contract-level data do not reliably reflect these ongoing schedule issues affecting the program at this time. In another recent GAO engagement, we found that because EVM is not applied at the full program level for ERAM and only at the contractor level, it is unclear in FAA’s reporting whether delays will affect the program’s overall costs.¹⁹ The ERAM program manager told us that the overall program cost is likely to be in excess of what was originally planned due to the ongoing software defects and schedule slippages the program is currently experiencing, but FAA’s program assessment report for ERAM does not indicate this issue. If the EVM processes had been implemented appropriately, the EVM data could

¹⁸GAO, *Air Traffic Control: FAA Uses Earned Value Techniques to Help Manage Information Technology Acquisitions, but Needs to Clarify Policy and Strengthen Oversight*, [GAO-08-756](#) (Washington, D.C.: July 18, 2008).

¹⁹GAO, *Information Technology: Agencies Need to Improve the Implementation and Use of Earned Value Techniques to Help Manage Major System Acquisitions*, [GAO-10-2](#) (Washington, D.C.: Oct. 8, 2009).

likely have provided an early warning of the problems the program is currently experiencing and enabled managers to take timely and aggressive action to mitigate them. (For a further discussion on ERAM and a more complete description of issues involved in its implementation, see app. II). For other programs like ADS-B, EVM data will be more accurate because EVM metrics have been established for the full program.

In other previous work, we found that FAA's measurement and reporting of its acquisition performance could mask budget increases and schedule delays that could negatively affect the transition to NextGen.²⁰ Consequently, budget increases and delays in one program that could slow the implementation of NextGen capabilities may not be apparent to Congress or aviation stakeholders. Our review of FAA's reports and interviews with program managers and other officials indicates that these problems persist. For example, according to the ERAM program manager, the implementation schedule for ERAM will affect the implementation schedule for ADS-B if the implementation of ERAM extends beyond April 2011. Generally, the individual program offices understand their programs' dependence on ERAM's implementation, but FAA has not developed a full listing of how ERAM schedule slippages could affect or put other programs' implementation schedules at risk or delay the implementation of capabilities or improvements.²¹ We recommended that FAA improve the usefulness of ATO's acquisition performance reporting by including information in the agency's Performance and Accountability Report or elsewhere on the potential effect of any budget or schedule slippages on the overall transition to NextGen. This recommendation remains open, as FAA has not definitively indicated how it will track slippages that will affect other dependent NextGen programs. Currently, FAA manages its acquisitions using its Acquisition Management System (AMS), which establishes policy and guidance for life-cycle acquisition management; however, AMS was not designed for managing NextGen programs in an integrated way. To assist in managing its NextGen portfolios, FAA is employing a solution set management approach, discussed in the next section of this report, which is designed to monitor all the activities of a

²⁰GAO, *Air Traffic Control: FAA Reports Progress in System Acquisitions, but Changes in Performance Measurement Could Improve Usefulness of Information*, [GAO-08-42](#) (Washington, D.C.: Dec. 18, 2007).

²¹FAA's Enterprise Architecture for the national airspace system shows the interdependencies and capabilities that may be affected by various programs, but this document cannot indicate specific scheduling milestones that might be affected.

particular operational improvement to ensure integration is on track. As this approach is more fully implemented, it will likely clarify the impact of slippages in one program's schedule on the implementation status of other NextGen programs and operational capabilities.

In addition to the issues described above, we have made several recommendations to FAA and DOT on acquisition performance measurement and reporting systems, and FAA has made many improvements in response, as shown in figure 4.

Figure 4: Implementation Status of Prior Selected GAO Recommendations to FAA and DOT as of June 2010

GAO Report	Recommendation (summarized)	Agency responsible	Status of recommendation
GAO-08-42 (Dec. 2007)	Improve the objectivity, reliability, and inclusion of core programs in ATO's acquisition performance measures.	FAA	●
GAO-08-42 (Dec. 2007)	Improve the clarity of ATO's annual acquisition performance measurement process by disclosing in its Performance and Accountability Reports that the measurement for on-budget performance covers 8 months and is measured against the most recently approved budget baselines.	FAA	●
GAO-08-42 (Dec. 2007)	Include information on any mitigation plans ATO has developed to lessen the effects of program slippages on the implementation of NextGen systems.	FAA	◐
GAO-08-756 (July 2008)	Modify acquisition policies governing EVM to require the use of a product-oriented standard work breakdown structure.	FAA	●
GAO-08-756 (July 2008)	Modify acquisition policies governing EVM to enforce existing EVM training requirements and expand these requirements to include senior executives responsible for investment oversight and program staff responsible for program oversight.	FAA	◐
GAO-08-756 (July 2008)	Modify acquisition policies governing EVM to define acceptable reasons for rebaselining and when seeking to rebaseline a program, require (1) a root cause analysis to determine why significant cost and schedule variances occurred, and (2) mitigation plans to address the root cause.	FAA	●
GAO-08-756 (July 2008)	Improve FAA's oversight processes by including an evaluation of contractors' performance data as part of FAA's program assessment criteria.	FAA	●
GAO-08-756 (July 2008)	Modify acquisition policies governing EVM to enforce existing EVM training requirements and expand these requirements to include senior executives responsible for investment oversight and program staff responsible for program oversight.	FAA	●
GAO-10-2 (Dec. 2009)	Modify policies governing EVM to ensure that they address the weaknesses that we identified. Direct managers of key system acquisition programs to implement the EVM practices.	DOT	○
GAO-10-2 (Dec. 2009)	Direct managers of key system acquisition programs to take action to reverse current negative performance trends, as shown in the earned value data, to mitigate the potential cost and schedule overruns.	DOT	○

- Closed (implemented)
- ◐ Open but in process
- Open

Source: GAO review of DOT and FAA responses to past recommendations.

