

April 2013

NEXTGEN AIR TRANSPORTATION SYSTEM

FAA Has Made Some Progress in Midterm Implementation, but Ongoing Challenges Limit Expected Benefits



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Why GAO Did This Study

FAA, collaborating with other federal agencies and the aviation industry, is implementing NextGen, an advanced technology air-traffic management system that FAA anticipates will replace the current ground-radar-based system. At an expected cost of \$18 billion through 2018, NextGen is expected to enhance safety, increase capacity, and reduce congestion in the national airspace system. To deliver some of these benefits in the midterm, FAA is implementing operational improvements using available technologies. Delivering midterm benefits could build support for future industry investments, but a task force identified obstacles, such as FAA's lengthy approval processes.

GAO was asked to review FAA's midterm NextGen efforts. GAO examined (1) key operational improvements FAA is pursuing through 2018, (2) the extent to which FAA is addressing known obstacles to the implementation of NextGen operational improvements, and (3) the extent to which FAA is measuring and demonstrating midterm benefits. GAO reviewed FAA documents, as well as the task force's recommendations to FAA, and interviewed FAA and airport officials and aviation experts.

What GAO Recommends

FAA should, among other things, better integrate NextGen efforts; develop processes for selecting new PBN procedures; and ensure that stakeholders have needed information on NextGen progress to facilitate investment decisions.

DOT did not agree or disagree with GAO's recommendations, but provided technical comments.

View [GAO-13-264](#). For more information, contact Gerald L. Dillingham at (202) 512-2834 or dillingham@gao.gov.

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FAA Has Made Some Progress in Midterm Implementation, but Ongoing Challenges Limit Expected Benefits

What GAO Found

The Federal Aviation Administration (FAA) is pursuing key operational improvements to implement the Next Generation Air Transportation System (NextGen) in the "midterm," which is 2013 through 2018. These improvements focus on establishing Performance Based Navigation (PBN) procedures at key airports, but benefits could be limited in the midterm. PBN uses satellite-based guidance to improve air-traffic control routes (known as "procedures"). These procedures can deliver benefits to airlines, such as fuel savings and increased efficiency, particularly in congested airspace. To deliver benefits more quickly, FAA made trade-offs in selecting sites and in the scope of proposed improvements. For example, FAA is not implementing procedures that will trigger lengthy environmental reviews. These trade-offs, with which airlines and other stakeholders generally agree, will likely limit benefits from these PBN initiatives early in the midterm. FAA has also made some progress in other key operational improvement areas, such as upgrading traffic management systems and revising standards to improve aircraft flow in congested airspace. However, FAA has not fully integrated implementation of all of its operational improvement efforts at airports. Because of the interdependency of improvements, their limited integration could also limit benefits in the midterm.

FAA has efforts under way to help overcome overarching obstacles to NextGen implementation identified by an advisory task force, but challenges remain, and many of these efforts are scheduled to take a number of years. FAA efforts include, for example, a new process for focused and concise environmental reviews for some proposed actions (e.g., new procedures), where a detailed analysis of the environmental impacts is limited to only those categories involving potentially significant impacts, such as increased noise or emissions. Some of these efforts do not, however, fully address previously identified obstacles. FAA has not fully addressed obstacles to selecting new PBN procedures that will best relieve congestion and improve efficiency, for example. FAA continues to rely on requests for new procedures from airlines and other stakeholders. This reliance may or may not result in procedures that maximize benefits to the national airspace system. Not addressing remaining challenges could delay NextGen implementation and limit potential benefits.

FAA has made progress in developing NextGen performance metrics, but according to key stakeholders, FAA currently provides limited data to demonstrate its progress in implementing midterm improvements and the associated benefits. FAA is in the process of harmonizing performance metrics across all agency programs to ensure that metrics align with agency targets and goals. However, information is incomplete on the midterm improvements and their benefits at selected airports, and airlines and others lack access to needed information to make fully informed investment decisions. FAA has developed a website to report on NextGen implementation, but published information is not fully tied to FAA's implementation goals. FAA's plans also provide limited information about future implementation, such as locations and expected benefits. Better performance and planning information would provide airlines with a stronger basis for making decisions to invest an estimated \$6.6 billion on NextGen technology through 2018.

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Abbreviations

ACI-NA	Airport Councils International-North America
ACRP	Airport Cooperative Research Program
ADS-B Out	automatic dependent surveillance-broadcast out
AeroNav Products	Aeronautical Navigation Product Group
AGL	above ground level
ASDE-X	Airport Surface Detection Equipment–Model X
ASSC	Airport Surface Surveillance Capability
ATO	Air Traffic Organization
CATM	Collaborative Air Traffic Management
Data Comm	Data Communications
DNL	Day-Night Average Sound Level
FAA	Federal Aviation Administration
ICAO	International Civil Aviation Organization
IDAC	Integrated Departure/Arrival Capability
JFK	John F. Kennedy International Airport
JPDO	Joint Planning and Development Office
NAC	NextGen Advisory Committee
NAS	national airspace system
NASA	National Aeronautics and Space Administration
NATCA	National Air Traffic Controllers Association
NAV Lean	Navigation Lean
NEPA	National Environmental Policy Act
NextGen	Next Generation Air Transportation System
OAPM	Optimization of Airspace and Procedures in the Metroplex
OEP	Operational Evolution Partnership
OPD	Optimized Profile Descent
PBN	Performance Based Navigation
RNAV	Area Navigation
RNP	Required Navigation Performance
SFO	San Francisco International Airport
SRER	System Risk Event Rate
TMA	Traffic Management Advisor
TRACON	terminal radar approach control

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United States Government Accountability Office
Washington, DC 20548

April 8, 2013

The Honorable Bill Shuster
Chairman
Committee on Transportation and Infrastructure
House of Representatives

The Honorable Frank A. LoBiondo
Chairman
Subcommittee on Aviation
Committee on Transportation and Infrastructure
House of Representatives

The Honorable John L. Mica
The Honorable Thomas E. Petri
House of Representatives

The Federal Aviation Administration (FAA) is transforming the nation's ground-based air-traffic control system to an air-traffic management system using satellite-based navigation and other advanced technology. This transformation is referred to as the Next Generation Air Transportation System (NextGen). FAA released its first plan for NextGen in 2004 after Congress passed Vision 100.¹ FAA has since issued a number of documents to guide NextGen's implementation, including annual updates to implementation plans since 2008. NextGen is intended to enhance airspace safety, reduce delays experienced by airlines and passengers, save fuel, and reduce carbon dioxide emissions and other adverse environmental impacts. NextGen improvements are projected to keep airport delays from getting worse than would be expected without implementation of the improvements. By 2020, the agency estimates that NextGen improvements, if implemented, could result in a cumulative reduction in fuel consumption of 1.46-billion gallons and a cumulative

¹Vision 100—Century of Aviation Reauthorization Act, Pub. L. No. 108-176, § 709, 117 Stat. 2490, 2582-2585 (2003). Vision 100 directed the creation of the Joint Planning and Development Office (JPDO) within FAA to create and carry out an integrated plan for developing NextGen and to facilitate collaboration between FAA and other federal agencies involved in the effort. In addition to FAA, federal partner agencies include the Departments of Commerce, Defense, Homeland Security, and Transportation; the National Aeronautics and Space Administration (NASA); and the White House Office of Science and Technology Policy.

reduction in carbon dioxide emissions of 16-million metric tons. FAA estimates that these benefits, combined with a projected 41 percent reduction in aircraft delays, will generate \$38 billion in savings through 2020 for aircraft operators, the traveling public, and FAA, as compared with a scenario where no further NextGen improvements were made. However FAA does not expect that NextGen improvements alone will be sufficient to meet the capacity needs of certain busy, complex airports in the national airspace system (NAS).² FAA's modeling indicates that even if all ongoing and planned NextGen technologies are implemented, some of the busiest airports may not be able to meet the projected increases in demand and will need additional capacity, which may require the construction of new runways or other infrastructure improvements. FAA believes that ongoing runway development programs are still needed at airports such as Chicago-O'Hare and Philadelphia International to meet long-term demand. NextGen improvements will complement these runway programs. Full implementation of NextGen will necessitate investment by airlines and others in new technologies. Airlines and other stakeholders, however, have expressed skepticism about the progress made to date by FAA, which, in turn, has affected their confidence about whether benefits will justify these investments. In addition to involving aviation stakeholders, the numerous improvements required for full NextGen implementation involve many parts of FAA and, in many cases, are mutually dependent in order to attain the full projected benefits. For example, the benefits of more efficient air-traffic control routes (called "procedures") may be limited if air traffic controllers do not have access to tools to better manage airborne traffic.

The need for stakeholder buy-in and investment, combined with the interdependencies of NextGen improvements, led FAA in 2009 to request that RTCA (once called the Radio Technical Commission for Aeronautics) recommend deliverables to help establish priorities and build support for long-term NextGen investments.³ RTCA's 2009 Midterm Implementation Task Force report included recommendations focused on key improvements that can be implemented with existing technologies and

²See FAA, *Capacity Needs in the National Airspace System 2007–2025* (Washington, D.C.: May 2007). FAA is in the process of updating this analysis and anticipates completing its report in September 2013.

³See RTCA, *NextGen Mid-Term Implementation Task Force Report* (Sept. 9, 2009).

capabilities in the “midterm,” which is 2013 through 2018.⁴ In 2012, at the request of FAA, the Integrated Capabilities Work Group of the NextGen Advisory Committee (NAC) reaffirmed the RTCA task force’s recommendations and developed a subset of priority operational improvements for major airports and multi-airport airspace (“metroplexes”) that have either the greatest need for improvements or offer the greatest potential benefit to the NAS in the midterm.⁵ Each NextGen operational improvement is a description of a specific operational change to the NAS, such as the implementation of improved air-traffic control procedures. The priority improvements included capabilities that are deemed to be of high value by industry stakeholders (particularly airlines), leverage existing airline equipment, and have the potential to accelerate the delivery of tangible benefits.

In addition to identifying priority NextGen operational improvements for the midterm, the RTCA task force also highlighted overarching recommendations to help FAA overcome challenges it has faced implementing and using those improvements. In 2012, FAA also worked with air traffic controllers to identify obstacles specific to the implementation and usage of existing high-performance NextGen air-traffic control procedures.⁶ FAA has undertaken some efforts to address challenges identified by the RTCA task force and FAA’s obstacles study.

⁴For purposes of this report, we will refer to the Midterm Implementation Task Force as the RTCA task force. To maintain consistency with the recommendations made by the RTCA task force and priorities identified by the NAC’s Integrated Capabilities Work Group (NAC work group), we are referring to the midterm in this report as lasting through 2018. FAA’s current NextGen implementation plans include a two-phased “midterm”—to 2015 and 2018, respectively—and the long term to 2025 and beyond, although agency officials now describe the midterm as extending until 2020.

⁵The NAC is comprised of aviation stakeholders from the government and industry. The NAC was set up by RTCA at the request of FAA, and is the follow-on to RTCA’s Air Traffic Management Advisory Committee. The NAC work group works to develop a common understanding of priorities in the context of overall NextGen capabilities and implementation constraints, with an emphasis on improvements through 2018. The committee primarily focuses on implementation issues, including prioritization criteria at a national level, joint investment priorities, and location and timing of capability implementation. See RTCA, *Applying the Metroplex Prioritization Criteria and Mapping the Integrated Capabilities to Identified Metroplexes* (February 2012).

⁶FAA, *Obstacles to Performance Based Navigation Implementation* (Washington, D.C.: Mar. 1, 2012) (FAA’s obstacles study).

Given questions you raised about challenges identified by RTCA, you asked that we review the implementation of NextGen. This report addresses the following questions: 1) What key operational improvements is FAA pursuing to deliver NextGen benefits with existing technologies through 2018? 2) To what extent is FAA addressing known obstacles to the implementation and usage of NextGen's operational improvements? 3) To what extent is FAA measuring and demonstrating midterm NextGen benefits and assessing outcomes?

To address these three questions, we reviewed agency-provided documentation, including planning documents such as FAA's 2012 NextGen Implementation Plan, internal reports related to NextGen initiatives, and FAA process and procedure documentation. We met with FAA officials across multiple offices that have a role in implementing NextGen, including units within the NextGen Office, the Office of Aviation Safety, and Air Traffic Organization (ATO). We also interviewed aviation stakeholders and experts with knowledge and experience related to NextGen implementation, including representatives from industry associations (such as RTCA and Airlines for America), airlines, airports, avionics and aircraft manufacturers, and other aviation vendors, as well as air traffic controllers.

To identify key NextGen operational improvements that use existing technology to deliver benefits through 2018, we reviewed the recommendations made by the RTCA task force report and by the NAC work group.⁷ These recommendations identify operational improvements FAA should prioritize and where those improvements should be implemented in the midterm, but do not include all operational improvements in FAA's 2012 NextGen Implementation Plan. Based on our analysis of these recommendations, we focused our evaluation on three broad areas of NextGen operational improvements and assessed the status of FAA's implementation of key operational improvements in those areas, the potential benefits to be achieved, and identified

⁷Organized in 1935, RTCA is a private, not-for-profit corporation that develops consensus-based recommendations for communications, navigation, surveillance, and air-traffic management system issues. RTCA's recommendations are the basis for a number of FAA's policy, program, and regulatory decisions, and have been incorporated into FAA's current NextGen implementation plans. Likewise the NAC—which includes representatives from industry and FAA's senior leadership—advises FAA on the implementation of NextGen.

challenges to the full implementation of those key operational improvements.⁸

To determine how FAA is addressing known obstacles to the implementation of NextGen operational improvements, we reviewed our prior work, FAA studies, and recommendations made by the RTCA task force and the NAC work group. These sources identified obstacles to developing, implementing, or fully using prioritized NextGen improvements—such as the limited involvement of stakeholders, including airport representatives, and the cumbersome process to implement flight procedures. We spoke with officials from relevant program offices and facilities within FAA to obtain information about efforts designed to address these obstacles. We also interviewed industry experts and stakeholders and assessed certain FAA efforts against established criteria, including best practices for stakeholder involvement from the Airport Cooperative Research Program (ACRP)⁹ and for organizational goal setting and performance measurement.¹⁰

To determine the extent to which FAA is measuring and demonstrating the benefits of NextGen, we reviewed and analyzed NextGen implementation plans, performance measures and metrics, and program targets. We updated our 2010 findings on the status of FAA's performance system, including setting goals and measuring NextGen progress.¹¹ We also reviewed FAA reports and the agency's publically available information, and interviewed industry stakeholders to assess the extent to which available information demonstrates the current and potential benefits of NextGen improvements. The RTCA task force pointed to the importance of delivering benefits in the midterm to gain

⁸We did not include improvements that were unlikely to be fully implemented in the midterm in our review, such as automatic dependent surveillance-broadcast out (ADS-B Out), which the FAA will require for some operations beginning in 2020. We also excluded Data Communications (Data Comm), which was in trials during our review.

⁹See Transportation Research Board of the National Academies, *Airport Cooperative Research Program Report 15, Aircraft Noise: A Toolkit for Managing Community Expectations* (Washington, D.C.: 2009).

¹⁰See GAO, *Government Reform: Goal-Setting and Performance*, [GAO/AIMD-GGD-95-130R](#) (Washington, D.C.: Mar. 27, 1995).

¹¹See GAO, *NextGen Air Transportation System: FAA's Metrics Can Be Used to Report on Status of Individual Programs, but Not of Overall NextGen Implementation or Outcomes*, [GAO-10-629](#) (Washington, D.C.: July 27, 2010).

stakeholder confidence and encourage airlines to invest in NextGen equipage.

We conducted this performance audit from November 2011 through April 2013 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives. For more information on our scope and methodology, including a listing of FAA divisions and industry stakeholders we interviewed, see appendix I.

Background

FAA's planning for the midterm includes improvements based on existing technologies that respond to recommendations made in 2009 by the RTCA task force.¹² The agency seeks to demonstrate tangible NextGen benefits to build industry support and encourage future needed investments from airlines and others to complete the transformation of the air-traffic control system. Industry investments can be significant; for example, FAA estimates that it would cost \$260,000 in 2011 dollars to equip—or \$525,000 to retrofit—a commercial aircraft with a Required Navigation Performance (RNP) package, which allows precision curved flight paths.¹³ In 2012, 50 percent of the domestic commercial aircraft fleet was RNP equipped.¹⁴ In 2011, RTCA reported that 80 percent of the airline fleet at high-density airports might need to be RNP equipped to accrue significant benefits for operators.¹⁵ In total, FAA estimates that airlines will need to invest \$6.6 billion—of the estimated \$18.1-billion overall implementation cost shared between airlines and FAA—on

¹²See RTCA, *Mid-Term Implementation* (2009).

¹³See FAA, *The Business Case for the Next Generation Air Transportation System* (Washington, D.C.: Aug. 2012).