NextGen Solution Set Approach Encompasses Program Metric Data and Other Initiatives and Processes but Has Yet to Be Fully Developed

The NextGen solution set organization and structure hold promise for monitoring NextGen implementation, but are still under development, and questions about appropriate roles have yet to be resolved. The solution set management team will be responsible for monitoring all aspects of NextGen implementation by tracking schedule and budget data, as well as changes in policies and processes affecting such things as certifications, standards, and staffing levels. Within the management team, solution set coordinators will be in charge of collecting and monitoring the status of all aspects of operational improvements and supporting activities within their solution sets. The coordinator's area of responsibility is vast and shifting because each solution set encompasses numerous capital acquisitions, programs, projects, and processes handled by various FAA offices. As of April 20, 2010, FAA had filled four permanent coordinator positions, one position was filled through a temporary assignment, and one position was vacant. In addition, the position of solution set manager, who oversees all the solution set coordinators, was being filled on a temporary basis. Filling key positions with qualified personnel is an ongoing challenge for FAA, as we have previously reported.²²

To support its monitoring of solution set activities, FAA is developing two key tools, the portfolio management tool and project-level agreements. The portfolio management tool is a database for tracking and monitoring key milestones and the status of funding that has been obligated and committed for individual budget line items. According to FAA officials currently, about 50 percent of the programs and projects that receive funding are loaded into the portfolio management tool; none of these are linked to specific NextGen operational improvements. This process has been slowed, in part, as FAA continues to staff the office. Once the remaining programs and projects are loaded into the portfolio management tool and linked to operational improvements, the solution set coordinators can monitor and report progress at a portfolio level. According to FAA officials, efforts to load the necessary information into the tool are ongoing and are expected to be completed by the first quarter of fiscal year 2011. Project-level agreements are annual agreements between the NextGen Integration and Implementation Office and the performing service organization (e.g., the Air Traffic Organization-Terminal for Flexible Terminals and Airports program, or FAA's Office of

²²GAO, *Federal Aviation Administration: Human Capital System Incorporates Many Leading Practices, but Improving Employees' Satisfaction with Their Workplace Remains a Challenge*, GAO-10-89 (Washington, D.C.: Oct. 28, 2009).

Environment and Energy for the Advanced Noise/Emissions Reduction program) for monitoring and reporting milestones and obligations to FAA management, OMB, and other stakeholders. In total, there are 95 project-level agreements for fiscal years 2009 and 2010, including 49 for fiscal year 2009 and 46 for fiscal year 2010 that were signed as of July 15, 2010. It is unclear whether the remaining nine agreements will be signed by the end of fiscal year 2010, as planned, because, according to FAA officials, work was slowed during the first part of fiscal year 2010 by issues associated with operating under a continuing resolution.

Our analysis of the solution set structure raises questions about whether sufficient processes are in place that will strengthen oversight and create a greater likelihood that actions required by various lines of business to produce operational improvements are implemented in a timely fashion across the agency. The project-level agreement outlines the key responsibilities of the performing organization, such as reporting information in the portfolio management tool and managing obligations and milestones. If a dispute arises or the performing organization does not perform its functions in a timely manner, the agreement provides for an informal resolution between the signers to the agreement (i.e., the solution set coordinator and the performing organization). According to FAA officials, if a dispute could not be resolved, it would be brought to the NextGen Management Board, which has authority to resolve any issues, such as ensuring that appropriate resources are available or issuing policy and guidance to force timely resolution. However, FAA has no written policy for resolving this type of dispute beyond what is described in the project-level agreement. Given that the solution set model is relatively new, there is little experience to draw upon to understand the impact of tasks not being completed on time or funding not being spent properly.

Metrics Have Yet to Be Developed to Measure the Performance of NextGen Improvements in Relation to Specific NextGen Goals, but Some Performance Metrics Are Available for Specific Programs

FAA Is Considering a Number of NextGen Performance Metrics, but Little Progress Has Been Made

FAA has broad goals for NextGen, such as enhancing safety, reducing aviation’s environmental impact, and increasing operations and efficiency, but specific goals for NextGen as a whole have yet to be determined and FAA has not agreed on a set of overall performance metrics that it can use to measure progress. In order to measure outcomes and performance as implementation progresses, the Senior Policy Committee– which is the interagency governing body for NextGen– will need to identify milestones or performance goals for NextGen as a whole across federal partner agencies. Relative to the broad goals outlined for NextGen, FAA will then need to identify a set of metrics and begin collecting baseline performance information against which to measure the effects of its NextGen activities.

GAO has identified criteria for sound performance management for federal agencies that may assist FAA as it continues to develop specific NextGen performance goals and metrics. According to previous GAO work, agencies that have been successful in measuring performance had performance measures that demonstrate results, are limited to the vital few, cover multiple priorities, and provide useful information for decision making.²³ Furthermore, GAO work cited specific attributes²⁴ that are key to successful performance measures:

²³ [GAO-03-143](#).

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- Linkage-Measure is aligned with division and agencywide goals and mission and clearly communicated throughout the organization.
 - Clarity-Measure is clearly stated and the name and definition are consistent with the methodology used to calculate it.
 - Measurable target-Measure has a numerical goal.
 - Objectivity-Measure is reasonably free from significant bias or manipulation.
 - Reliability-Measure produces the same result under similar conditions.
 - Core program activities-Measures cover the activities that an entity is expected to perform to support the intent of the program.
 - Limited overlap-Measure should provide new information beyond that provided by other measures.
 - Balance-Balance exists when a suite of measures ensures that an organization's various priorities are covered.
 - Governmentwide priorities-Each measure should cover a priority such as quality, timeliness, and cost of service.

Having performance metrics with these attributes will help FAA management and stakeholders, such as Congress, make decisions about how to fund and monitor the progress of NextGen.