¹⁴For the purposes of determining the capabilities of the commercial aircraft fleet, FAA assesses the equipage levels of major air carriers (airlines); regional carriers, which consist of passenger-carrying airlines that only fly aircraft with less than 100 seats; and cargo carriers.

¹⁵See RTCA, *NextGen Equipage: User Business Case Gaps, A Report of the NextGen Advisory Committee in Response to Tasking from the Federal Aviation Administration* (Sept. 2011).

avionics through 2018 to realize the full potential benefits from NextGen capabilities.¹⁶

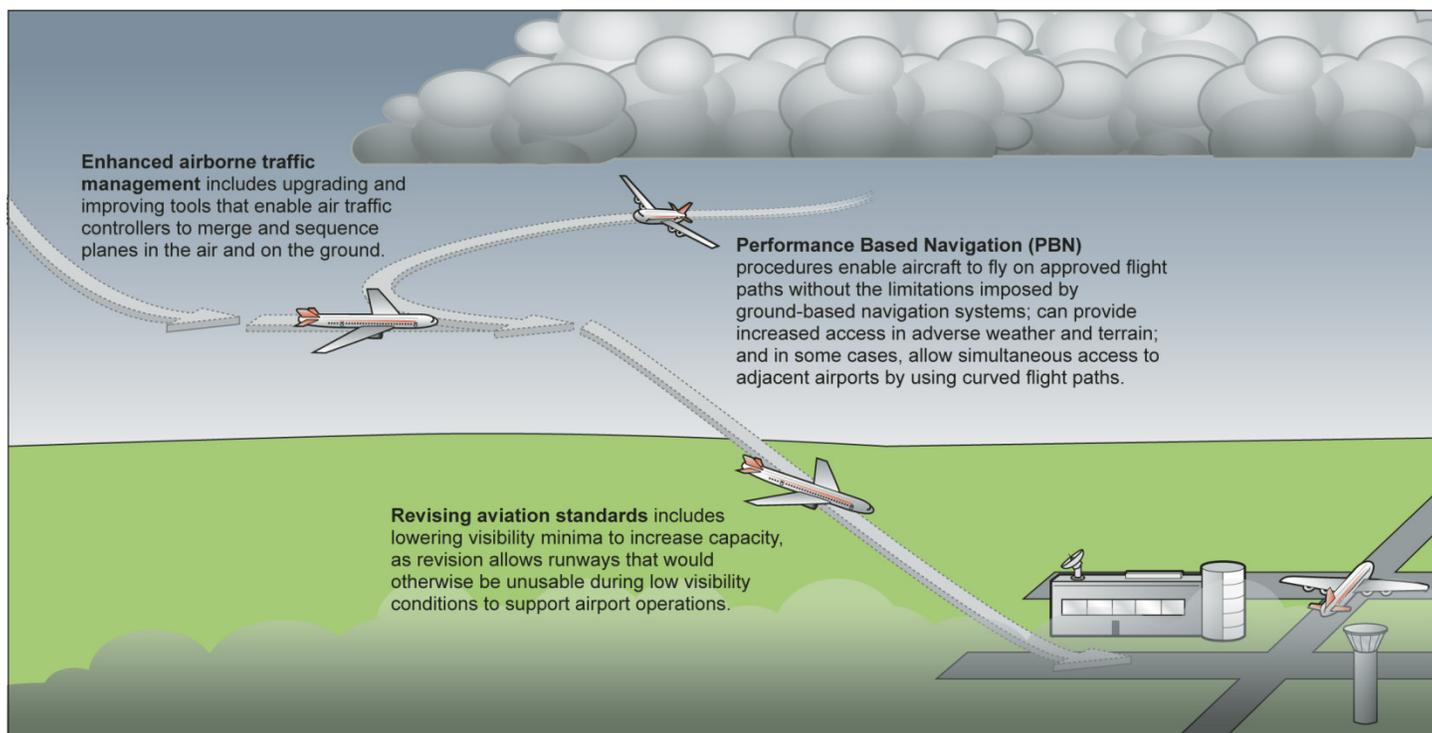
The RTCA task force and the NAC work group identified priority operational improvements that could provide substantive benefits and are viewed as feasible to implement between now and the end of 2018, and we grouped these into three improvement areas:

- Performance Based Navigation (PBN), which uses satellite-based guidance to route aircraft and improve approaches at airports. There are two main types of PBN procedures, including Area Navigation (RNAV) and RNP, which vary in the level of precision guidance they can provide.
- Enhanced airborne and surface traffic management, which includes tools that help air traffic controllers merge and sequence planes in the air and on the ground.
- Additional or revised aviation safety standards, such as those that establish the minimum required distances between aircraft in the air or minimum visibility distances to the ground. These changes are made possible by leveraging advances in technology and are anticipated to maintain or enhance safety.

FAA and the aviation industry have emphasized the interrelated nature of NextGen's many components (see fig. 1). Although NextGen improvements in each of these three areas offer some benefits when implemented individually, they achieve the greatest benefits when integrated, according to FAA officials, air traffic controllers, and other industry stakeholders, including airline representatives.

¹⁶These estimates are in 2011 dollars and reflect total expenditures on NextGen midterm improvements from 2007 through 2018. These estimates include equipping aircraft with RNP, as well as other NextGen technologies.

Figure 1: Examples of Prioritized Midterm NextGen Operational Improvements



Sources: GAO and FAA.

Through 2018, FAA's implementation of key NextGen operational improvement areas is focused on 30 core airports and key air-traffic control facilities.¹⁷ These air-traffic control facilities include terminal radar-approach control (TRACON) facilities and the 20 traffic control centers that manage enroute traffic throughout the NAS.¹⁸ In an effort to help FAA prioritize the implementation of NextGen, in 2012 the NAC work group identified seven priority multi-airport metroplexes based on an

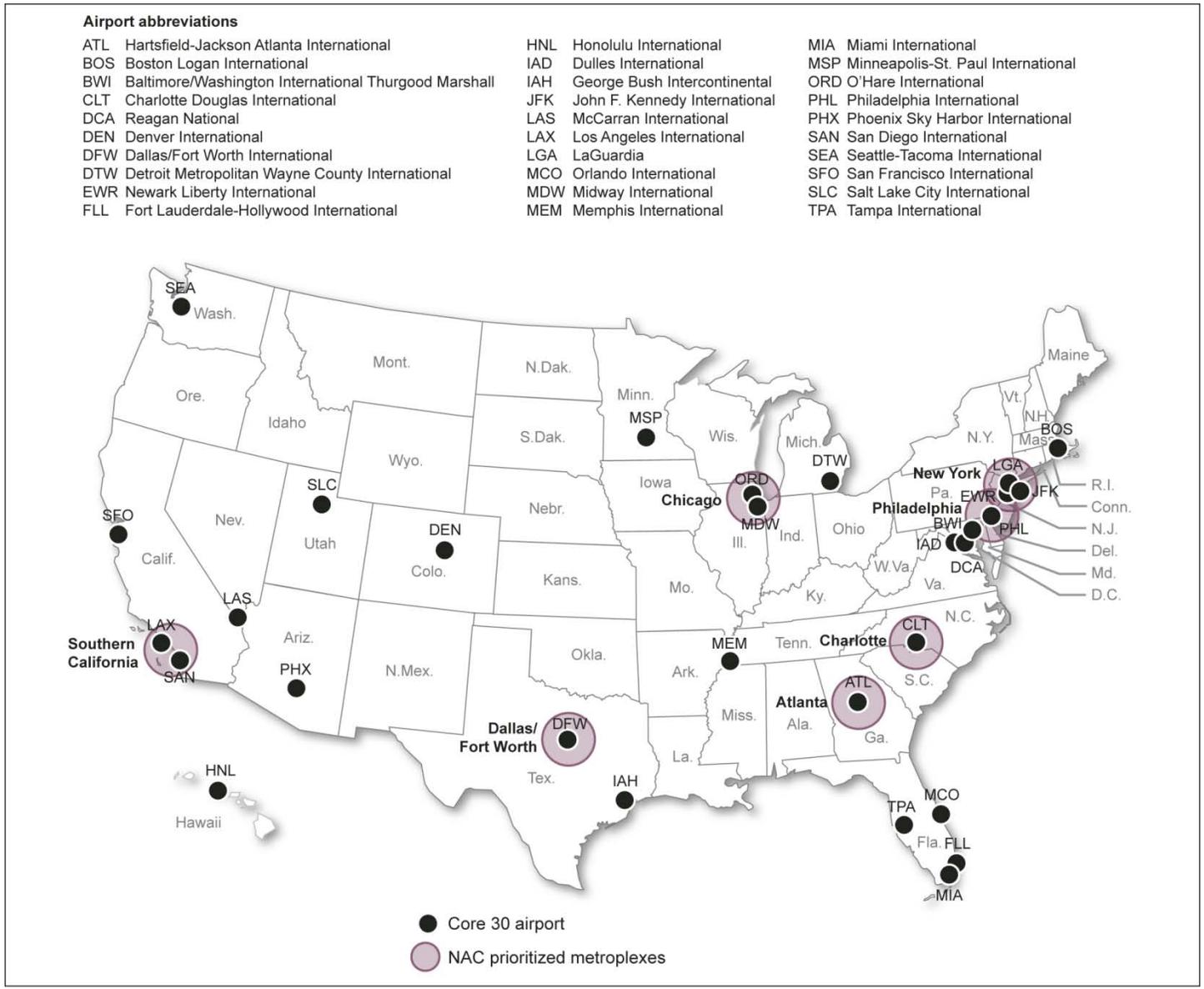
¹⁷In 2011, the FAA identified 30 core airports with the greatest impact on the performance of the NAS and which had more than one percent of passenger enplanements. This list of core airports replaced what used to be 35 Operational Evolution Partnership (OEP) airports, which had been identified by FAA in 2000.

¹⁸TRACONs typically handle air traffic to within about 40 miles of an airport. Air traffic greater than 40 miles from the airport is referred to as enroute air traffic and is controlled by enroute traffic control centers.

assessment of operational need (see fig. 2).¹⁹ Because of the integrated nature of the NAS, improvements or changes to a portion of the airspace or at one airport can affect other parts of the system.

¹⁹The NAC work group equally weighed five categories of operational need to identify critical metroplexes: delay, operations, efficiency, complexity, and metroplex connectivity. See RTCA, *Metroplex Prioritization* (2012).

Figure 2: Core Airports and Metroplex Sites Prioritized by the NextGen Advisory Committee (NAC) Work Group, 2012



A number of offices within FAA, including ATO, the Office of Aviation Safety, and the Aeronautical Navigation Product Group (AeroNav Products), are involved in the management and implementation of NextGen, as well as the NextGen Office, which oversees implementation

and reports directly to the Deputy Administrator.²⁰ The NextGen Office is tasked with linking NextGen's strategic objectives with operational requirements in an effort to ensure integration and implementation across FAA program offices. The NextGen Office includes a Performance and Outreach Office that is tasked with providing information on implementation progress, enabling successful collaboration and decision making with internal and external stakeholders, and reporting on performance measurements. At present, the position heading the NextGen office is vacant, which is further discussed later in this report. FAA's Office of Environment and Energy develops and coordinates policy relating to NextGen's environmental impact, including noise and emissions. In 2011, this office developed a new NextGen National Environmental Policy Act (NEPA) Plan to help ensure timely, effective, and efficient environmental review of proposed NextGen improvements.²¹

To address the majority of current flight delays throughout the NAS, the RTCA task force identified the implementation of new PBN procedures as a high priority initiative. Requests for new air-traffic control procedures, including PBN procedures, can come from a variety of sources, including airlines, airports, Congress, or individual air-traffic control facilities. According to FAA, there are core steps and processes that are common to the development of most procedures and involve a number of offices within the agency.

- ATO designs and develops procedures and conducts environmental reviews. According to FAA officials, environmental reviews typically take from 30 days to 2 years, depending on project factors such as the presence of sensitive environmental resources (e.g., national parks) and the potential for significant impacts such as noise or emissions. ATO also helps implement new procedures once they have been published by providing needed documentation or training to air traffic controllers.

²⁰A recent initiative called Foundation for Success was designed to address challenges that had been identified by FAA, including the incomplete integration of NextGen, diffused and overlapping governance structures, and difficulty managing project complexity, among other things, and involved pulling the NextGen Office out of ATO.

²¹FAA, *NextGen National Environmental Policy Act (NEPA) Plan* (Washington, D.C.: Dec. 2011).

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- The Office of Aviation Safety establishes design criteria²² for new procedures and conducts safety testing, such as flight simulations testing that includes controllers and pilots. It also grants operations approval and certification for aircraft equipment used to fly air-traffic control procedures.
 - AeroNav Products tests new procedures against design criteria and includes new procedures on published charts for pilots. AeroNav Products also maintains existing procedures, which need to be assessed every 2 years to assure that they still meet criteria and that conditions have not changed to render the existing procedures unsafe.²³

The other priority operational improvements, including those related to airborne and surface traffic management and enhanced standards, are largely managed by offices within ATO and the Office of Aviation Safety.

Federal actions, including airport expansion and large capital projects that use federal funding, require compliance with NEPA.²⁴ Under NEPA, federal agencies evaluate the potential environmental effects of actions they are proposing or ones for which third parties, such as airports, seek federal approval or funding. Agencies can meet the NEPA requirements by categorically excluding the project, using an environmental assessment to evaluate the likely environmental effects of the project, or, if actions are likely to significantly affect the environment, preparing a more detailed environmental impact statement. When an agency determines that proposed activities fall within a category of activities the agency has already determined have no significant impact—called a

²²Design criteria for procedures provide rules for safely constructing the nominal longitudinal and vertical path for departure, enroute, arrival, approach, missed approach, and holding procedures. These criteria are developed and published by FAA's Flight Procedure Standards Branch in Oklahoma City.

²³The conditions around an airport may change over time, making procedures unsafe. For example, new construction may result in taller structures around an airport or other changes that would affect minimal altitude requirements.

²⁴42 U.S.C. ch. 55. According to FAA, Environmental Impacts: Policies and Procedures Order 1050.1E, March 20, 2006, all formal actions taken by FAA officials are subject to NEPA review unless statutory law applicable to the FAA's operations expressly prohibits or makes compliance impossible, or are otherwise excepted by NEPA regulations.

categorical exclusion—then the agency generally need not prepare an environmental assessment or environmental impact statement.²⁵

For the development of new flight procedures, FAA assesses the potential environmental impacts of proposed changes, including changes to carbon dioxide emissions and noise levels for communities below the new or changed routes.²⁶ New or revised routes above 3,000 feet above ground level (AGL) typically qualify for categorical exclusion in the absence of extraordinary circumstances.²⁷ Additionally, the FAA Modernization and Reform Act introduced two new categorical exclusions, one of which categorically excluded RNAV and RNP procedures below 3,000 feet AGL at core airports and certain other airports, absent extraordinary circumstances.²⁸ According to FAA, extraordinary circumstances would include significant increases in noise over noise-sensitive areas (e.g., homes, schools, hospitals) under the new or changed flight path. Noise screening and carbon dioxide emissions analysis are required for procedures from 3,000 feet AGL to 7,000 feet AGL for arrivals and up to 10,000 feet AGL for departures. Noise screening may be required up to 18,000 feet AGL for special resources, such as national parks or wilderness areas. For changes closer to the ground, below 3,000 feet AGL, more environmental review may be required because of the potential for significant noise or emissions increases. Figure 3 illustrates the appropriate level of NEPA review needed for actions at various heights AGL.

²⁵A federal action may be categorically excluded—thus exempting it from further federal environmental review—if, based on agency experience, the agency has determined the proposed action is within a category of actions that do not individually or cumulatively have a significant effect on the environment and there are no extraordinary circumstances in which a normally excluded action may have a significant environmental effect. See 40 C.F.R. § 1508.4.

²⁶FAA Order 1050.1E, Chg 1, which is the most recent version, was updated on March 20, 2006.

²⁷Extraordinary circumstances are factors or circumstances in which a normally categorically excluded action may have a significant environmental effect that then requires further analysis in an environmental assessment or an environmental impact statement. See FAA Order 1050.1E.

²⁸FAA Modernization and Reform Act, Pub. L. No. 112-95, § 213(c), 126 Stat. 11, 49 (reauthorization act).

Figure 3: FAA’s Environmental Review Process for New and Revised Air-Traffic Control Procedures

Height above ground level	Rules / examples of potential environmental triggers
18,001 feet and above	<ul style="list-style-type: none"> Change can typically be made using a categorical exclusion No current screening/analysis required In the future, fuel burn/carbon dioxide emissions analysis may be required 
18,000 feet to 10,001 feet	<ul style="list-style-type: none"> Change can typically be made using a categorical exclusion Noise screening required if there are certain triggers in the area under the change, such as the presence of national parks or wilderness areas, schools, hospitals, or any other location where a quiet setting is a generally recognized purpose and attribute Fuel burn/carbon dioxide emissions analysis required 
10,000 feet to 3,000 feet	<ul style="list-style-type: none"> Change can typically be made using a categorical exclusion Noise screening required Certain increases in noise at certain levels over noise sensitive areas may lead to an environmental assessment Fuel burn/carbon dioxide emissions analysis required 
2,999 feet and below	<ul style="list-style-type: none"> Change can typically be made using an environmental assessment Change may be made using a categorical exclusion, if over non-noise sensitive areas or if “reauthorization categorical exclusion” applies Potential for significant impacts over noise sensitive areas that require an environmental impact statement Noise screening and/or analysis is required Fuel burn/carbon dioxide emissions analysis required Air quality analysis under Clean Air Act required 
Ground level	

Source: GAO analysis of FAA information.

Operational Improvements Largely Target Key Airports for Benefits, but Lack Integration and Have Limited Results to Date

FAA is concentrating its operational improvement efforts at key airports and metropolitan areas and focusing primarily on PBN procedures, including in its Optimization of Airspace and Procedures in the Metroplex (OAPM) initiative and another effort in the Seattle metropolitan area called “Greener Skies over Seattle” (Greener Skies). Increasing the number and use of PBN procedures is viewed as a way to accelerate the delivery of benefits, such as fuel savings, to airlines in some of the most-congested metroplex areas. To deliver benefits more quickly and avoid some obstacles that have hampered prior NextGen efforts, FAA has made trade-offs in selecting sites and the scope of proposed improvements, concentrating on those projects that can demonstrate some benefits in the midterm and leaving more time-consuming but potentially higher benefit-yielding projects for the longer term. The agency has also made some progress in the other key operational improvement areas, such as upgrading airborne traffic management to enhance the

flow of aircraft in congested airspace and revising standards to enhance airport capacity. By contrast, FAA has made more limited progress enhancing surface traffic management at airports, which will likely limit overall benefits in the midterm. Finally, there has been little integration of key operational improvements, which limits the potential benefits offered by any single improvement as well as the potential impacts on the NAS.

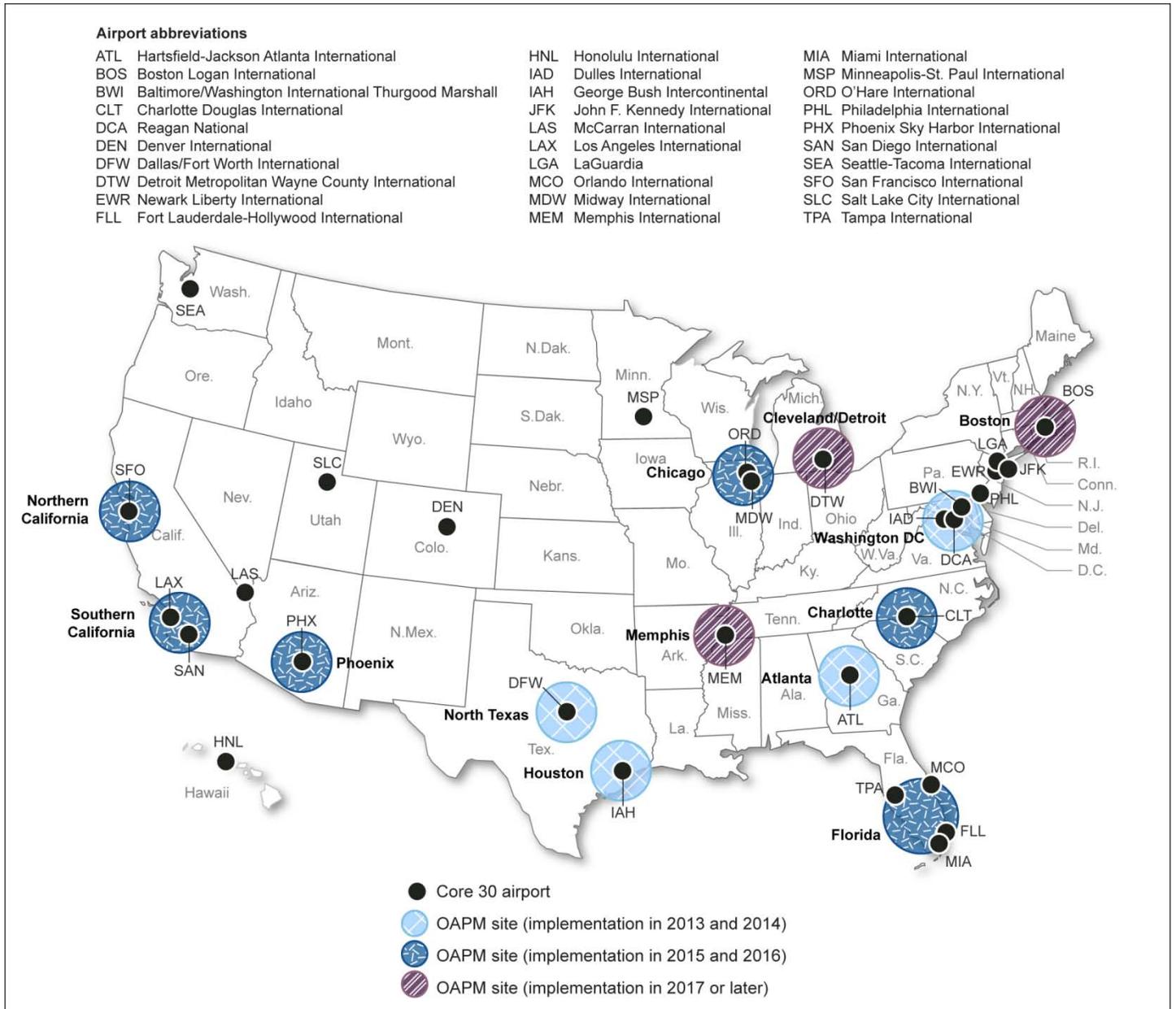
FAA Has Made Certain Trade-offs in Designing and Implementing PBN Efforts to Deliver Midterm Benefits

FAA's primary effort to implement new PBN procedures in the midterm is the OAPM initiative, which focuses on priority metroplexes with airport operations that have a large effect on the overall efficiency of the NAS. This initiative is also designed to provide benefits to airlines and airports in those metroplexes. If OAPM proceeds as planned, FAA expects to begin to demonstrate benefits at the eight sites that are currently active by the end of 2015. (See fig. 4.) Projects at five additional sites are expected to be fully operational before the end of 2017, according to current FAA plans.²⁹ With the exception of the Houston project, each OAPM project has about a 3-year implementation time frame, which includes 12 to 18 months for the environment assessment process.³⁰

²⁹In total, FAA has identified 18 metroplexes for its OAPM initiative, but does not yet have plans or associated timeframes for completing efforts at the final 5 sites.

³⁰The Houston project is part of a White House initiative to expedite reviews—including required environmental reviews—and the permit-issuance process. Consequently, the project has a shortened 2-year time frame, with new procedures scheduled to be implemented in 2013. FAA officials expressed skepticism about applying the Houston project's time frame to other OAPM sites, given potential environmental considerations at those other sites and resource limitations. Each OAPM is different because of the number of airports involved, the arrival and departure procedures deployed, and the proximity of other congested airspace. As a consequence, time frames vary by location.

Figure 4: Optimization of Airspace and Procedures in the Metroplex (OAPM) Sites and Implementation Dates, as of December 2012



Sources: GAO analysis of FAA data.

OAPM focuses primarily on implementing PBN procedures—long viewed as a cornerstone of NextGen—and any necessary airspace redesign for

deployment of the new procedures.³¹ PBN procedures provide the foundation for flight paths, airspace design, route separation, and obstacle clearance. (See fig. 5 for an illustration of these procedures.) Potential PBN benefits include shorter, more direct flight paths, reduced aircraft fuel burned—and resulting reductions in carbon dioxide emissions—and reduced noise in surrounding communities. The following are the key types of PBN procedures.

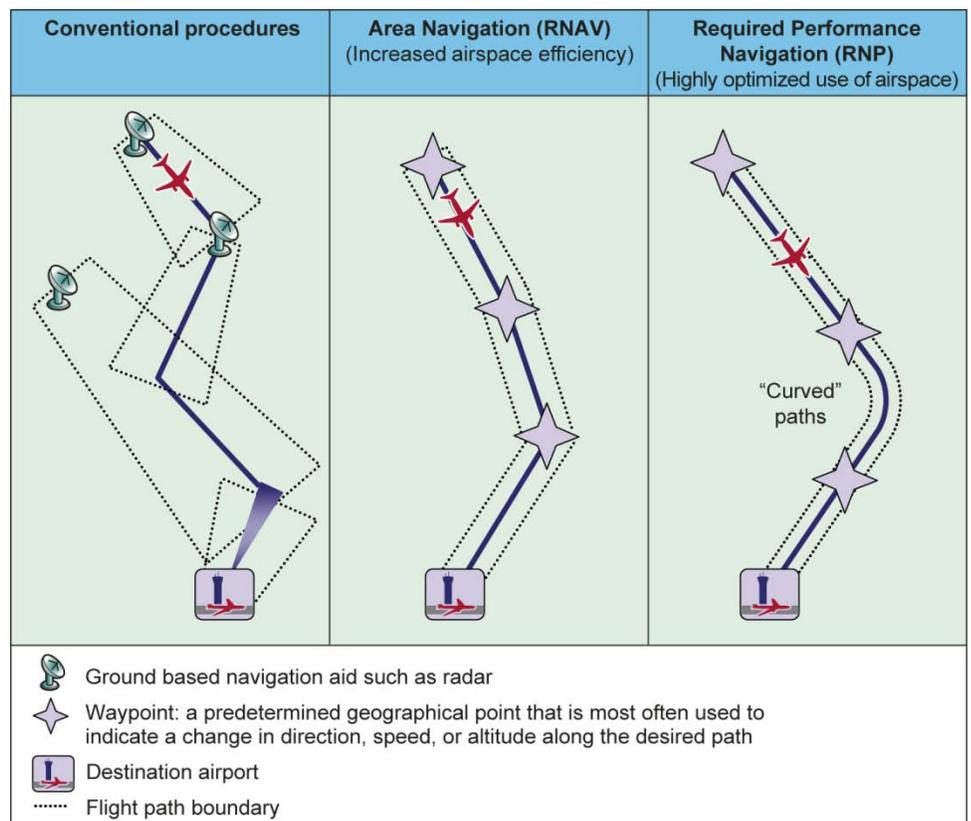
- RNAV procedures, which are enabled by technology available on nearly all commercial aircraft in the United States, provide aircraft with routing flexibility and more efficient flight paths than conventional procedures, and can allow improved access to airports in congested airspace or in bad weather.³² In 2011, 96 percent of the domestic commercial fleet was equipped for RNAV. As of January 10, 2013, there were over 12,500 public RNAV procedures available for all aircraft capable of flying them.
- RNP procedures (a subset of RNAV) add additional onboard-aircraft performance monitoring and alerting and require additional equipment as well as specialized crew training. In some cases, RNP can increase aircraft access to airports in adverse weather and terrain and help air traffic controllers keep aircraft operations at one airport from interfering with aircraft operations at adjacent airports by using curved flight paths. As mentioned above, in 2012, approximately 50 percent of the domestic commercial fleet was equipped for RNP. As of January 10, 2013, 352 public RNP procedures are included on charts for pilots.
- Optimized Profile Descent (OPD) procedures allow aircraft to descend from cruise altitude to final approach more efficiently, eliminating or reducing the level offs or step downs of a traditional descent. Low or

³¹FAA began implementing PBN procedures on a limited basis in 1996, before the launch of the NextGen transformation effort. The agency began publishing *private* routes—which can be used only by the airline for which the procedure is designed or approved—in 1996 in the state of Alaska for use by Alaska Airlines. In 2001, the agency implemented its first *public* RNAV routes, followed by the first public RNP routes in 2005 and its first public Optimized Profile Descent procedures in 2007. Public routes are air-traffic control routes that are available to all aircraft that are qualified or capable of flying them. According to FAA officials, many of the PBN routes that were initially developed were overlays—in that new flight tracks followed the existing radar-track flight routes—to set the foundation for a satellite-based NAS. Overlay PBN routes also allow aircraft operations in some bad weather conditions that otherwise would not be possible.

³²According to FAA, before RNAV, aircraft navigation had long been constrained by the location of ground-based navigation aids (i.e., radar) that restricted aircraft paths.

idle engine power settings save fuel and reduce emissions. OPD procedures also require less dialogue between air traffic controllers and pilots, which may improve safety by reducing the potential for miscommunications.

Figure 5: Procedures Using Conventional Equipment and Performance Based Navigation (PBN) Technologies

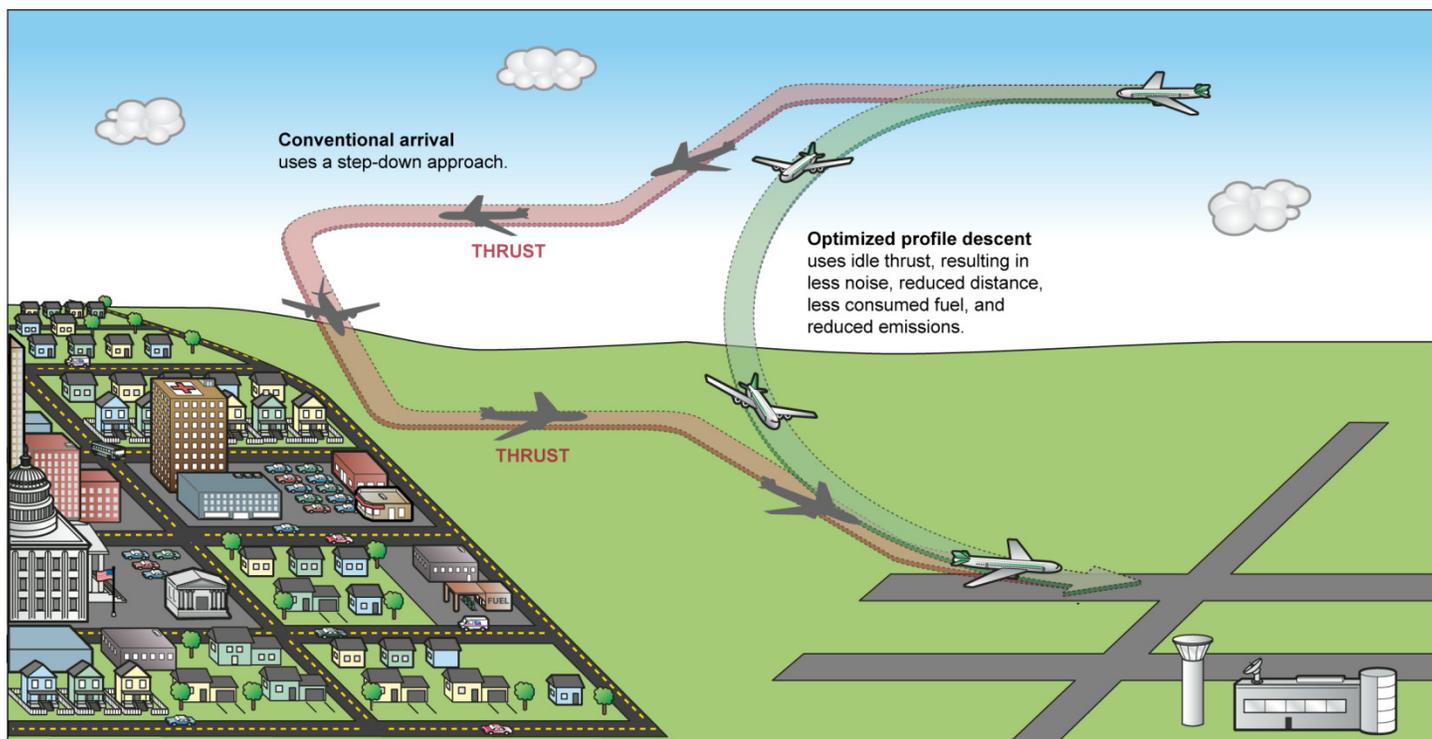


Sources: FAA and GAO.

According to reports by teams planning OAPM implementation, OAPM's benefits for airspace users will stem mostly from implementing OPD procedures enabled through the use of RNAV and the resulting reductions to fuel use and associated fuel costs. (See fig. 6.) For example, FAA projected that shorter routes and OPDs at its eight active sites could save at least 29-million gallons of fuel and reduce carbon dioxide emissions by 299,000 metric tons annually when fully implemented. In turn, improved efficiency and predictability at key metroplexes is expected to improve the efficiency of the NAS. FAA

estimated total annual benefits resulting from new OAPM procedures and associated airspace changes using aircraft simulators. As previously mentioned, all eight active sites are predicted to begin demonstrating benefits in the 2013 through 2015 time frame.

Figure 6: Optimized Profile Descents



Source: GAO.

To achieve the time frames of its OAPM initiative, FAA has made trade-offs, which are summarized below, between procedures that yield some benefits and can be implemented relatively quickly and those that could result in greater benefits but would take much longer to implement.