While there are currently no agreed-upon NextGen performance goals or metrics available, JPDO and ATO are working to develop such performance tools. First, JPDO has developed a list of potential performance metrics for measuring progress toward the goals of federal partner agencies—not just FAA, as shown in table 3.

²⁴All attributes are not equal and failure to have a particular attribute does not necessarily indicate that there is a weakness in that area or that the measure is not useful; rather, it may indicate an opportunity for further refinement.

Table 3: Selection of JPDO’s Proposed Performance Metrics

Performance area	Metrics
Expand capacity	Throughput and average delay
	Difference in delay between good and bad weather delays
	Cancellations and consequent passenger delay time
	Curb-to-curb travel time
Safety	Percentage of proposed improvements evaluated for safety
Environment	Fuel consumed per unit of distance flown
National defense	Reduced flight time from flexible use of special use airspace
Security	Time passengers spend in airport security

Source: JPDO.

Second, ATO recently stated in the 2010 NextGen Implementation Plan that it would begin to consider what NextGen performance metrics are feasible for both FAA and industry. ATO officials told us that FAA is forming a team of staff from FAA and MITRE²⁵ to develop metrics as part of the agency’s response to a recommendation from the RTCA Task Force. However, this effort has only recently begun, and no timeline or action plan has yet been established. Under the direction of the NextGen Management Board, this group will be charged with identifying performance metrics in consultation with industry. According to an FAA official, one of the group’s first tasks will be to review an extensive list of several hundred potential metrics that FAA has considered in the past and to recommend those metrics that the group considers the most appropriate for use. Table 4 shows an initial list of FAA’s proposed metrics. This list will be revised and changed as the work group gets underway. Additionally, FAA has modeling efforts under way to estimate the impacts of NextGen technologies on safety, environmental operations and total delay reduction. Specifically, FAA estimates that, in aggregate, planned NextGen technologies—including performance based procedures and planned runway improvements will reduce delays by about 21 percent by 2019 as measured against doing nothing at all and will save 1.4 billion gallons of fuel from air traffic operations. These modeling efforts are somewhat preliminary and still under development and these estimates of

²⁵MITRE is a not-for-profit organization chartered to work in the public interest. It manages four Federally Funded Research and Development Centers, including one for FAA. MITRE has its own independent research and development program that explores new technologies and new uses of technologies to solve problems in the near term and in the future.

benefits are not currently performance targets for planned NextGen improvements.

Table 4: Selection of FAA Proposed Performance Metrics

Performance area	Performance indicators
Access and equity	Fleet penetration Number of airports with enhanced NextGen capabilities Number of centers with enhanced NextGen capabilities
Capacity	Peak-hour throughput at airports Peak-hour airspace throughput Difference between throughput and demand
Cost-effectiveness	Number of air traffic controllers per operation Number of air traffic controllers per flight hour Air traffic controller cost per operation Air traffic controller cost per flight hour Air traffic controller cost per flight mile Number of air traffic controllers per facility or facility type
Efficiency	Delay Excess fuel consumed Excess distance flown Distance flown at suboptimal altitude Peak-hour average taxi-time
Environment	Aircraft emissions below 3,000 feet Full flight emissions Terminal noise contour area Noise population exposure Temperature change, premature mortality, and noise exposure
Flexibility	Percent of flight trajectory flown at optimal parameters Percent of user requests granted
Predictability	Delay variance Variance of excess fuel consumed Variance of excess distance flown Variance of distance flown at suboptimal altitude Variance of peak-hour average taxi-time Variance of demand Variance of peak-hour throughput
Safety	Number of accidents per operation Number of losses of separation per operation Number of pilot deviations per operation Number of air traffic management induced accidents Runway incursions

Source: FAA.

Note: The metrics in this table were extracted from FAA's draft NextGen performance assessment plan. FAA acknowledged that some of these metrics could not be quantified empirically and were more appropriate for cost-benefit analysis.

While this list of metrics is preliminary and will be changed as the work group proceeds, we identified some areas in the course of our work that do not appear on this list. For example, one industry stakeholder suggested that average gate-to-gate times for city pairs would be a useful metric, as several NextGen improvements are meant to shorten both the time spent flying between two cities, as well as the time spent taxiing and waiting at the airport. Furthermore, we recently recommended that FAA develop airport-specific on-time performance targets to better prioritize its actions and demonstrate their benefits.²⁶ The Senate FAA reauthorization bill²⁷ also proposes metrics that are not included here, such as flown versus filed flight times for key city pairs.

Lastly, developing and agreeing on the right set of goals and metrics is difficult because many aspects of performance and actions that will influence outcomes are not exclusively under FAA's control. For example, to assess its progress in achieving benefits associated with implementing performance-based navigation procedures, FAA currently measures the number of procedures it develops annually. While FAA may be moving away from this approach, stakeholders argue that, by not measuring outcomes associated with those procedures, such as improved runway utilization and reduced travel times, FAA has not developed procedures that have the most significant benefit.²⁸ However, achieving the benefits of the new procedures requires actions both outside and within FAA. Outside FAA, airlines must train their pilots and crews to use the procedures and equip their aircraft for flight using the procedures. Similarly, JPDO, as the federal agency coordinator for NextGen, shares responsibility for developing and agreeing on several proposed metrics whose outcomes will be affected by the actions of multiple agencies and stakeholders. For example, JPDO's proposed metric, the outcome of "time passengers spend in airport security," will be influenced not only by security procedures from the Department of Homeland Security, but also by airport configurations and airline scheduling patterns, among other things. In these cases, developing and agreeing on metrics will require collaboration with partner agencies, airports, industry, and a variety of other

²⁶GAO, *National Airspace System: Setting On-Time Performance Targets at Congested Airports Could Help Focus FAA's Actions*, [GAO-10-542](#) (Washington, D.C.: May 26, 2010).