- *Excluded new procedures that would require route changes below 3,000 feet AGL or very close in to the airport.* Although all new flight procedures require NEPA review, those deemed to have extraordinary circumstances such as significant environmental

impacts—including a significant increase in noise or emissions around an airport—would require a full environmental impact statement, which can take several years to complete.³³ By excluding changes closer to the airport, FAA is seeking to avoid the lengthy environmental reviews that have delayed the implementation of some other FAA efforts. For example, we previously reported that FAA’s airspace redesign effort in the New York, New Jersey, and Philadelphia area has provoked significant community opposition, including legal challenges to the environmental review process used by FAA.³⁴ That effort, which began in 1998, is currently scheduled for completion in 2016.³⁵ Representatives from airlines, equipment manufacturers, and industry associations that we spoke with acknowledged that there could be additional efficiency benefits from new PBN procedures closer to the airport. For example, new procedures that would allow for tight turns for the arrival into the airport can reduce flight times and associated fuel use and costs and facilitate the flow of air traffic flying into or out of different airports in a metroplex, as well as increasing predictability of flight schedules. Nonetheless, most of these stakeholders did not believe that these potential additional benefits warranted the longer project timeframes that would be necessary to complete more detailed environmental reviews.³⁶

³³A significant increase in noise is defined by FAA as an increase in the Day-Night Average Sound Level (DNL) of 1.5 decibels or more over noise sensitive areas at or above the DNL 65-decibels noise exposure level. As we have previously reported, factors such as an airport’s number of operations, runway orientation and use, and the type of aircraft using the airport are fundamental drivers of the size and shape of an airport’s noise exposure area. See GAO, *Airport Noise Grants: FAA Needs to Better Ensure Project Eligibility and Improve Strategic Goal and Performance Measures*, [GAO-12-890](#) (Washington, D.C.: Sept. 12, 2012).

³⁴For more information about this airspace redesign project, see GAO, *FAA Airspace Redesign: An Analysis of the New York/New Jersey/Philadelphia Project*, [GAO-08-786](#) (Washington, D.C.: July 31, 2008). At the time that report was issued, plans were to have the redesign completed by 2012.

³⁵When we reported on this project in 2008, 13 separate lawsuits had been filed relating to the potential environmental impacts of the project. On June 10, 2009, the U.S. Court of Appeals for the District of Columbia Circuit dismissed or otherwise disposed of all claims against the FAA’s Record of Decision. *County of Rockland v. FAA*, 335 Fed. Appx. 52 (CA DC 2009), cert. den., 175 L.Ed.2d 975.

³⁶Additionally, while some of the proposed changes would benefit a particular procedure or operator, they may not fit within the air-traffic control structure for an OAPM effort without wholesale airspace redesign, according to FAA officials.

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- *Excluded new procedures that would require new design criteria.* FAA officials explained that having to wait for new design criteria for procedures could jeopardize the OAPM time frames. Outside of the OAPM initiative, FAA acknowledged that its staff had at times initiated work on a requested PBN procedure only to discover that the design criteria—which ensure the safety of procedures—do not yet exist for the desired procedure. FAA officials stated that new design criteria would be needed to more widely deploy PBN procedures, but that effort is being undertaken independently of the OAPM initiative.
 - *Excluded sites with ongoing airspace redesign projects.* Concerns about potential implementation delays also factored into FAA’s decision about which metroplexes to address in the midterm. Some industry stakeholders have voiced concerns that FAA did not include in its current OAPM plans the New York/Philadelphia metroplex, which is the nation’s most congested airspace and contributes to over half of domestic flight delays.³⁷ However, FAA decided to exclude that metroplex in light of the Record of Decision for the existing environmental reviews for FAA’s ongoing airspace redesign work for that area, because the agency did not want to initiate a new environmental review process.³⁸

In addition to the OAPM initiative, FAA has other PBN initiatives that aim to deliver midterm benefits in less congested areas. For example, FAA’s Greener Skies project, which was initiated by Alaska Airlines, aims to deliver benefits to the Seattle metroplex beginning in 2013, and was shaped by local considerations.³⁹ The initiative’s first phase focuses on a new set of PBN procedures planned for implementation in March 2013.⁴⁰

³⁷FAA officials we spoke with acknowledged that no matter which prioritization factor (delays, daily operations, extent of connectivity) is weighed most heavily, this metroplex is identified as the first priority site for the NAS. It was also identified as the highest priority metroplex by the NAC.

³⁸FAA and the Port Authority of New York and New Jersey officials pointed out that it would not be possible to begin a new project before the ongoing work is done under the existing environmental impact statement without triggering the need for a new environmental review. The Record of Decision completed the FAA’s NEPA review and describes the final action that FAA has decided to take.

³⁹Greener Skies was initiated by Alaska Airlines in collaboration with Boeing, other airlines, and the Port of Seattle, which operates Seattle-Tacoma International Airport. Greener Skies became an FAA-sponsored NextGen initiative in 2010.

⁴⁰The second phase is a longer-term research effort to revise separation standards for the NAS, which will be discussed in the following section.

The procedures are designed to shorten flight tracks and route aircraft over water. FAA estimates that the new Greener Skies procedures would reduce annual fuel consumption by 112,420 barrels annually, resulting in potential annual savings of \$13.5 million. To facilitate implementation of the project, a number of potentially beneficial procedures were scoped out of the Greener Skies effort based on local concerns. For example, FAA officials and other Greener Skies participants stated that new procedures to the east of the airport were not included because of known community concerns about new aviation noise in those areas and to avoid any changes that could violate noise commitments made in a recent Record of Decision. In addition to Greener Skies, FAA also has non-OAPM PBN efforts in place in Denver and Minneapolis.⁴¹

Although FAA's current PBN efforts have the potential to deliver midterm efficiency and environmental benefits, the benefits obtained will greatly depend on the extent to which the new procedures are used. In the past, industry stakeholders, especially airlines, have expressed concerns that some published PBN procedures, including those developed at priority metroplexes, have not provided sufficient benefits. According to FAA, the OAPM and Greener Skies efforts were structured in part to address such stakeholder concerns. In each OAPM project, airlines that serve the airports are invited to participate fully in the studies and design work that produce the PBN procedures to be implemented, for example. For those routes that were not developed through such efforts, however, usage remains a challenge. For example, an Alaska Airlines analysis of the airline's use of RNP routes in Alaska and in the continental U.S. showed that while 5 of its 10 RNP routes in Alaska—which are routes designed by or for Alaska Airlines to allow poor-weather airport access—were flown more than 40 percent of the time, all 16 of the RNP routes outside of Alaska were flown by its pilots fewer than 5 percent of the time, with most not used at all.⁴² An airline representative suggested that pilots were not requesting to use RNP procedures after having been denied them a

⁴¹In another new initiative, Delta Airlines has requested that FAA assess the potential for the development of full RNP simultaneous operations—allowing for the use of parallel runways independently—at Hartsfield-Jackson Atlanta International Airport. This effort would resemble the Greener Skies work in the Seattle metroplex.

⁴²According to analysis done by Alaska Airlines, of the 27 RNP charts that are carried by the airline's flight crews, 5 of the routes in Alaska were flown more than 40 percent of the time, while at least 11 of the routes in the lower 48 states were flown less than 1 percent of the time.

number of times by air traffic controllers. Southwest Airlines has expressed similar concerns about not being able to obtain projected benefits of new PBN procedures. For example, in 2011 the airline reported that its usage of RNP procedures had dropped, in part, because approval to use existing procedures was often not granted by air traffic controllers.⁴³ Some controllers told us that using new PBN procedures can be difficult for a number of reasons, including a lack of guidance and tools, which will be further discussed later in this report. Finally, in some cases, pilots prefer to fly traditional routes—particularly if the PBN route is longer or less efficient than a shortcut that may be approved by an air traffic controller on a traditional procedure when conditions allow it. According to FAA officials, when conditions do not allow for such shortcuts, pilots can use the PBN procedures.

FAA does not currently have a system to track the use of PBN procedures, and is unable to provide information on the extent to which existing procedures are either unused or are used on a limited basis. There are currently no automatic data collection systems to track the use of procedures, either on the aircraft flying the routes or at the air-traffic control facilities managing those aircraft. FAA officials stated that current efforts to track the use of procedures through pilot reporting have been hindered by insufficient and unreliable data. Without a way to systematically measure the use of particular procedures, the agency may not recognize routes that need to be revised to ensure that airlines are able to get expected benefits such as reduced fuel use or improved access in bad weather. As we have previously reported, critical success factors for goal setting and performance management by leading organizations include systematically measuring their performance to guide goal-setting, managerial decision-making, resource allocations, and day-to-day operations.⁴⁴

⁴³See Southwest Airlines, *Annual Report Pursuant to Section 13 or 15(D) of the Securities Exchange Act of 1934 for the fiscal year ended December 31, 2011*.

⁴⁴See [GAO/AIMD-GGD-95-130R](#).

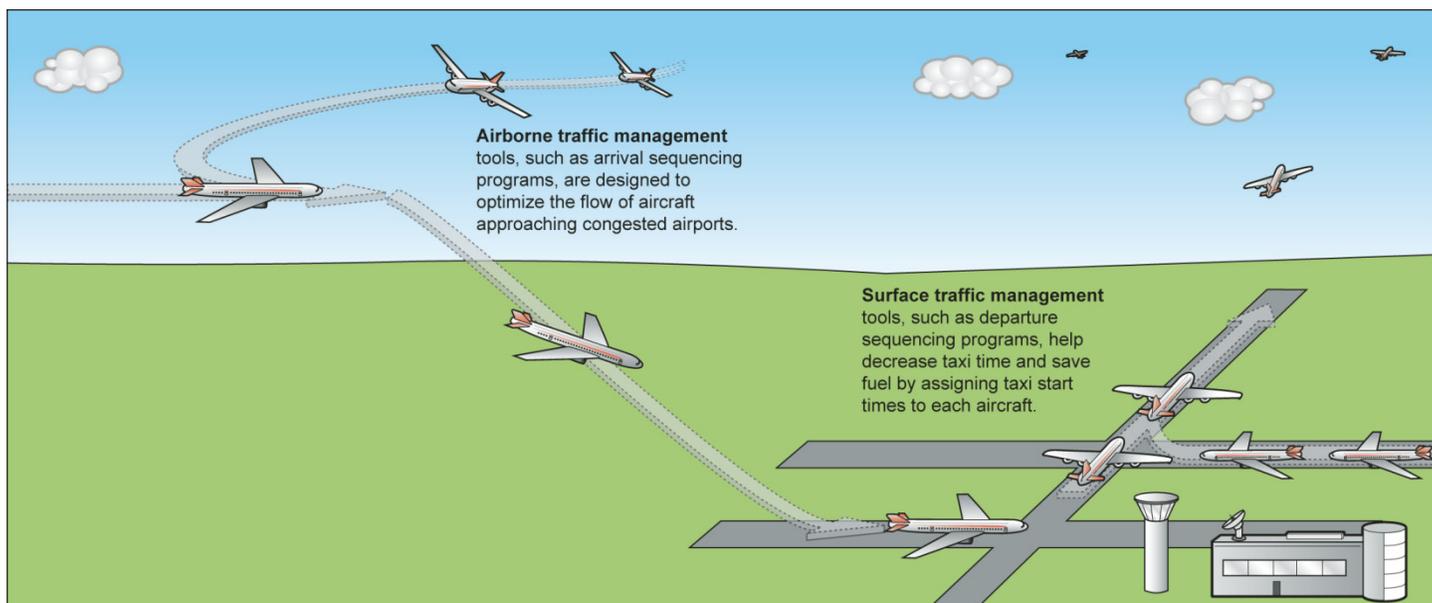
Mixed Progress in Other Key NextGen Improvement Areas Could Limit Benefits

Airborne and Surface Traffic Management

Through 2018, FAA is focusing on updating its Traffic Management Advisor (TMA), which is an airborne arrival-sequencing program that assigns times when aircraft destined for the same airport should cross certain points in order to reach the destination airport at a specific time and in an efficient order. TMA can enhance the effectiveness of new PBN procedures, particularly when controllers are mixing traffic using different types of procedures and aircraft with different levels of equipment (e.g., RNP equipped mixed with non-RNP equipped aircraft). For example, controllers can better merge aircraft on conventional, straight flight paths with those on PBN curved approaches and obtain a clearer picture of traffic on the ground and in terminal airspace when TMA is used with surface management tools (see fig. 7). Currently, TMA is primarily used for arrival sequencing by certain air-traffic control facilities at times when the demand for arrivals exceeds the capacity of a specific airspace or airport.⁴⁵ The upgrades could allow for TMA to be used more often, for more purposes (e.g., sequencing aircraft further away from the airport), and at additional facilities.

⁴⁵According to FAA officials, TMA is currently deployed and operational at all 20 enroute air-traffic control facilities, as well as 30 TRACONS and 29 airport towers, and it can be used in support of arrival, enroute, and departure flows.

Figure 7: Airborne and Surface Traffic Management Tools



Source: GAO.

Many of the active OAPM teams recommended upgrades to TMA's capabilities for their respective air-traffic control facilities; such upgrades could provide significant benefits to priority metroplexes, as well as at core airports faced with similar congestion issues. For example, the North Texas OAPM study team recommended separating the traffic to Dallas/Fort Worth International Airport from Dallas Love Field's airport traffic more efficiently, largely through TMA upgrades. North Texas OAPM team members told us that implementation of the procedures they are developing would depend principally on planned TMA upgrades. Likewise, the Houston OAPM study team recommended that arrival procedures it identified for the Houston metroplex to increase efficiency be managed using an enhanced TMA system. FAA has worked to align its plans for upgrading the TMA system with issues and concerns raised by OAPM teams.⁴⁶ For example, FAA plans to launch a new time-based

⁴⁶Of the eight OAPM study team reports published as of January 2013, three of these (North Texas, Houston, and Charlotte) stated that an upgraded TMA system would be needed to successfully deploy their proposed solutions for new PBN procedures and airspace changes, while two other study teams (Atlanta and Northern California) noted that their airspace would be more efficient if the TMA system were enhanced.

metering capability for PBN, which could help facilitate the corresponding launch of new PBN procedures in four priority metroplexes.

As part of its upgrades to airborne traffic management, FAA is also deploying a system to improve air traffic management in metroplexes by sharing information between adjoining air-traffic control facilities. The new system allows these facilities to share information and workload. It has been deployed at air-traffic control facilities for key metroplexes—including Atlanta, Los Angeles, Newark, and San Francisco—and FAA plans to complete the installation at at least three other sites by the end of 2014. Finally, FAA is implementing a system that will enable the sequencing of aircraft further from the destination airport—current sequencing typically occurs at the border between the enroute and terminal airspace. This system is to be implemented at one site in 2014, and the agency plans to subsequently install it at all others, but locations and timeframes have not been specified.

FAA-led surface-traffic management enhancements are not expected to begin to be implemented until 2015 at the earliest, mostly through the greater use of automated departure-queue management programs that are already in place at a number of metroplex airports.⁴⁷ These existing programs include queue-managements programs currently in use at John F. Kennedy International Airport (JFK) in New York and in Memphis, for example, which allow pilots to put their aircraft into a virtual departure queue before leaving the gate or ramp area instead of taxiing out and waiting on the runway for takeoff. Fuel savings, reduced taxiway congestion, and enhanced safety are among the benefits. FAA is working to determine which surface-traffic management capabilities to implement through testing with air traffic controllers, airlines, general aviation, and airport operators. While the airports have not yet been identified and the capabilities are still being determined, according to FAA officials, the agency tentatively plans to complete the rollout of enhanced surface-traffic management improvements by the end of the midterm.

FAA is also developing a new surface-management capability system, the Terminal Flight Data Manager, but does not plan to implement it until at

⁴⁷A number of airport authorities in major metroplex areas have purchased their own systems to improve surface traffic management, including at JFK in New York, Hartsfield-Jackson Atlanta International Airport, and Denver International Airport.

least 2017, which will likely limit potential midterm benefits.⁴⁸ According to FAA, reductions in surface traffic congestion largely depend on the new system's implementation. Further, the Terminal Flight Data Manager is also key to producing desired efficiency benefits—that is increasing arrivals and departures at busy metroplex airports where demand for runway capacity is high or where there are multiple runways with conflicting traffic. As a result, the agency will not be able to manage traffic throughout all phases of a flight—referred to as “end-to-end metering”—until these improvements are completed, including the integration of TMA enhancements with the Tower Flight Data Manager.⁴⁹ While originally envisioned for the midterm, end-to-end metering is now scheduled to be implemented in the long term (by 2025).

FAA has already implemented systems to increase the safety of surface traffic. To improve safety for taxi and surface movement at airports, for example, FAA installed Airport Surface Detection Equipment—Model X (ASDE-X)—a ground monitoring system—for 35 major airports from 2003 to 2011. FAA is also installing Airport Surface Surveillance Capability (ASSC) for another 9 busy and complex airports. These operational improvements were prioritized by the RTCA task force and enhance safety and traffic flow on runways, taxiways, and some ramps and allow for collaborative decision making among air traffic controllers and pilots.