²⁷S.1451, 111th Cong, § 317.

²⁸For example, these procedures decrease flight miles, which reduce an aircraft's fuel burn and carbon emissions.

stakeholders, and will also require commitments from other parties to take responsibility for various outcomes and aspects of performance.

FAA Reports Some Performance Metrics for Existing Modernization and NextGen Programs to OMB, but These Metrics Are Not Always Outcome Oriented

FAA reports quarterly to OMB on metrics identified in Exhibit 300 reports for major acquisitions approved through the Joint Resources Council, but these metrics are not always outcome based or focused on the performance of the system; therefore, they do not always clearly indicate progress toward performance goals.²⁹ For example, one metric for ERAM is related to achieving the capability to utilize 64 ground radar sensors as compared with 24 under the current system. Performance measures should clearly represent or be related to the performance they are designed to assess.³⁰ In this case, the metric measures an output from the ERAM system—utilization of radar sensors—but does not measure any outcome of having the capability to utilize more radar sensors – such as improved adherence to aircraft separation standards and a resulting increase in capacity or reduction in congestion. Such an outcome would indicate progress toward an FAA strategic goal to increase capacity. Other metrics FAA reports are focused on outcomes and will show progress toward goals. For example, another ERAM metric—to be measured in 2012—is for 10 percent fewer flight delays to be attributable to ERAM as compared with the average annual number of flight delays attributable to its predecessor system between 2000 and 2008. This metric will allow FAA to measure progress toward FAA’s goal to improve on-time arrivals. Hence, the metric is clearly related to the performance that it is designed to assess and it identifies a baseline from which to measure progress.

Performance metrics for NextGen programs are also identified in Exhibit 300³¹ reports to OMB and include a similar mix of outcome and output measures. For example, the report on the ADS-B program identifies a number of clear and specific outcome-based performance metrics, such as reducing passenger delay hours by 28 percent in the Gulf of Mexico, or

²⁹OMB transmits some of this information into its “IT Dashboard.” See GAO, *Information Technology: OMB’s Dashboard Has Increased Transparency, but Data Accuracy Improvements Needed*, GAO-10-701 (Washington, D.C.: July 17, 2010).

³⁰GAO, *The Results Act: An Evaluator’s Guide to Assessing Agency Annual Performance Plans*, GAO/GGD-10.1.20 (Washington, D.C.: Apr. 1998).

³¹OMB 300, also called the Capital Asset Plan and Business Case, is a document that agencies submit to OMB to justify resource requests for major information technology investments.

maintaining a 13 percent reduction in the accident rate in Alaska. However, for other aspects of the ADS-B program, metrics are related to outputs with no corresponding link to outcomes or goals. For example, one metric is to maintain the service that transmits weather information via ADS-B, but there are no metrics associated with the outcome or benefit of having such services available, the quality of those services, or how the availability of those services furthers progress toward any of FAA's stated goals, such as reducing the impact of weather on delays. Without links to outcomes and goals, metrics will not help to measure progress toward those goals and the agency may not emphasize the quality of the services it provides or the resulting benefits to users. In this case, additional metrics, such as the rate at which aircraft operators subscribe to ADS-B services or the rates of satisfaction reported by users of the information, would provide FAA and observers with more information to indicate the performance of the program and the benefits derived from public expenditures.

Information on NextGen Outcomes and Performance Is Limited in FAA Performance Reporting

In addition to reporting to OMB, FAA uses its annual Flight Plan and Performance and Accountability Report to report its performance and activities. However, these documents discuss only a few NextGen capabilities and programs that are expected to have an effect on existing agencywide metrics and do not include any performance information specific to ongoing NextGen capabilities that are being implemented.³² For example, for one of FAA's metrics—decreasing the commercial air carrier fatality rate—the Flight Plan reports that the deployment of ADS-B will help drive the commercial fatality rate down.³³ As discussed in the previous section, one of the performance metrics associated with ADS-B is to maintain a 13 percent accident reduction rate in Alaska. However, the performance and accountability report does not currently indicate whether or how the ongoing deployment of ADS-B has affected the accident rate in Alaska. Such information would help stakeholders understand the progress of ADS-B on the performance metric. Outcome goals should be included in the annual performance plan whenever

³²The Flight Plan outlines the agency's four goals (Increase Safety, Increase Capacity, Organizational Excellence, and International Leadership) along with numerous performance metrics, and the Performance and Accountability Report shows the results.

³³Commercial aviation does not include general aviation.

possible and annual performance plans should identify performance goals that cover all of the program activities in an agency's budget.³⁴

In other cases, NextGen improvements are meant to enhance performance in certain areas, but the Flight Plan and Performance and Accountability Report do not mention those planned improvements. For example, some air traffic modernization and NextGen activities – such as implementing performance-based navigation procedures³⁵ – are meant to increase aviation fuel efficiency, and this is one of the performance metrics in FAA's Flight Plan, yet these reports include no discussion of the activities underway that are intended to affect this metric. Table 5 identifies the current metrics described in the Flight Plan for the goals of increasing safety and capacity; indicates whether NextGen activities are included in those metrics; and shows our analysis of whether NextGen activities are captured by the performance reports.

Table 5: Alignment of NextGen Activities with Existing Flight Plan Metrics

Flight Plan goal	Flight Plan performance metric	NextGen activities captured (per FAA reports)	Areas NextGen will affect
Increase safety			
	Commercial air carrier fatality rate	√	√
	General aviation fatal accident	√	√
	Alaska accidents	√	√
	Runway incursions		√
	Commercial space launches		
	Operational errors	√	√
	Safety management system		√

³⁴GAO/GGD-10.1.20.