Additional or Revised Standards

FAA has recently approved a few revisions to existing standards, which should benefit a handful of airports in the midterm, but further revisions are required before the envisioned efficiency and capacity benefits of midterm NextGen improvements can be fully realized. A key component of FAA's NextGen plans involves updating separation and other flight safety standards to better accommodate modern aircraft and advances in technology. Separation standards—required minimum distances used for safely spacing aircraft from other aircraft, terrain, and objects—have a

⁴⁸According to FAA officials, the Terminal Flight Data Manager program has developed a phased approach to the implementation of both surface-queue and tower-automation decision support tools. It is expected that this approach will provide incremental benefits while reducing implementation risks. In 2015, FAA plans to deploy an enhancement to departure sequencing. FAA plans to then implement additional enhancements and to deploy the full system in 2017.

⁴⁹With end-to-end metering, flights can be seamlessly managed from the departure gate, through all flight phases, to arrival at the destination gate, thereby increasing airport capacity.

large effect on airport capacity and the overall capacity of the NAS. Consequently, according to FAA and industry stakeholders, updating separation and other standards could increase the efficiency, capacity, and predictability of the NAS. By contrast, if standards are not updated to facilitate the use of new technologies and procedures, projected NextGen benefits might not be achievable to the same degree. Such revisions to standards can be time intensive because safety assessments are required to ensure the safety of the changes. Figure 8 provides examples of key additional or revised standards that FAA is pursuing through 2018.⁵⁰

Figure 8: Examples of Revised and Updated Standards

Standard under consideration	Potential benefit
<p>Lowering the visibility minima</p> 	<p>A lower visibility minimum could increase the use of a runway during foggy conditions.</p>
<p>Increased use of closely spaced parallel operations</p> 	<p>Revised standards can improve overall capacity at the busiest airports by allowing them to make better use of their existing parallel, converging, or intersecting runways.</p>
<p>Revising the wake separation requirements</p> 	<p>Decreasing the established minimum following distances between aircraft can better accommodate modern aircraft and increase capacity.</p>

Sources: FAA and GAO.

Recent work completed by FAA’s Closely Spaced Parallel Operations working group⁵¹ could soon provide benefits to one large metroplex airport and several smaller airports. In 2008, the working group initiated a

⁵⁰According to FAA officials, FAA has plans to make other improvements involving separation standards, including an initiative to reduce the required distance between runways for same direction operations and another for reduced spacing for dependent simultaneous approaches, among others. These efforts are still being planned and will need to undergo safety assessments before implementation.

⁵¹The Closely Spaced Parallel Operations working group includes participants from several FAA units such as the office of Aviation Safety, ATO, and the Office of Airports, MITRE, the Massachusetts Institute of Technology, and NASA.

series of research studies to investigate the potential for reducing runway separation standards—the required distance between runway centerlines for simultaneous use—to provide increased arrival and departure capacity in all weather conditions.⁵² After a lengthy safety assessment, the working group determined in 2011 that this standard could be reduced from 4300 feet to 3600 feet. FAA is proceeding with the implementation of the new standard.⁵³ According to FAA officials, once this new standard is implemented, it will benefit four airports immediately.⁵⁴ FAA’s 2012 NextGen Implementation Plan indicates that such reductions in runway separation standards should improve overall capability on runways, especially during poor weather conditions, but does not provide any quantitative estimates of benefits from this new standard.

FAA has also recently revised standards in two key metroplex areas in an effort to increase capacity and efficiency.

- In October 2011, FAA implemented a new standard that decreases the required angle of divergence between aircraft using RNAV departure procedures on the same or parallel runways at Hartsfield-Jackson Atlanta International Airport—the busiest airport in the NAS. According to FAA, this reduction has given controllers the ability to allow between 8 and 12 additional aircraft to depart the airport every

⁵²When weather conditions are not clear (Instrument Meteorological Conditions) the required separation standard for simultaneous independent operations on closely spaced parallel runways is 4,300 feet.

⁵³This effort involved 3 years of data collected on blunders recorded from over 1.4 million simultaneous independent parallel instrument approach operations. (A blunder occurs when an aircraft inadvertently changes course. It may result in a loss separation from the other aircraft on the parallel approach.) It involved research efforts on the part of FAA’s Aviation Safety teams, MITRE, and NASA and also involved Human In the Loop simulations with controllers and pilots. FAA officials told us that when they began this work, they were hoping to allow a national standard for runways separated by 2,400 feet to allow independent parallel operations, which would have benefited many more airports; however, the safety assessment revealed that there would be too many blunders with less than 3,600 feet spacing. The working group continues researching the possibility of further reducing separation standards for both dependent and independent parallel operations at other airports.

⁵⁴According to FAA officials, going forward, the revised independent and dependent standards will also provide airports more options to build parallel runways and, in some cases, possibly reduce the amount of land required. Such proposals would have to be carefully analyzed to determine whether other factors (including taxi routes and other surface movement considerations) would make such proposals workable. Moreover, any such proposals would be subject to environmental review under NEPA.

hour and is expected to save airlines \$10 million annually from reduced fuel burn on taxiways.

- Throughout 2011 and 2012, FAA implemented several revised standards at San Francisco International Airport (SFO) that FAA officials said could improve airport efficiency.⁵⁵ An FAA official and industry representatives who participated in this initiative noted that these revisions should help address capacity issues at the airport created by regional wind and fog patterns. Revised standards include a lower visibility minimum for certain types of approaches, as well as departures. FAA also increased the use of the airport's optimal runway configurations during various wind conditions.

Integration of Improvements Is Minimal

FAA has had varying success in integrating its NextGen implementation efforts, and stakeholders see opportunities for additional integration to better deliver benefits in the midterm. In 2010, the NAC approved of FAA's plans to focus its early OAPM efforts on new PBN procedures and airspace changes to expedite the delivery of benefits for operators, but suggested that FAA incorporate additional operational improvements—such as revised standards—into future OAPM efforts. In 2012, the NAC recommended that FAA incorporate into future OAPM efforts additional midterm operational improvements, such as enhanced airborne and surface-traffic management tools and other capabilities to enhance the capacity of metroplex areas. FAA has coordinated the development of PBN procedures with the implementation of airborne-traffic management tools in some OAPM projects when study teams identified improvements that would facilitate the implementation or usage of new PBN routes, but this integration has not been systematic for current OAPM efforts. For example, in response to a request from the North California OAPM team, FAA has added the San Francisco metroplex to the list of metroplexes that will receive an upgraded TMA system, which would allow the enroute center to manage traffic in concert with those air-traffic control facilities that manage surrounding airspace. The consideration of other non-PBN improvements, however, has been done at the discretion of OAPM

⁵⁵FAA and industry representatives told us that this work at SFO began as an attempt to mitigate some especially challenging constraints at SFO. Specifically, two of SFO's runways were scheduled to be periodically closed from the spring of 2012 through 2015 to make safety-related upgrades in line with FAA's Runway Safety Area program. At the same time as these intermittent closures were planned to begin, several airlines were planning to add flights at SFO.

teams—rather than being included as a goal of the overall OAPM effort—and has been largely limited to enhancements to TMA.

More broadly, FAA’s obstacles study pointed to the lack of airborne management tools as a key obstacle to the use of existing PBN procedures, including tools that help air traffic controllers sequence aircraft and better predict and visualize the flight trajectories of aircraft on PBN procedures. These tools are needed to fully use RNP curved approaches in congested metroplex areas, according to the study. One such tool will not be operationally available until 2016, according to FAA’s 2012 NextGen Implementation Plan, and the plan did not clearly indicate how or where this capability would be rolled out. Stakeholders have raised concerns that the lack of some key tools will slow the potential benefits of PBN efforts, including those associated with the OAPM initiative. Likewise, as mentioned above, the rollout of surface-traffic management improvements are scheduled to begin in 2015 at a few airports, which may hinder FAA’s ability to deliver the full benefits of its other improvement efforts, including PBN.

FAA Is Addressing Some Obstacles, but Project Prioritization, Stakeholder Participation, and Consistent NextGen Leadership Remain Challenges

As noted above, FAA’s current operational improvement efforts have involved certain trade-offs to achieve some near and midterm benefits, in large part, because of the context within which these improvements are being made. FAA has long-established processes and requirements in place that have made the U.S. airspace among the safest in the world. A number of those processes are, however, complex, lengthy, and at times, unclear as they relate to new technologies, procedures, and capabilities. FAA has a number of efforts under way to help overcome previously identified, overarching obstacles to NextGen implementation, such as streamlining processes and updating the air traffic controller handbook and procedure design criteria.⁵⁶ Many of these efforts are scheduled to take a number of years, particularly when proposed changes must be evaluated to ensure that they will maintain, if not enhance, the system’s current level of safety. Some, such as those aimed at increasing stakeholder involvement in planning and implementation of PBN procedures, do not, however, fully address previously identified obstacles. Nor do they change FAA’s overall approach to identifying potential PBN

⁵⁶As previously mentioned, design criteria provide rules for the safe development of air-traffic control procedures.

procedures for development or amendment, which relies on requests from airlines and other stakeholders without determining their impact on improving efficiency in the NAS. Finally, continued uncertainty about the FAA's leadership of NextGen affects the agency's ability to manage and oversee the various improvements and efforts needed to achieve the full implementation of NextGen.

Flight Procedure Implementation Process Is Being Streamlined, but Impact Will Not Be Known for Several Years

FAA and others have identified the process for developing PBN and other new flight procedures as a challenge. For example, in 2009 the RTCA task force recommended streamlining the operational approval and certification processes for new flight procedures. Likewise, an FAA report described the existing process as a bundle of interconnected, overlapping, and sometimes competing processes.⁵⁷ It also found variations and contradictions in existing guidance on procedure development and implementation, which result in a process that is “far from optimal, frequently generates rework, and on occasion results in the implementation of low- or no-benefit procedures.” To address these challenges, FAA initiated the Navigation Lean (NAV Lean) initiative to focus on streamlining the implementation and amendment processes for all flight procedures, releasing a report with planned improvements in 2010. FAA anticipates that the initiative will cumulatively cut 40 percent off the time needed to implement new procedures (assuming a full environmental impact statement is not required), though it acknowledged that it will be difficult to measure actual time saved. ATO and the Office of Aviation Safety share responsibility for overseeing the initiative, which began with the identification of overarching issues that negatively affect procedure implementation efficiency. The NAV Lean working groups identified nine issue areas with 21 associated recommendations, which focus, among other things, on minimizing the workload and delayed implementation associated with minor amendments of procedures, amending agency guidance to clarify and promote preparation of focused environmental assessments, and overcoming challenges to the development and implementation of criteria for flight procedures. (See fig. 9.)

⁵⁷ See FAA, *Navigation (NAV) Procedures Project Final Report* (Washington, D.C.: September 2010).

According to the NAV Lean implementation plan, all planned improvements are scheduled to be completed from 2013 through 2015. FAA envisions that some are likely to produce benefits soon after implementation.⁵⁸ However, FAA has acknowledged that it will have difficulty setting a baseline from which to measure many of the NAV Lean improvements. Agency officials, for example, told us that it would not be possible to determine how long the current PBN procedure implementation process takes both because the process varies for each effort and because agency databases do not track the amount of time taken for individual steps in the process. They explained that the more than 40 percent cumulative NAV Lean timesaving estimate was developed by asking officials the amount of time they expected to save in the procedure development process. In February 2013, FAA reported that it had made progress on all but one of the recommendations and had completed work on three recommendations, including a recommendation regarding the use of focused NEPA reviews in some circumstances. However, it is too early to determine outcomes associated with the implementation of these recommendations such as developing more procedures in less time.

⁵⁸The NAV Lean implementation plan provided initial action plans to relevant FAA offices, including the phases, timelines, actions, metrics, and estimated costs associated with implementing the recommendations. A majority of the recommendations involve multiple FAA offices.

Figure 9: Status and Projected Completion Date for Navigation (NAV) Lean Recommendations, as of February 2013

Issue Area	Recommendation	Percentage completion as of February 2013	Projected completion date
1	Minor amendments of flight procedures result in added workload and delayed implementation		
	Develop expedited process for minor revisions	50%	July 2014
2	An automated traffic simulation tool used to design Area Navigation (RNAV) arrival procedures is not an approved Aeronautical Navigation Products (AeroNav Products) tool and cannot be used to electronically communicate with AeroNav Products software, leading to manual rework of those procedures		
	Approve traffic simulator tool for electronic data transfer	75%	July 2013
	Establish abbreviated amendment process for arrival procedures in FAA Orders	70%	December 2013
	Direct to AeroNav Products for arrival procedures developed using traffic simulator tool	90%	July 2014
3	Databases used in flight procedure design are not standardized and are not available to all service providers		
	Establish standardized databases and designate responsibility	50%	February 2013
	Provide access to, and mandate use of, a single set of data for all flight procedure providers	10%	September 2015
4	Manual transfer of flight procedure data creates human error and wastes time		
	Standardize data precision, resolution, and rounding values	65%	September 2014
	Standardize software and data formats	40%	May 2015
	Enable electronic transfer of data	35%	September 2015
5	FAA guidance on preparation of environmental assessments does not address situations where the environmental analysis is narrowly focused on only certain potential environmental impacts		
	Issue interim guidance for focused approach to environmental assessments	100%	Complete
	Provide guidance on focused approach to environmental assessments and use of radar track data for noise analysis	45%	December 2013
	Enhance environmental assessment screening tools	65%	September 2015
6	Inconsistent interpretation of FAA environmental policy and guidance causes delays in developing and implementing flight procedures		
	Standardize management and environmental specialist training	55%	June 2013
	Modify FAA Order to define responsible federal official for environmental work	80%	August 2013
7	No systems approach to flight procedure criteria development and implementation; competing agency initiatives impede criteria requirements definition; and implementation aspects of criteria development are not currently addressed		
	Establish U.S. Instrument Flight Procedures Panel as focal point for criteria changes and new requests	100%	Complete
8	Inconsistent application of FAA policy regarding the need to develop documentation for safety risk management for new or amended flight procedures causes delays		
	Develop interim guidance for Safety Risk Management System compliance for flight procedure development and implementation	100%	Complete
	Standardize Safety Management process for implementation of flight procedures	40%	August 2013
9	Processing delays occur because there is no standardized process to accept input from all flight procedure proponents and stakeholders to access, request, track, edit, store, and manage information throughout the flight procedure development process		
	Amend FAA Order to define life cycle policy for flight procedure development	35%	January 2014
	Establish a Web-based Operations Approval portal	25%	March 2014
	Establish and implement a Web-based request and access portal for flight procedures	25%	September 2014
	Develop an outreach/communication plan to educate users on use of flight procedure portal	0%	September 2015

Source: GAO analysis of FAA information.

As part of addressing concerns about the length of its environmental review process, FAA released guidance on preparing concise and focused environmental assessments for proposed FAA actions (including new procedures) in January 2011.⁵⁹ Lengthy environmental reviews have been identified as an obstacle to the timely implementation of PBN by FAA and others. Environmental considerations were frequently not addressed until late in the procedure development process. The NAV Lean working group found that previous FAA guidance on the preparation of environmental assessments did not adequately address circumstances where the environment analysis could be more narrowly focused on only certain potential environmental impacts. In those circumstances, FAA offices should be preparing environmental assessments that consider all impact categories for applicability and significance, but focus the analysis only on the impact categories (e.g., noise) where there is potential for significant impacts caused by the proposed action (i.e., procedures). FAA anticipates that for small, non-OAPM projects involving one airport, “focused” environmental assessments could potentially take from 3 to 6 months, with a cost of \$300,000 or less.⁶⁰ For more complex OAPM projects—involving multiple airports and the assessment of numerous new flight procedures—focused environmental assessments generally will have 12- to 18-month time frames. By contrast, FAA officials estimate that non-focused environmental assessments traditionally take 6 months to 2 years for new flight procedures and cost \$300,000 to over \$1 million.

Although FAA has used focused environmental assessments for other types of proposed agency actions, FAA is first applying the new guidance to procedure-related actions for projects in Houston and Denver. Thereafter, the agency intends to use the new guidance at select OAPM sites (i.e., based on their complexity, number of potential environmental impacts, local considerations, and where proposed changes would not qualify for a categorical exclusion under NEPA), and will apply this approach to other projects as appropriate. FAA is also working to enhance or integrate several environmental screening and modeling

⁵⁹FAA, Guidance on Preparing Focused, Concise and Timely Environmental Assessments, FAA Order 1050.1E, Change 1, Guidance Memo #2, January 10, 2011.

⁶⁰In contrast to environmental assessments—either traditional or focused—a full environmental impact statement may take 2 to 5 years, on average, with costs ranging from \$500,000 to \$5 million, depending on the timely delivery of final procedure and airspace designs, the amount of potential controversy, and the amount of significant impact.

tools—by including fuel burn analysis in its noise screening tools and incorporating environmental screening into a traffic simulator used to design PBN procedures. These screening tools allow procedure developers to evaluate environmental implications early in the design process and determine the potential for extraordinary circumstances that would warrant environmental assessments rather than categorical exclusions. FAA has also been developing a new tool—the Aviation Environmental Design Tool—to facilitate its environmental assessment process.⁶¹

The FAA reauthorization act included a second new categorical exclusion for new PBN procedures that would result in measurable reductions in fuel consumption, carbon dioxide emissions, and noise, on a per-flight basis, as compared to aircraft operations that follow existing procedures.⁶² Currently potential noise impacts are measured cumulatively for all flights, and FAA has not yet identified an approach for such per-flight assessments. According to FAA officials, no currently available methodology resolves the technical problems involved in making such a determination, so the agency has not applied this new categorical exclusion. FAA officials have requested NAC's input on how to address these technical challenges.

Also as part of NAV Lean, FAA is working to change the way flight procedures requests are prioritized and how existing RNAV procedures are amended.⁶³ The change would expedite minor procedures revisions—which, to date, are subject to the procedure development process that FAA's obstacle study found long and cumbersome—by excluding

⁶¹In March 2012, FAA released guidance on the initial version of the Aviation Environment Design Tool (version 2a), a software-based tool which replaces the noise modeling tool currently used for air traffic airspace and procedure actions. See FAA, Guidance on Using the Aviation Environment Design Tool (version 2a) to Conduct Environmental Modeling for FAA Air Traffic Airspace and Procedure Actions, FAA Order 1050.1E, Change 1, Guidance Memo #4, March 21, 2012. A second version of the tool is anticipated for release in 2014, which will integrate additional existing modeling tools to produce fuel-burn, emissions, and noise estimates.

⁶² Pub. L. No. 112-95, § 213(c)(1), (2), 126 Stat., 49 (2012).

⁶³FAA has proposed reducing the priority categories from 10 to 3, which FAA expects will make the process more flexible. As mentioned above, requests for new air-traffic control procedures—as well as for amending procedures—can come from a variety of sources and are added to a queue with a priority ranking based on the type of procedure involved. See FAA Order 8260.43A, *Flight Procedures Management Program*, October 22, 2001.

amendments from the regional and national prioritization processes. This would allow FAA to make minor changes to existing—but potentially underused—RNAV arrival and departure procedures more expeditiously. This could be an efficient and cost-effective way for FAA to increase PBN usage.

While NAV Lean does not assign one FAA office responsibility for developing and implementing new procedures, implementation of several NAV Lean recommendations will provide additional tools to allow for better coordination among ATO, the Office of Aviation Safety, AeroNav Products, and others involved in the process. In 2012, FAA's obstacles study pointed to the lack of an accountable FAA office for the development of PBN to oversee a coherent design, development, production, and implementation strategy for new procedures. FAA is developing a web-based system to allow each interested party to access procedure designs and suggest improvements or mitigate potential problems throughout the development process. This is expected to result in a more cohesive procedure-development process when implemented in 2015. Furthermore, NAV Lean efforts are also intended to strengthen the role of the United States Instrument Flight Procedures Panel to improve coordination among parties responsible for the development and implementation of procedure design criteria.

New Efforts May Better Address New Procedure Requests, but Do Not Proactively Identify Needs

The RTCA task force and the NAC work group have pointed to the importance of prioritizing the implementation of key operational improvements, including focusing on the most appropriate PBN options such as RNAV or RNP. FAA officials said that they are in the early stages of developing a toolbox for those requesting new procedures, which would match solutions to identified problems and allow the agency to better target its efforts. FAA does not currently assess individual procedure requests—which can be made by a number of parties, including airlines—to determine if the proposed new procedures would generate expected benefits or resolve problems for airports or airspace. Rather, once a request for a new PBN procedure is received it is prioritized for development as requested on a first-come, first-served basis. Requests for new RNP procedures do not currently trigger an assessment by FAA (or by the requester) of the potential to use a less-costly option to resolve the underlying problem or gain the expected

benefits.⁶⁴ FAA officials noted that, in some cases, new RNAV procedures could be used by more aircraft and pilots than the more precise RNP curved routes that were being or had been developed. Over 90 percent of commercial aircraft are equipped for RNAV procedures—which also allow for curved flight paths—and the RTCA task force recommended that FAA should focus on leveraging RNAV and reserve RNP to locations where tighter turns are needed.

Industry stakeholders have argued that third parties could play a greater role in the development of flight procedures, a move that would help FAA respond to the current demand for new PBN procedures in the face of limited agency resources.⁶⁵ The FAA reauthorization act called for the agency to establish a program for qualified third parties to develop, test, and maintain flight procedures.⁶⁶ In May 2012, FAA awarded a \$2.8-million contract to GE's Naverus and a partner to develop two RNP approach procedures each at five mid-sized airports.⁶⁷ The contractors are to design, evaluate, and maintain these RNP approaches and be responsible for providing environmental data and analysis to FAA to support categorical exclusions and for drafting any required NEPA reviews, for review and approval by FAA.⁶⁸ According to FAA officials, the pilot project will allow FAA to assess the potential for third parties to have an expanded role in helping address those PBN procedures that FAA, because of a lack of resources, may be unable to address.⁶⁹ FAA has made progress in recent years in developing a framework plan for

⁶⁴As mentioned above, the majority of commercial aircraft in the United States are currently equipped for RNAV procedures, while RNP routes may require equipment upgrades and additional pilot training.

⁶⁵There are only a finite number of procedures that are needed. Once these routes are developed, the demand for new procedures should be reduced.

⁶⁶Pub. L. No. 112-95, § 213(f), 126 Stat., 50 (2012).

⁶⁷FAA considered a number of factors when choosing the five airports (Syracuse, NY; Milwaukee, WI; Anchorage, AK; Dayton, OH; and Kansas City, MO), including whether the airport had been identified by airlines.

⁶⁸Pub. L. No. 112-95, § 504, 126 Stat., 104 (2012).

⁶⁹FAA is developing a plan to review and assess reports developed by the contractors, as well as identifying measureable benefits and developing metrics criteria to track and report progress. FAA plans to evaluate the technical, operational, and costs value propositions measured out of this pilot project and will provide recommendations regarding the further use of the third-party developers for PBN procedure development.

leveraging third-party procedure developers and overseeing them. The potential of third party procedure development may be limited, however, given that there are currently two third-party procedure developers—GE’s Naverus and Boeing’s Jeppesen—that are eligible to develop public RNP approach procedures.⁷⁰ The use of third-party developers may be more costly than the in-house FAA development and maintenance of procedures. FAA officials estimate that new RNP procedures cost \$58,100 on average to develop, conduct safety testing, and implement—and \$2,300 per year to maintain—when these efforts are undertaken in house.⁷¹ This total is significantly less than the \$280,000 average cost for each of the 10 procedures that are being developed by the third party, although these FAA procedure-development costs do not include additional expenses for any NEPA reviews above a categorical exclusion. If an environmental assessment is required, then FAA costs could exceed \$58,100, as the cost of conducting a focused environmental assessment can range from \$0 to \$300,000.⁷²

Despite efforts to streamline the development of flight procedures, FAA does not have a process to proactively identify those PBN procedures that would best further NextGen goals. Much of the work done by the RTCA task force and the NAC work group has focused on prioritizing improvements, and the identification of needed new routes might prove beneficial in easing congestion in the NAS and key airspace, or in solving local problems that have ripple effects across the NAS. OAPM was designed, in part, to fill this void, but for airspace or airports that are not included in the initiative, FAA depends on stakeholders to initiate requests. Once requests are made, however, they are added to the procedure-development queue, and are not assessed against other PBN procedures in the queue to determine their respective potential to benefit the NAS or to resolve problems at specific airports. Further, requests may be driven by where a requesting airline flies and not where new

⁷⁰FAA has not authorized third-party developers to prepare RNAV procedures or those involving RNP departures in the United States.

⁷¹According to FAA officials, the 2012, non-OAPM estimated cost per procedure includes funding for contract support, AeroNav Products, flight inspection, and Aeronautical Information Management. The costs do not include environmental work above a categorical exclusion, overhead, or the cost for analytical support by a contractor.

⁷²According to FAA officials, the third-party contractors will be responsible for providing environmental information to support a categorical exclusion and for preparing any required environmental assessments, for review and approval by FAA.

procedures are most needed. In 2012, Airlines for America, an airline trade organization, led an effort—called 20/20—to identify those 20 new procedures most wanted by airlines, as well as the 20 procedures they viewed as most in need of amendment.⁷³ Four of the identified new procedures were at airports included in the OAPM initiative, so participating airlines agreed that FAA should address those new procedures through ongoing airspace redesign efforts. Of the remaining 16 identified procedures, 13 were found to already be under development by FAA.⁷⁴ Similarly, for procedures needing revision, FAA found that 13 of the 20 identified procedures were already in the process of being revised. In the absence of a procedure-development tracking tool, such as is being developed as part of NAV Lean, airlines were not able to monitor FAA's procedure development process for these routes. In response to the 20/20 effort, FAA agreed to track the development of the 16 desired new routes on its website, although it is not tracking those procedures that were identified for revision on the website.⁷⁵ Without a systematic means to identify procedures that are most critical to achieving NextGen goals and sharing information about its plans and progress in developing needed new procedures, it will be difficult for FAA to provide reasonable assurance that its efforts are efficiently delivering benefits.

OAPM or similar efforts may present an opportunity to assess the utility of some existing, but underused, conventional air-traffic control routes in a more efficient, systematic way. FAA maintains more than 22,000 PBN and conventional procedures in the NAS, and the agency is looking to cancel underused or redundant flight procedures.⁷⁶ As noted, these procedures cost \$2,300 or more per year to maintain and may be used

⁷³The 20 new procedures identified by airlines are located at nine airports.

⁷⁴According to FAA, one procedure identified in the 20/20 effort—for Anchorage, Alaska—is being developed as part of the third-party contract.

⁷⁵As of December 2012, the agency reported publishing (i.e., implementing) 9 of the identified new procedures; another 6 new procedures are expected to be completed by the end of May 2013, with the final procedure scheduled to be published in October 2013.

⁷⁶In 2010 FAA awarded a grant to Flight Safety Foundation to research and develop a process that can be used to identify and eliminate underutilized or redundant approach procedures. See Flight Safety Foundation, *A Recommended Process: Safely Reducing Redundant or Underutilized Instrument Approach Procedures* (Alexandria, VA: Mar. 2011).

only occasionally, if at all.⁷⁷ Although FAA does not track the number of unneeded routes, in a 2011 report, the Flight Safety Foundation proposed a process to identify 800 such procedures for potential elimination, representing a 12 percent reduction in the total number of ground-based approach procedures and a 4 percent reduction in the total number of procedures. Identifying these procedures for decommissioning could result in savings of approximately \$1.8 million per year—or about \$18 million over 10 years—in maintenance costs. An official with AeroNav Products pointed out that when OAPM teams assess current needs within a metroplex’s airspace, they are ideally positioned to identify some of the existing procedures that could be decommissioned, although they are not currently tasked with assessing the continued utility of existing routes. Once good candidates for route decommissioning are identified, FAA could further assess these routes and begin the public-notification process that leads to decommissioning.

Standards and the Air Traffic Controller Handbook Are Being Amended

The lack of design criteria can impede the development of new procedures. FAA’s obstacles study, for example, notes that AeroNav Products is often unable to design a requested procedure because the criteria for the procedure have yet to be developed by the Office of Aviation Safety. According to the report, this lack of a coherent design, development, production, and implementation strategy slows down the process and creates frustration among air traffic controllers and system users, such as airlines. FAA officials in the Office of Aviation Safety responsible for developing PBN criteria told us that their units have made progress in recent years in updating the design criteria to better use the capabilities of PBN to respond to requests for new procedures. They also told us that they are currently focused on clarifying and consolidating all the PBN criteria into one document to make it easier for air traffic controllers and others, and have in place several efforts related to specific design criteria, such as updating the criteria for holding—a maneuver used to delay an aircraft already in flight—for RNAV and RNP procedures. However, officials in the Office of Aviation Safety and other FAA officials acknowledged that much work remains to be done to

⁷⁷ According an FAA official, it can cost more to maintain non-PBN procedures, given that these procedures may require that more notifications are made to pilots regarding radar problems or other conditions.

develop new criteria before PBN can be deployed nationwide.⁷⁸ Several officials also acknowledged that it can be difficult to meet user requests for new PBN design criteria given variations in terrain and changing technology, especially because the safety tests that are often required for changing or amending the design criteria can be time and labor intensive.

Controllers and others have also pointed to obstacles posed by existing separation standards. For example, the RTCA task force recommended that FAA work to encourage controllers to minimize unnecessary buffers added to existing separation standards.⁷⁹ In a separate study, MITRE found that controllers often separate aircraft by more than the prescribed minimum distances to address any uncertainty about the actual positions of aircraft as well as to reduce the likelihood of violating the required separation distances. NextGen technologies and procedures can provide controllers with more precise information about the locations of aircraft and allow for aircraft to operate closer to one another, but controllers are not able to take full advantage of these capabilities. For example, current rules for air traffic controllers do not allow them to reduce the distance between aircraft on simultaneous approaches, even though these distances can be lessened when aircraft are on traditional routes under certain conditions. One of the aims of the Greener Skies initiative is to identify obstacles, such as these, to the full implementation of PBN, both in Seattle and across the NAS, and to develop solutions, especially any needed changes to existing separation standards relative to non-PBN

⁷⁸FAA is evaluating further enhancements to PBN and has developed general criteria for Advanced RNP in coordination with the International Civil Aviation Organization (ICAO). If these operations can provide additional benefits to the NAS, FAA will develop the schedule for their implementation in coordination with the Performance Based Operations Aviation Rulemaking Committee. The Performance Based Operations Aviation Rulemaking Committee provides a forum for the U.S. aviation community to discuss, prioritize, and resolve issues, provide direction for U.S. flight operations criteria, support FAA's NextGen Implementation Plan, and produce U.S. consensus positions for global harmonization.

⁷⁹RTCA has pointed to the potential for changes in the way FAA tracks and assesses any errors—notably losses of separation where aircraft come in closer proximity than allowed—made by air traffic controllers to encourage closer adherence to existing standards by eliminating incentives to add buffers between planes. For example, the RTCA task force recommended and FAA implemented a non-punitive reporting system for losses of separation. For more information about FAA's new systems for assessing losses of separation caused by controllers, see GAO, *Aviation Safety: Enhanced Oversight and Improved Availability of Risk-Based Data Could Further Improve Safety*, [GAO-12-24](#) (Washington, D.C.: Oct. 5, 2011).

procedures to parallel runways.⁸⁰ Potential solutions are then forwarded to FAA for consideration, such as a 2011 proposal that would better leverage the safety benefits of PBN to change certain separation standards for the use of parallel runways based on safety assessments conducted by the Greener Skies team.⁸¹

FAA's primary effort to address issues with the air traffic controller handbook is also part of the Greener Skies initiative. The Greener Skies team has identified 95 needed changes in FAA orders and regulations to date to address obstacles that have contributed to limiting the usage of PBN procedures. FAA's obstacles study noted that the lack of standard language for controllers and pilots for certain types of PBN procedures could create uncertainty in communications, which would require such a change to the handbook. Officials we interviewed at a Seattle-area air-traffic control facility acknowledged that they had known for years before the Greener Skies project began that the handbook was outdated. According to these officials, although FAA has published many PBN routes throughout the NAS, from a controllers' perspective, there were few rules in place for using those procedures. For example, under the current handbook there is little guidance on how to safely give less than the standard separation for merging planes—as is often done for traditional procedures in clear weather conditions—even if the aircraft are on precise paths. The separation standards heavily influence the guidance in the controller handbook, because much of a controllers' responsibility is to keep safe distances between aircraft. According to FAA's obstacles study, these concerns have led controllers to not approve the use of PBN procedures, in some cases.

FAA and others have also pointed to the need for additional training of air traffic controllers as a potential obstacle to the use of PBN procedures, and FAA's obstacles study suggested developing a national training plan for PBN operations. While we did not look at the extent of training provided when PBN procedures are implemented at individual airports,

⁸⁰The Greener Skies team was uniquely equipped to identify problems with standards and the handbook, because the team included members of the Performance Based Operations Aviation Rulemaking Committee, as well as FAA PBN developers. According to officials, this level of expertise allows the Greener Skies team to address issues that extend beyond the Seattle metroplex or airspace.

⁸¹See Performance Based Operations Aviation Rulemaking Committee, *RNP Established-Parallel Approach* (Jan. 10, 2011).

the larger-scale initiatives in our review have included time and resources for controller training. For example, OAPM plans dedicate from 9 to 15 months to the implementation phase, which includes controller training. Officials with the North Texas team told us that some new OAPM procedures, such as OPDs, would require significant changes from the way local controllers traditionally managed aircraft, so adequate training would be especially important for the successful implementation of their OAPM procedures. Likewise, officials from the Seattle-area TRACON noted that it had taken them about 2 months to develop the controller training for using new Greener Skies procedures.