³⁵Performance-based navigation includes such things as Area Navigation (RNAV), which enables aircraft to fly on any path within coverage of ground- or space-based navigation aids, permitting more access and flexibility for point-to-point operations; and Required Navigation Performance (RNP), which, like RNAV, enables aircraft to fly on any path within coverage of ground-or space-based navigation aids, but also includes an onboard performance monitoring capability. RNP also enables closer en route spacing without intervention by air traffic control and permits more precise and consistent arrivals and departures.

Flight Plan goal	Flight Plan performance metric	NextGen activities captured (per FAA reports)	Areas NextGen will affect
Increase capacity			
	Average daily airport capacity (35 OEP airports)	√	√
	Average daily capacity (7 metro areas)	√	√
	Annual service volume		√
	Adjusted operational availability		√
	Noise exposure		√
	Aviation fuel efficiency		√
	NAS on-time arrivals	√	√

Source: GAO analysis of FAA Flight Plan and NextGen Implementation Plan.

Further clarification and consistency in reporting the outcomes and performance of new technologies and capabilities as they are deployed, and how those activities will further affect progress toward agencywide goals, would provide users with additional context to discern the impact of ongoing air traffic modernization and NextGen activities. Recently, FAA has begun an initiative that aims to align NextGen activities and performance with FAA's Flight Plan and expects to deliver a report by early 2011.

Conclusions

NextGen is an undertaking of significant breadth and complexity and touches several federal agencies, nearly every office within FAA, and nearly every existing system and piece of infrastructure currently operating in the national airspace system. As a result, determining the status and performance of the effort as a whole is, therefore, a broad, complex undertaking, requiring multiple reports and pieces of information from multiple parties. While we currently have several open recommendations related to improving FAA's use of EVM and its acquisition management system, FAA's current reporting mechanisms can give overseers and interested parties certain information that can indicate potential problems with the cost and pace of individual programs' implementation. However, these mechanisms are insufficient to report on the status of NextGen portfolios or how delays and cost overruns in one acquisition can impact implementation of other programs or capabilities.

FAA's portfolio approach to implementation is designed to help the agency assess and convey the implementation status of interrelated capabilities and operational improvements. However, because implementation of solution sets requires action across various lines of business with separate budgets within FAA, it is important to ensure that processes are in place that will strengthen oversight and create a greater likelihood that required activities are completed on time. While the NextGen Management Board is ultimately responsible for resolving disputes, there are no written policies and procedures to guide its resolution of disputes between the parties to project-level agreements. A lack of clear dispute resolution procedures raises questions about how quickly and effectively any such disputes will be resolved.

Finally, while several of FAA's efforts to develop, agree on, and implement a suite of performance metrics are relatively recent or still in progress, action is needed that will provide stakeholders with a clear vision of what is required by each one. Without a timeline and action plan that stakeholders have agreed on, it remains to be seen if these actions will enable FAA to provide stakeholders, interested parties, Congress, and the American people with a clear 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.

Recommendations for Executive Action

To ensure that FAA can effectively manage NextGen solution sets, we recommend that the Secretary of Transportation direct the FAA Administrator to develop written policies and procedures for dispute resolution across different FAA lines of business and outline the appropriate roles of the solution set managers, program managers, and the NextGen Management Board in managing these portfolios of improvements.

To ensure that the outcomes and performance expected from NextGen improvements are understood and can be monitored, we recommend that the Secretary of Transportation direct the FAA Administrator to develop a timeline and action plan to work with industry and federal partner agencies to develop an agreed-upon list of outcome-based performance metrics and goals for NextGen broadly and for specific NextGen portfolios, programs, and capabilities. The Administrator should then share this list with the appropriate congressional oversight committees. Furthermore, the Administrator should establish a clear timeline to align

NextGen performance metrics with FAA's agencywide goals and performance plans.

Agency Comments

The Department of Transportation provided comments on a draft of this report via e-mail. In those comments, the department agreed to consider the report's recommendations. The department also provided technical comments, which we have incorporated in this report as appropriate.

We are sending copies of this report to interested congressional committees, the Secretary of Transportation, the Administrator of the Federal Aviation Administration, and other parties. In addition, the report will be available at no charge on the GAO Web site at <http://www.gao.gov>.

If you or your staff have any questions about this report, please contact me at (202) 512-2834 or dillingham@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 major contributions to this report are listed in appendix III.



Gerald Dillingham, Ph.D.
Director, Physical Infrastructure Issues

List of Committees

The Honorable Jerry Costello
Chairman
The Honorable Thomas Petri
Ranking Member
Subcommittee on Aviation
Committee on Transportation and Infrastructure
House of Representatives

The Honorable John D. Rockefeller
Chairman
The Honorable Kay Bailey Hutchinson
Ranking Member
Committee on Commerce, Science, and Transportation
United States Senate

The Honorable Bart Gordon
Chairman
The Honorable Ralph Hall
Ranking Member
Committee on Science and Technology
House of Representatives

Appendix I: Objectives, Scope, and Methodology

In response to a congressional request, we examined the Federal Aviation Administration's (FAA) ability to monitor the implementation of the Next Generation Air Transportation System (NextGen) portfolio of air traffic control systems and programs and whether they will deliver the desired benefit to the national airspace system. Specifically, we reviewed (1) FAA's metrics for tracking the status of NextGen acquisition programs and the implementation of NextGen capabilities, the reliability of these metrics and the data underlying them, and any limitations or gaps in FAA's efforts to track the status of NextGen implementation; and (2) how FAA currently measures the performance of NextGen programs and capabilities, FAA's progress in developing a full suite of metrics to measure the outcomes and performance of NextGen capabilities once implemented, and any limitations or gaps in FAA's approach to developing these metrics.

To determine FAA's metrics for tracking the status of NextGen acquisition programs and acquisition programs critical to NextGen implementation (i.e., ERAM), and the implementation of NextGen capabilities, we analyzed the process for individual program managers to report their metrics to internal and external stakeholders and gained an understanding of the database that houses the information. We reviewed program and process reviews from FAA's acquisition offices to identify key areas of oversight focus and key findings that have been reached in such reviews regarding acquisition procedures and policies. To ensure acquisition program information is reliable, we drew on past work in which we undertook detailed reviews of the status of FAA acquisition programs, and we obtained updated information as necessary from FAA by reviewing documents and interviewing agency officials. Based on these past reviews, we determined that FAA's acquisition data were sufficiently reliable for the purposes of our report. To determine any limitations in FAA's effort to track the status of NextGen implementation, we obtained and analyzed recent metric reports for various FAA acquisitions to determine what information is readily available for FAA management and stakeholders outside FAA to monitor NextGen programs. We interviewed FAA officials, including acquisition, finance, and program managers. We then reviewed this information in light of our past recommendations and findings to determine the extent to which a program's implementation status can be discerned from the available information, how well that information allows reviewers to understand whether any issues may result in delays to a program, and whether those delays will affect the implementation of other programs or operational improvements. We also interviewed ERAM program office officials and representatives of the National Air Traffic Controllers Association (NATCA) in Washington, D.C.; Salt Lake City; and Seattle to obtain information related to discrepancies in program reports

associated with ERAM. We did not conduct an individual or in-depth review of the effectiveness of the specific programs selected for performance reporting. We also did not identify a comprehensive list of programs that were excluded from acquisition performance reporting. This was beyond the scope and intent of this study.

To gain an understanding of how FAA currently measures the performance of NextGen programs and capabilities, we reviewed documents that outline FAA's solution set organization and management approach, and interviewed officials involved in coordinating and managing solutions sets. We also reviewed our past reports on FAA's acquisition metrics and the status of prior recommendations. To determine FAA's progress in developing metrics to measure the outcomes and performance of NextGen capabilities once implemented, we first reviewed how FAA currently reports on its performance, both internally and externally, and how information on the performance of specific NextGen capabilities is incorporated into those metrics. We reviewed FAA's performance and accountability reports and discussed internal performance reporting methods with relevant FAA officials. Specifically, we reviewed FAA's Flight Plan, Performance and Accountability Report, 2009 and 2010 NextGen Implementation Plans, Enterprise Architecture, and reports to the Office of Management and Budget (OMB) (known as Exhibit 300 reports).¹ To understand FAA's approach and progress toward developing a suite of NextGen metrics, we interviewed FAA officials with responsibilities for NextGen planning and implementation, particularly officials within the Air Traffic Organization (ATO) and the Joint Planning and Development Office (JPDO) responsible for modeling NextGen benefits and developing NextGen performance metrics. To evaluate the metrics that FAA is considering for potential gaps and limitations, we compared proposed metrics with key attributes of successful performance metrics that we identified in past GAO work.² Metrics should cover key program activities and represent program and agency goals and priorities

¹FAA's Flight Plan is a 5-year strategic plan that outlines agency goals and metrics. FAA's NextGen Implementation Plan is an annual workplan that defines the midterm operational capabilities the agency plans to deliver between now and 2018. FAA's Enterprise Architecture is the structure to relate organizational mission, vision, and goals to business processes and the technical or IT infrastructure required to execute them. An exhibit 300—also called a Capital Asset Plan and Business Case—is used to justify resource requests for major investments and is intended to enable an agency to demonstrate to its own management, as well as to OMB, that a major project is well planned.

²[GAO/GGD-10.1.20](#).

to help identify those activities that contribute to the goals and priorities. To the greatest extent possible, metrics should be objective, that is reasonably free of bias or manipulation that would distort an accurate assessment of performance, and clearly defined such that they can be understood by stakeholders both internally and externally. When appropriate, metrics should be measurable and quantifiable, including having annual targets, to facilitate future assessments of whether goals or objectives were achieved. We also interviewed several key stakeholders for NextGen, including representatives from airlines, equipment manufacturers, federal partner agencies, and NATCA to get their views on the metrics they deem most appropriate to measure the performance of NextGen.

We conducted this performance audit from June 2009 through July 2010 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the work 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.

Appendix II: Further Information on the ERAM Program

The En Route Automation Modernization system (ERAM) replaces the existing en route air traffic control automation system at FAA's Air Route Traffic Control Centers (ARTCC). ERAM will replace the hardware and software in the en route Host Computer System and its backup system, the Direct Access Radar Channel, as well as associated interfaces, communications, and support infrastructure at 20 en route centers across the country. This effort is critical because ERAM is expected to upgrade hardware and software for facilities that control high-altitude air traffic. ERAM will modernize the En Route infrastructure to provide a supportable open standards-based system that will be the basis for future capabilities and enhancements ERAM will provide existing functionality and new capabilities needed to support NextGen.

New Information Indicates That Software Issues Will Delay ERAM's Deployment

FAA's ability to keep ERAM on schedule remains uncertain because problems with software at key test sites could delay work at other sites and on other systems. Recently, FAA halted testing and is revising its implementation schedule to reflect the effects of these software problems. Two key sites, Salt Lake and Seattle en route centers, although achieving initial operating capability (IOC)¹ in June 2009 and September 2009 respectively, under FAA's master schedule, failed to have an operational ready decision (ORD)² by December 2009. As these sites conducted ERAM testing on live air traffic during the past year, usually late at night when air traffic volume was low, FAA and controllers found both critical and non-critical software issues that prompted the center, at times, to revert to the HOST system. Specifically, instructions to a controller to hand off control of an aircraft in one sector to a controller in an adjacent sector failed, and flight data were lost or reassigned to another flight. Although some progress has been made to correct these problems, some of these issues remain. FAA continued working with its contractor, Lockheed Martin, to correct many software issues, but further testing on live air traffic continues to produce critical safety errors. As a result, in March 2010, FAA decided, with the support of the air traffic controllers' union, to halt all ERAM testing on live traffic and to revise the deployment schedule. Such revisions will affect numerous sites across the country (see table 6 for the original schedule).