FAA Has Involved More Stakeholders, but Is Not Fully Engaging Airports

FAA is making progress in systematically involving industry stakeholders, air traffic controllers, and other key subject matter experts in its initiatives, including OAPM and Greener Skies, as well as surface-traffic management initiatives. As we have previously reported, collaboration has been an ongoing challenge for FAA.⁸² For example, officials with the Port Authority of New York and New Jersey told us that the failure to include controllers early in the procedure design process for the airspace redesign effort for the New York, New Jersey, and Philadelphia area—some of the most complex and congested airspace in the world—contributed to the 4-year-plus implementation delay, because some proposed routes had to be amended following controller input. As such, we as well as others have made numerous recommendations that FAA should collaborate better with key stakeholders to facilitate the implementation of NextGen and enhance results. Many of these key stakeholders are also involved in other efforts to improve capacity in the NAS, such as the development of new or expanded runways, which are or will be pursued concurrently with NextGen. FAA officials, local controllers, airline officials, and others generally agreed that FAA has made significant progress in recent years in its ability to collaborate to achieve results. For example, FAA officials and industry stakeholders emphasized that OAPM is highly collaborative, as the study teams and design teams include local air traffic controllers and airline officials, FAA officials with experience in airspace redesign and other fields, environmental specialists, and others. The following are among the anticipated benefits of this collaborative approach.

⁸²See GAO, *Mechanisms for Collaboration and Technology Transfer Could Be Enhanced to More Fully Leverage Partner Agency and Industry Resources*, [GAO-11-604](#) (Washington, D.C.: June 30, 2011).

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- Enhances PBN usage: A number of FAA officials and air traffic controllers told us that FAA now recognizes that new procedures are much less likely to be used if controllers are not involved in the design. New procedures developed without controller input may not be feasible from an operational or safety perspective, and controllers may not see that the new routes are advantageous. Controllers serving the Seattle metroplex told us that their level of involvement in Greener Skies was more extensive and occurred earlier than in any previous procedure or airspace project. According to FAA officials and airline representatives, the inclusion of airline stakeholders in the design process also helped keep industry informed and involved and helps assure that the proposed procedures can be flown by participating airlines.
 - Addresses community concerns: We have previously reported that the inclusion of airports in PBN procedure development and other projects can help address potentially adverse environmental—often noise-related—community impacts, since these entities often have primary responsibility for addressing community concerns and are likely more familiar than FAA with the airport’s environmental impacts and the surrounding communities.⁸³ According to best practices established by ACRP regarding community involvement in airport projects, trust and respect are the keys to a long-term relationship between stakeholders—in this case between FAA and airport representatives, who are responsible for addressing community concerns about airport-related noise.⁸⁴

While FAA has made progress involving airports in NextGen projects, several FAA officials, a representative of Airport Councils International-North America (ACI-NA), and officials from several airports said that FAA is not fully leveraging the expertise of airport officials about local community concerns, although the ACI-NA representative noted that FAA has begun to involve airports earlier as the OAPM effort has continued. Airport officials in one OAPM metroplex told us that FAA had not adequately included them in early planning for new PBN routes. Consequently, the airport hired environmental consultants to analyze, among other things, the potential noise impacts of proposed PBN

⁸³See GAO, *Aviation and the Environment: Systematically Addressing Environmental Impacts and Community Concerns Can Help Airports Reduce Project Delays*, [GAO-10-50](#) (Washington, D.C.: Sept. 13, 2010).

⁸⁴ACRP, *Aircraft Noise Toolbox* (2009).

procedures and submitted concerns to FAA. In addition, although the Port of Seattle was initially involved in designing procedures for Greener Skies, airport officials told us that they were concerned that FAA had not included them during the environmental assessment process or in conducting local outreach. The project has raised some community concerns about aircraft noise from new flight paths, and some neighborhoods have expressed concerns that FAA had not clearly explained the potential noise impact on their neighborhoods.⁸⁵ New aviation noise is one of the largest obstacles to NextGen implementation, according to FAA officials and others. It can be difficult to address community concerns about aviation noise, but FAA may be able to mitigate such concerns by involving airport officials more closely in procedure design and community outreach efforts.⁸⁶ FAA officials involved in another OAPM team, for example, noted that local airport officials, who were not included in initial route planning for the metroplex, later provided information about potential community impacts that FAA had not anticipated. Information provided by FAA on establishing OAPM study teams, however, does not include guidance on the timely involvement of airport representatives on these teams, if such involvement is appropriate; rather the information indicates that OAPM teams should brief airport authorities as the process continues. This is in contrast to the best practices established by ACRP, which state that educating—in this case briefing—interested stakeholders after the fact is not sufficient for effective involvement; rather, proactive involvement is required.⁸⁷ A collaborative approach for NextGen that involves key stakeholders, such as airport officials, would better position FAA to fully leverage those stakeholders' expertise, help identify possible solutions, and facilitate implementation of NextGen improvements.

⁸⁵According to FAA officials, the final environmental assessment for Greener Skies included a finding of no significant impact and the Record of Decision was signed on November 1, 2012. Subsequently, no petition for review was filed by the appropriate filing deadline.

⁸⁶For more information about FAA's noise-abatement efforts, see [GAO-12-890](#).

⁸⁷ACRP, *Aircraft Noise Toolbox* (2009).

Consistent NextGen Leadership Remains a Challenge

Although the RTCA task force and NAC work group did not make recommendations regarding NextGen organizational issues, more broadly, FAA has struggled to have the leadership in place to manage and oversee NextGen implementation. In the past, industry stakeholders have expressed concerns about the fragmentation of authority and lack of accountability for NextGen, two factors that could delay its implementation. Leading practices of successful organizations reflect that programs can be implemented most efficiently when managers are empowered to make critical decisions and are held accountable for results.⁸⁸ To ensure accountability for NextGen results, several stakeholders suggested that an office was needed that would report directly to the FAA Administrator or the Secretary of Transportation. FAA has made organizational changes in the past in an effort to address these concerns.⁸⁹

Beginning in 2011, FAA made additional changes to its NextGen organizational structure to address NextGen leadership issues. Specifically, FAA reorganized the structure of the office responsible for carrying out NextGen implementation, moving the office from within the ATO to under FAA's Deputy Administrator. According to FAA, this change increased NextGen's visibility within and outside the agency and created a direct line of authority and responsibility for NextGen. In addition, in February 2012, the FAA reauthorization act designated that the Director of JPDO—who is responsible for NextGen planning and coordination—report directly to the FAA Administrator⁹⁰ and created a new leadership position—the Chief NextGen Officer.⁹¹

⁸⁸See GAO, *Best Practices: Better Support of Weapon System Program Managers Needed to Improve Outcomes*, [GAO-06-110](#) (Washington, D.C.: Nov. 30, 2005). In this study of private sector best practices that could be applied to federal programs, we found that program managers at highly successful companies were empowered to decide whether programs were ready to move forward and to resolve problems and implement solutions. In addition, program managers were held accountable for their choices.

⁸⁹For example, in May 2008, FAA announced a reorganization of its NextGen management structure and created a new Senior Vice President for NextGen and Operations Planning who reported to ATO's Chief Operating Officer. It also made the JPDO director report directly to this newly created position. Prior to this change, the JPDO director reported directly to both the Chief Operating Officer and the FAA Administrator.

⁹⁰Pub. L. No. 112–95, § 204, 126 Stat., 37.

⁹¹Pub. L. No. 112–95, § 208(a), 126 Stat., 40.

While these changes indicate a positive step towards addressing accountability issues, FAA continues to work to fill NextGen leadership positions. As of February 2013, FAA had not yet made all the organizational changes called for by the FAA reauthorization act. The Administrator has indicated that the new Deputy Administrator will serve as Chief NextGen Officer and that a search is on for qualified candidates for both the Deputy Administrator and Assistant Administrator of NextGen positions. The Administrator, who was sworn-in to the office in January 2013, has not yet clearly defined the relationship between the JPDO Director and other NextGen officials. Appointing a new Deputy Administrator to also serve as Chief NextGen Officer and concluding its candidate search for the Assistant Administrator of NextGen position, would better position FAA to resolve these remaining leadership challenges.

FAA Has Limited Data to Demonstrate Midterm NextGen Benefits, and More Information Is Needed in NextGen Plans

Performance Metrics Are Being Developed and Linked to Targets

FAA has made some progress developing performance metrics, which we recommended that the agency do in 2010.⁹² The NAC recommended in 2011 that FAA adopt performance areas used by ICAO and, as of February 2013, FAA had adopted 6 of the 11 ICAO performance areas.⁹³ FAA provided information about 5 of these performance areas—Environment, Safety, Efficiency, Capacity, and Cost Effectiveness—and

⁹²See [GAO-10-629](#).

⁹³As of February 2013, FAA is not including the following ICAO performance areas: Global Interoperability, Flexibility, Security, Participation by Air Traffic Management Community, and Access and Equity.

the metrics associated with these areas. Performance metrics for the sixth performance area—Predictability—are being developed.⁹⁴ As we have reported in the past, having performance measures is important, because they allow an agency to track its progress in achieving intended results and develop contingency plans if milestones to complete tasks are not met, both of which can be particularly important during the implementation stage of a new program.⁹⁵ Performance metrics would also enable stakeholders, such as airlines, to hold FAA accountable for results, as well as to make their own business decisions about whether to invest in equipment needed to enable the use of NextGen technologies and procedures.⁹⁶

FAA is currently conducting an agency-wide effort to review and harmonize its performance metrics to bring order, consistency, and accuracy to metrics reporting across its lines of business. The agency began this effort to address several problems, including managing and monitoring an increasing number of metrics and inconsistent metrics names and definitions. Once the harmonization is complete, ATO will create a website to display the harmonized metrics, which, according to FAA officials, will provide information for many FAA activities, including the implementation of NextGen.⁹⁷ The ongoing modifications to performance metrics must be completed before FAA can establish baselines from which it can measure progress. Baselines are essential to compare past performance to current performance. For some established metrics for which FAA already has extensive data, establishing a baseline is not expected to be a challenge. By contrast, establishing a baseline for

⁹⁴FAA has plans to consider and include two additional performance areas, Flexibility and Access and Equity. Access and Equity is one performance area.

⁹⁵Performance metrics measure the impact or results of a program or activity once it is implemented relative to desired outcomes or goals. 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. See [GAO-10-629](#) (comparing proposed FAA metrics with key attributes of successful performance metrics identified in prior GAO work).

⁹⁶See [GAO-08-786](#) and GAO, *Aviation Safety: Additional FAA Efforts Could Enhance Safety Risk Management*, [GAO-12-898](#) (Washington, D.C.: Sept. 12, 2012).

⁹⁷According to FAA officials, the website is preliminary and awaits review from the FAA Administrator.

new metrics for which FAA has not yet collected data may present challenges and is expected to take time.

FAA is also developing additional NextGen performance metrics in response to the FAA reauthorization act, in addition to responding to the NAC recommendations.⁹⁸ FAA was mandated to establish and, beginning in 2013, to track 12 performance metrics to measure progress for implementing some NextGen capabilities and improvements.⁹⁹ Although these new reauthorization metrics do not clearly link to the existing NextGen key performance areas mentioned above, some of the reauthorization metrics are similar to and reflect the same information that is already expected to be measured. According to FAA officials, 7 of the reauthorization performance metrics are already established, however the agency faces some challenges in developing 5 of the remaining metrics. For example, FAA is working with the NAC to identify a technically feasible way to measure and report on the amount of fuel used between key city-to-city (city-pair) markets—one of the required new metrics. It is not known at this time if these key city pairs will include some or all locations where midterm NextGen operational improvements are being implemented.

FAA has made minimal progress in developing goals for NextGen, which we also recommended in our 2010 report. FAA's Destination 2025 report establishes cross-cutting agency-wide goals for the midterm, although these are not all related to the implementation of NextGen.¹⁰⁰ Agency

⁹⁸Pub. L. No. 112-95, § 214, 126 Stat. 50 (2012).

⁹⁹While FAA has reported it is making progress in establishing metrics and baselines, the agency failed to meet the August 2012 reporting deadline specified in the FAA reauthorization act. The required report was supposed to describe the metrics to be used going forward—to include the midterm and thereafter—information on any additional metrics developed, and a process for holding the Administration accountable for meeting or exceeding the metrics. Currently, FAA officials have said that this report to Congress is being reviewed by the Administrator and have not provided a date on which the report will be provided to Congress.

¹⁰⁰FAA, *Destination 2025* (Washington, D.C.: 2011). Destination 2025 outlines the long-term, strategic vision for the agency and addresses the transformation of the NAS and the FAA itself over the next 15 years. According to FAA officials, NextGen Interoperability is the Destination 2025 metric that is the most obviously attributable to NextGen. According to FAA officials, it is important to note that NextGen may affect Destination 2025 metrics but that there are many other factors involved. Isolating NextGen's influence on broad-based measures such as the Destination 2025 metrics is very difficult.

officials emphasized that Destination 2025 goals were intended to be aspirational and that FAA business plans, which are developed by each individual business office, would provide NextGen targets and goals. However, agency officials in the NextGen Office acknowledged that individual business offices are still developing their respective targets. When FAA provided information to us in January 2013 about its efforts to align goals and performance metrics, the goals included in Destination 2025 were used as the source for many of the included metrics. As we reported in 2010, having goals and performance measures in place 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.¹⁰¹ Thus, we continue to believe that fully addressing our 2010 recommendations has merit. (See app. II for more information about performance areas and metrics.)

Information on Some Costs and Benefits Is Available, but Insufficient to Encourage Airline Investments in the Midterm

FAA has begun to report on implementation progress and benefits at certain airports and metroplexes, as well as for some capabilities, but implementation and benefits information is incomplete. In March 2012, FAA made publically available the NextGen Performance Snapshot website¹⁰² to provide post-implementation performance data. The website is designed to emphasize the link between NextGen investments and benefits. To date, information on the website provides performance progress on the near-term implementation of some, but not all, locations and initiatives where FAA has implemented NextGen capabilities.¹⁰³ As of January 2013, the website had information on established metrics for three performance areas—efficiency, environment, and access. Efficiency is reported at the core 30 airports; environment and access are reported

¹⁰¹See [GAO-10-629](#).

¹⁰²See <http://www.faa.gov/nextgen/snapshots/>.

¹⁰³During the course of our review, in late October 2012, FAA modified the NextGen Performance Snapshot website to focus on two implementation levels—the airport-specific level and the NAS-wide level—where NextGen initiatives have been deployed. According to FAA officials, once the website being developed by ATO is available, it is expected to provide aggregated NAS-wide data using agencywide performance metrics. By contrast, the NextGen Performance Snapshot website will provide retrospective information once a program has been implemented at specific locations.

at the NAS-wide level. For example, the NextGen Performance Snapshot website reports some efficiency data, such as the average number of minutes that it takes flights to taxi-in and taxi-out at each of the core 30 airports, and environmental data, such as NAS-wide noise exposure data for the U.S. population. In the absence of specific NextGen targets, we looked to track FAA's progress vis-à-vis the NextGen-related goals in Destination 2025 on FAA's NextGen Performance Snapshot website, but found it difficult to do so. Information presented was in many cases neither in the same format nor on the same scale as goals in Destination 2025. For example, one goal in Destination 2025 is to improve throughput at core airports during adverse weather by 14 percent through 2018, but the NextGen Performance Snapshot website tracking progress did not include this information either as an average or for individual core airports. Likewise, another Destination 2025 goal is to reduce the amount of fuel burned per miles flown by at least 2 percent annually—which corresponds to international objectives accepted by ICAO—but information provided showed changes in the cumulative amount of fuel burned per kilometers flown. According to agency officials, the NextGen Performance Snapshot website is currently undergoing improvements that will include more meaningful measures and additional reporting levels—such as metroplex and key city-pair views—to more fully demonstrate progress at core airports, prioritized metroplexes, and across the NAS. An updated NextGen Performance Snapshot website has the potential to help stakeholders—such as airports and airlines—and the public understand the progress and some benefits occurring at various airports and metroplexes across the nation in a more systematic way, as well as providing a link between these benefits and the investments made in NextGen by FAA and others.