¹IOC is the declaration by site personnel that the system is ready for conditional operational use in the national airspace system.

²ORD signifies the end of conditional use, at which time, switchover to the new product is complete.

Table 6: ERAM Status for Achieving Key Program Milestones

Site	Government acceptance (GA)	Initial operational capability (IOC)	Operation readiness decision (ORD)
Salt Lake	5/3/2008	6/18/2009	10/30/2009
Seattle	5/8/2008	9/21/2009	10/30/2009
Minneapolis	7/24/2008	11/6/2009	12/6/2009
Denver	5/20/2008	10/25/2009	11/30/2009
Albuquerque	6/19/2008	2/11/2010	3/13/2010
Dallas-Ft. Worth	2/17/2009	2/14/2010	3/16/2010
Chicago	4/15/2009	2/27/2010	3/29/2010
Houston	4/23/2009	3/3/2010	4/2/2010
Oakland	1/8/2009	3/13/2010	4/12/2010
Cleveland	11/6/2008	3/20/2010	4/19/2010
Kansas City	6/19/2008	4/9/2010	5/9/2010
Indianapolis	10/28/2008	4/25/2010	5/25/2010
New York	5/18/2009	5/7/2010	6/6/2010
Memphis	9/18/2008	5/21/2010	6/20/2010
Los Angeles	2/19/2009	6/4/2010	7/9/2010
Washington, D.C.	1/28/2009	6/19/2010	7/19/2010
Boston	3/19/2009	7/9/2010	8/8/2010
Atlanta	8/10/2009	7/31/2010	8/30/2010
Jacksonville	10/23/2008	8/18/2010	9/17/2010
Miami	5/20/2009	9/24/2010	10/24/2010

Source: FAA.

Testing at Key Sites Yielded Software Issues

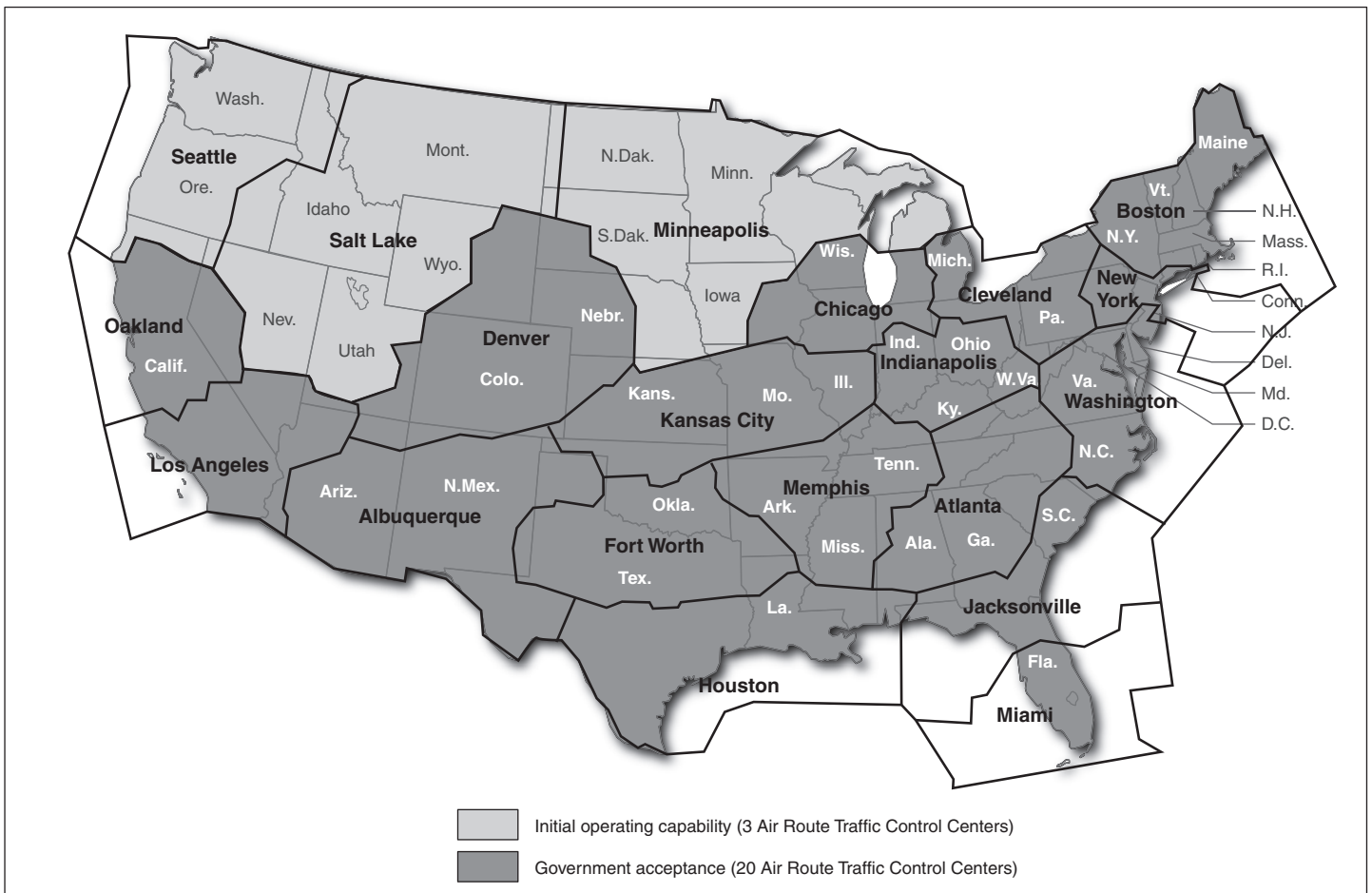
In testing and evaluating ERAM at two key sites, the Seattle and Salt Lake en route centers, FAA has encountered both anticipated and unanticipated software issues.³ Before this testing began last year at these sites, FAA formally accepted the system from the contractor—a contractual milestone known as government acceptance (GA)—which indicates in this case, that equipment has performed to specification at all 20 sites.⁴ After GA, FAA designated the Salt Lake and Seattle sites as key sites for initial live testing on traffic in order to reach the next milestone, IOC, which FAA defines as the separation of two aircraft by the ERAM system for as little

³The Minneapolis Center became a third key site in 2010.

⁴Prior to field testing at the key centers testing was done at FAA's Technical Center.

as 1 minute. (Fig. 5 shows the en route centers progress in reaching GA and IOC.) However, during the testing process, controllers discovered a variety of software issues when ERAM was turned on. When FAA encountered a software issue that required a change, it assigned a code to the issue to indicate its severity and tracked the contractor's efforts to correct the issue in a database. During the life of the program, approximately 15,000 software issues have been identified. According to FAA officials, problems with the software are expected and common during the testing phase, especially for a program as large as ERAM (1.3 million lines of code) and time to correct them is built into the schedule.

Figure 5: Current Phase of ERAM Testing at FAA's En Route Centers as of May 2010



Sources: FAA and Map Resources (map).

While some testing at FAA's Technical Center preceded testing at the two key sites, the Tech Center could not fully test the system because each of the 20 en route centers has unique airspace or operational issues that controllers have resolved over the years. Specifically, the Tech Center ERAM test room has only 12 ERAM positions compared with the 40 or more controller stations in an enroute center. As a result the Tech Center could test only limited scenarios. According to FAA officials, the testing accomplished what was expected, but the Tech Center environment was not robust enough to capture all issues. The more extensive testing that has since been conducted in the field with multiple operational facilities and systems has identified many issues, both expected and, as field personnel have become involved, unexpected and these unexpected issues have slowed the scheduled work. NATCA officials stated that the original ERAM schedule was aggressive and did not account for such issues and is thus the principal factor driving the delay.

FAA Halted ERAM Testing in Response to Mounting Software Issues It Must Address at the Key Sites

FAA has halted ERAM testing because so many software issues have to be addressed at the key sites. FAA anticipated the potential for software issues and initially scheduled approximately 6 to 9 months between IOC and ORD to fix critical software issues. From the beginning, FAA has tracked more than 15,000 issues; currently, however, there are approximately 1,400 unresolved software issues, ranging from not tracking targets correctly to unwarranted safety alerts for altitude risk. Out of the 1,400 issues, about 200 are critical and will need to be resolved before testing on live traffic can resume, according to FAA and NATCA.

The union was not initially involved in ERAM development but its recent inclusion may resolve some issues. NATCA officials stated the many of problems arising with ERAM could have been corrected earlier if NATCA had been involved. ERAM was designed during a period when controllers did not participate in efforts to design and test new systems. Because active users of the system from different locations could not provide insight early on, issues that could have been addressed early in the design phase were not addressed. To ensure that controllers will be involved as efforts go forward, unlike during the design of ERAM requirements, FAA and NATCA recently entered into a memorandum of understanding (MOU)⁵ that is designed to bring in controllers for testing and evaluation of ERAM to alleviate some of the same types of problems that arose earlier

⁵The MOU was signed December 2009.

because they were not involved. Under this agreement, NATCA will have ERAM technical, evaluation and training representatives as well as a team of 16 controllers (including 12 from en route and 4 from terminal facilities) who will be detailed to test and validate software fixes with contractor engineers at the FAA Tech Center.

**FAA Indicates Revised
Schedule May Not Delay
Other Programs, but
Software Changes Will
Slightly Increase Costs**

FAA acknowledges ERAM is unlikely to be operational at all 20 sites as originally planned due the unexpectedly large number of software issues. According to FAA, which has not released a revised schedule, it is working to fix the 200 or so critical software issues identified before ERAM testing on live traffic will resume at the key sites. FAA expects this testing to resume by early fall 2010 with the remaining sites reaching IOC soon thereafter.

ERAM is a key platform for NextGen programs and keeping it on schedule is critical to maintaining the schedules for many NextGen programs, most notably ADS-B. FAA officials stated that the revised schedule for ERAM is not likely to delay the deployment of ADS-B, which is the first scheduled NextGen program to come online over the next couple of years. However, if additional delays occur and push the completion of testing beyond April 2011, ADS-B's deployment may be delayed. Specifically, Houston is the first en route center slated to receive ERAM version 3 in April 2011, which will support ADS-B demonstrations in the Gulf of Mexico, and reaching IOC on schedule is a critical step to ensure that ADS-B's deployment schedule is not delayed. ERAM officials stated they are coordinating with the ADS-B office and that it has been notified of the potential schedule slippage.

Because FAA has assumed ownership of the system from the contractor, it is responsible for additional costs associated with any software changes. Because of the large number of unanticipated software issues, FAA will have to pay the contractor more than the \$2.1 billion originally budgeted to complete the program. FAA is working to revise its test schedule and backlog of outstanding software issues and plans to provide a revised cost and schedule estimate.

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

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Staff Acknowledgments

In addition to the contact named above, individuals making key contributions to this report include Andrew Von Ah (Assistant Director), Kevin Egan, Elizabeth Eisenstadt, Brandon Haller, Rich Hung, Bert Japikse, Dominic Nadarski, and Josh Ormond.

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