FAA is also developing a PBN assessment tool—the PBN dashboard—to enable FAA to assess the PBN capabilities at individual airports and within the NAS. According to FAA officials and the contractors developing the dashboard, it will be able to measure PBN usage and impacts and changes to conditions (fleet, equipage, etc.). Representatives from one airline we spoke with said that they currently do not collect the information on procedure usage that FAA needs for the dashboard. In response to industry stakeholders' aforementioned concerns and perceptions that some published PBN procedures have provided limited benefits or have not been sufficiently used, FAA had undertaken some analyses to determine how often published PBN procedures are being used. This analysis of flight track data for airspace around some airports showed that more aircraft were following the airborne routes of published PBN procedures than was being reported by airlines or air-traffic control

facilities. However, the analysis was unable to determine whether the aircraft were actually flying the published PBN procedure or merely following the same track on the conventional procedure.¹⁰⁴ FAA officials stated that the dashboard could help FAA better assess the extent to which the fleet is able to use existing procedures. The OAPM study team for South/Central Florida used the dashboard to determine the percentage of operations at each airport in the metroplex that would benefit from proposed new procedures. It is unclear the extent to which the dashboard will be used to measure the impact of improvements or assess progress toward overarching NextGen goals. FAA officials do not plan to use the dashboard to proactively identify additional needed procedures at individual airports or make the dashboard available to external stakeholders, such as airlines, that may want to identify additional needed procedures.

Key stakeholders, such as airlines and equipment manufacturers continue to express the need for timely and reliable information about future anticipated benefits from technological and equipment investments that FAA deems necessary to take advantage of the NextGen infrastructure. According to RTCA, additional information is needed to understand potential direct costs, benefits, and return on investments that might be realized within approximately 3 years. FAA's 2012 NextGen Implementation Plan provides some examples of benefits that have been achieved, as well as projected benefits for planned improvements, from the implementation of NextGen capabilities and initiatives. For example, FAA reported that during flight demonstrations of OPD procedures at San Francisco International Airport from December 2007 to September 2010, airlines achieved an average fuel savings of 99 to 176 gallons per flight depending on the aircraft type. While FAA plans include such examples, RTCA reported that available FAA plans do not include sufficient information for airlines making investment decisions,¹⁰⁵ such as forecast benefits by either location or usage, or the proportion of the local fleet that

¹⁰⁴FAA officials explained that it was unlikely that so many aircraft flying conventional procedures would adhere to the PBN route, but using flight track data did not allow them to preclude the possibility that the matching radar track was coincidental. PBN procedures may overlay or closely approximate existing conventional routes, so it can be difficult using only radar track data to determine what procedure the pilots were actually approved to fly, and FAA does not currently collect complete information on PBN route usage.

¹⁰⁵RTCA, *NextGen Equipment: User Business Case Gaps* (Sept. 2011).

is currently equipped.¹⁰⁶ For example, RTCA noted that FAA's long-range implementation plans should provide information on the roll out of RNP procedures at specific airports—the type of information that would be useful for airlines that are considering investing in this technology. However, RTCA found that the plans lacked such information. Nor do FAA implementation plans identify criteria with which additional sites would be selected in the case of demonstration projects. Without greater certainty on when and where NextGen improvements are planned, airlines and others are unlikely to invest in the equipage (and conduct the associated staffing and training) that will help achieve the full benefits of NextGen implementation.¹⁰⁷ FAA has estimated that total industry equipage could cost \$6.6 billion—compared to \$11.5 billion in NextGen implementation costs for FAA—through 2018.¹⁰⁸ Deciding whether to invest in most of that equipage is at each airline's discretion.¹⁰⁹

Conclusions

The implementation of NextGen is expected to enhance safety, improve efficiency, and result in a reduction in the environmental costs of aviation. Achieving the benefits of NextGen is a collaborative task that not only relies on timely and reliable information on progress implementing NextGen, but also depends heavily on airlines' and other stakeholders' continued or increased investments in NextGen technology and training. The improvements included in NextGen plans are often interrelated, with

¹⁰⁶Information about the level of local equipage is important because the level of equipage can affect how often airlines are able to use new routes. A new route in Chicago, for example, that allows for the simultaneous use of runways at O'Hare International and Midway has to be closed whenever a non-equipped aircraft arrives on the approach to Midway.

¹⁰⁷We have previously reported that effective performance plans communicate what an agency proposes to accomplish, how it will accomplish its goals, and how it will assess whether those results were achieved. For more information about best practices for performance plans, see GAO, *The Results Act: An Evaluator's Guide to Assessing Agency Annual Performance Plans*, [GAO/GGD-10.1.20](#) (Washington, D.C.: Apr. 1, 1998).

¹⁰⁸According to FAA estimates, purchasing and installing RNP will account for \$1.4 billion (in 2011 dollars)—about 22 percent—of total equipage costs for aircraft operators by 2018.

¹⁰⁹In some cases, airlines must comply with future NextGen equipage requirements. For example, equipage with ADS-B Out is mandated by 2020 for a variety of operations in U.S. controlled airspace. FAA estimates that the total cost to aircraft operators to purchase and install ADS-B Out will be \$2.3 billion dollars (in 2011 dollars) by 2018.

benefits in one area dependent on the full implementation of other operational improvements.

FAA does not have a system for systematically tracking the use of existing PBN procedures. As a result, FAA is unable to assure that investment in these routes is worthwhile or that they justify the cost to develop and maintain them. In the absence of data on the use of existing PBN routes, airlines and other stakeholders remain unconvinced that the investments needed for the full implementation of NextGen will be justified. Such information could help the agency demonstrate the value of PBN technologies and any resulting benefits, as well as allow the agency to identify routes that need to be revised to increase their use.

Without a process for proactively identifying new PBN procedures based on NextGen goals and targets, requests for new PBN procedures largely originate from outside FAA. While the agency has attempted to work with industry stakeholders, such as airlines in the 20/20 effort, to identify needed routes, results have been mixed. The use of criteria to proactively identify needed routes at individual airports, such as criteria used by the NAC to prioritize metroplexes, could enable FAA to identify routes that can maximize benefits for the NAS. Furthermore, FAA does not assess requests received to determine whether the requested route or type of procedure (e.g., RNAV or RNP) maximizes potential benefits. Since requestors, such as airlines, may have their own reasons for requesting routes at certain locations or using specific technologies, their requests may not correspond with NextGen goals or result in the most efficient use of resources for PBN implementation or vis-à-vis the needs of other users.

The NAC work group recommended that FAA develop an integrated approach to increase airspace efficiency in key metroplexes, including OAPM sites. While FAA has consistently emphasized the importance of integrating key operational improvements to maximize NextGen benefits, FAA has primarily focused its midterm efforts on PBN and has not systematically integrated airborne- and surface traffic management and revised standards into these efforts. FAA officials explained that non-PBN improvements were not systematically included in the first round of OAPM, in part, to achieve OAPM time frames. However, with the implementation of some first round improvements, as well as progress made in developing and deploying some non-PBN improvements, FAA is better positioned to systematically integrate PBN and other improvements going forward. Insufficient integration of key improvements decreases midterm NextGen benefits, since these benefits are interdependent.

Furthermore, by not including the identification of unused flight routes for decommissioning in OAPM and similar efforts, FAA could be missing an opportunity to leverage the expertise of participating stakeholders. Decommissioning unused or little-used conventional, non-PBN procedures could allow FAA to make better use of its resources by reducing maintenance costs.

FAA has made progress in recent years in ensuring the inclusion of stakeholders in NextGen efforts, especially air traffic controllers. Some airport officials, however, expressed concern that FAA had not fully involved them in current efforts or involved them too late in the process, although a representative with ACI-NA noted that FAA has recently begun to involve airports more significantly in NextGen design and implementation efforts. However, FAA has not developed guidelines for the timely and consistent inclusion of these stakeholders. Some FAA officials told us that they had not fully appreciated the potential value that airport officials could provide. A collaborative approach that timely involves key stakeholders—including the agency, airport officials, air traffic controllers, and airlines—enables FAA to fully leverage the expertise of these stakeholders, helps identify the best possible solutions, and facilitates the implementation of those improvements.

FAA has made some progress in developing and aligning performance metrics and goals since we recommended these actions in 2010. It is important for FAA to complete this work to measure progress and demonstrate benefits across the NAS, gain confidence, and engender needed investments to support the full implementation of NextGen. Furthermore, RTCA and others have pointed to the importance of having stable, long-term implementation plans for NextGen capabilities and determining specific location benefits and implementation dates, but FAA's NextGen implementation plans do not detail such deployment information. As a consequence, airlines and other stakeholders have been reluctant to invest in expensive avionics, including RNP equipage.

Recommendations for Executive Action

To help ensure that NextGen operational improvements are fully implemented in the midterm, we recommend that the Secretary of Transportation direct the FAA Administrator to take the following five actions:

- work with airlines and other users to develop and implement a system to systematically track the use of existing PBN procedures;

-
- develop processes to proactively identify new PBN procedures for the NAS, based on NextGen goals and targets, and evaluate external requests so that FAA can select appropriate solutions;
 - require consideration of other key operational improvements in planning for NextGen improvements, including PBN projects at metroplexes such as OAPM, as well as the identification of unused flight routes for decommissioning;
 - develop and implement guidelines for ensuring timely inclusion of appropriate stakeholders, including airport representatives, in the planning and implementation of NextGen improvement efforts; and
 - assure that NextGen planning documents provide stakeholders information on how and when operational improvements are expected to achieve NextGen goals and targets.

Agency Comments

We provided the Department of Transportation (DOT) with a draft of this report for review and comment. DOT responded by email and did not agree or disagree with our recommendations, but provided technical clarifications, which we incorporated into the report as appropriate.

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

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



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

Appendix I: Objectives, Scope, and Methodology

Our objective was to assess the Federal Aviation Administration's (FAA) progress implementing key Next Generation Air Transportation System (NextGen) operational improvements in the midterm and demonstrating benefits from these improvements. To do so, we addressed the following questions: 1) What key operational improvements is FAA pursuing to deliver NextGen benefits with existing technologies through 2018? 2) To what extent is FAA addressing known obstacles to the implementation and usage of NextGen operational improvements? 3) To what extent is FAA measuring and demonstrating midterm NextGen benefits and assessing outcomes?

To address these three questions, we reviewed our prior reports, met with FAA officials with a role in implementing NextGen, including units within the NextGen Office, the Office of Aviation Safety, the Air Traffic Organization (ATO), Aeronautical Navigation Products (AeroNav Products), and the Office of Environment and Energy. We reviewed FAA planning documents for NextGen, including the 2012 NextGen Implementation Plan and work plans for individual lines of business within FAA, as well as FAA reports and briefings related to ongoing NextGen efforts, including the Optimization of Airspace and Procedures in the Metroplex (OAPM) initiative, and FAA process and procedure documentation. We also interviewed aviation stakeholders and experts with knowledge and experience related to NextGen implementation:

- representatives from industry associations, including RTCA, Airlines for America, and the Airports Council International–North America;
- airlines, including Alaska Airlines and Southwest Airlines, which have both advocated for the increased use of Performance Based Navigation (PBN) procedures;
- airports involved in OAPM efforts in North Texas and Southern California, in the Greener Skies over Seattle (Greener Skies) initiative, and in surface improvement efforts for airports in New York and New Jersey;
- avionics and aircraft manufacturers and other aviation vendors, including Boeing, Honeywell, and Raytheon; and
- air traffic controllers with the National Air Traffic Controllers Association (NATCA) and at individual air-traffic control facilities, including facilities involved in the OAPM effort in North Texas and the Greener Skies initiative.

To assess the status of FAA's implementation of key operational improvements and the potential benefits to be achieved, and identify challenges to the full implementation of those key operational

improvements, we assessed FAA implementation progress for operational improvements that were recommended by RTCA's Midterm Implementation Task Force (RTCA task force) in 2009 and those that were prioritized by the Integrated Working Capabilities Work Group of the NextGen Advisory Council (NAC work group) in 2012.¹ (See table 1.) RTCA's recommendations are the basis for a number of FAA's policy, program, and regulatory decisions, and have been incorporated into FAA's current NextGen implementation plans.² Likewise, the NAC—which includes representatives from industry and FAA's senior leadership—advises FAA on the implementation of NextGen. The recommendations made by the RTCA task force and NAC work group represent consensus views in the aviation community regarding which operational improvements FAA should prioritize and where those improvements should be implemented in the midterm—through 2018—but do not include all operational improvements in FAA's implementation plans. They are limited to those improvements that use existing technologies. We grouped these operational improvements into three key improvement areas for midterm NextGen implementation:³

1. Performance Based Navigation (PBN),
2. enhanced airborne and surface traffic management, and
3. additional or revised aviation safety standards.

Table 1 provides a listing of the operational improvements recommended by the RTCA task force and NAC work group. Operational improvements are grouped by the implementation portfolios used by FAA in its planning documents.

¹See RTCA, *NextGen Mid-Term Implementation Task Force Report* (Sept. 9, 2009) and RTCA, *Applying the Metroplex Prioritization Criteria and Mapping to the Integrated Capabilities to Identified Metroplexes* (Feb. 2012).

²Organized in 1935, RTCA is a private, not-for-profit corporation that develops consensus-based recommendations for communications, navigation, surveillance, and air traffic management system issues.

³We did not include improvements that are unlikely to be fully implemented in the midterm in our review, including automatic dependent surveillance-broadcast out (ADS-B Out), which will be required by FAA for some operations beginning in 2020. We also excluded Data Communications (Data Comm), which was in trials during our review.

Table 1: Prioritized NextGen Operational Improvements

FAA implementation portfolio	Operational improvements
Improved Surface Operations	<ul style="list-style-type: none"> Improved Runway Safety Situational Awareness for Controllers (ASDE-X and ASSC) Initial Surface Traffic Management (departure routing, external data exchange)
Time-Based Flow Management	<ul style="list-style-type: none"> Point-in-Space Metering (extended metering; arrival interval management using ground automation or flight deck capability) Time-Based Metering Using Area Navigation (RNAV) and Required Navigation Performance (RNP) Route Assignments Improved Management of Arrival/Surface/Departure Flow Operations (IDAC) Current Tactical Management of Flow in the En Route for Arrivals/Departures (TMA capability at additional locations/airports) Integrated Arrival/Departure Airspace Management
Improved Multiple Runway Operations	<ul style="list-style-type: none"> Improved Parallel Runway Operations (wake management; separation standards (inc. CSPO); SATNAV or ILS for parallel operations.)
Improved Approaches and Low-Visibility Operations	<ul style="list-style-type: none"> Use Optimized Profile Descent (OPD) Expanded Low-Visibility Operations Using Lower RVR Minima
Performance-Based Navigation	<ul style="list-style-type: none"> RNAV SIDs, STARs, and Approaches Increase Capacity and Efficiency Using RNAV and RNP (OAPM and legacy projects; PBN routing for cruise; PBN route eligibility check)
Collaborative Air Traffic Management (CATM)	<ul style="list-style-type: none"> Traffic Management Initiatives with Flight-Specific Trajectories (rerouting; rerouting information to controllers) Provide Full Flight Plan Constraint Evaluation with Feedback (electronic negotiations)
Separation Management	<ul style="list-style-type: none"> Automation Support for Separation Management (ATPA)

Source: GAO analysis of information from FAA, RTCA, and the NAC.

To determine how FAA is addressing known obstacles to the implementation of NextGen operational improvements, we identified obstacles and challenges to developing, implementing, or fully using key NextGen improvements primarily from findings and recommendations made by the RTCA task force and an FAA study on obstacles to PBN

implementation.⁴ To obtain information about FAA efforts to address these obstacles, we reviewed agency reports and documents, including FAA's report on efforts to streamline the process for developing and implementing flight procedures,⁵ and spoke with officials from relevant program offices and facilities, including environmental review specialists and air-traffic control facilities. To assess agency progress toward addressing these obstacles and identify ongoing challenges, we spoke with industry experts and stakeholders, including airport officials, airline representatives, avionics manufacturers, members of the NAC work group and the Performance Based Operations Aviation Rulemaking Committee, and air traffic controllers. We also assessed certain FAA efforts against established criteria, including best practices for stakeholder involvement from the Airport Cooperative Research Program (ACRP)⁶ and for organizational goal-setting and performance measurement.⁷

To determine the extent to which FAA is measuring and demonstrating the benefits of NextGen, we reviewed FAA lines of business documents and analyzed NextGen implementation plans, performance areas, metrics, measures, and program targets. We updated our 2010 findings on the status of FAA's performance system, including setting goals, developing metrics, and measuring NextGen progress.⁸ To understand FAA's approach and progress toward developing NextGen metrics, we interviewed FAA NextGen Office officials that coordinate NextGen initiatives, programs, and policy development across the various FAA lines of business, and staff offices including the NextGen Performance

⁴FAA, *Obstacles to Performance Based Navigation Implementation* (Washington, D.C.: Mar. 1, 2012).

⁵FAA, *Navigation (NAV) Procedures Project Final Report* (Washington, D.C.: Sept. 2010).

⁶See Transportation Research Board of the National Academies, *Airport Cooperative Research Program Report 15, Aircraft Noise: A Toolkit for Managing Community Expectations* (Washington, D.C.: 2009).

⁷See GAO, *Government Reform: Goal-Setting and Performance*, [GAO/AIMD-GGD-95-130R](#) (Washington, D.C.: Mar. 27, 1995).

⁸See GAO, *NextGen Air Transportation System: FAA's Metrics Can Be Used to Report on Status of Individual Programs, but Not of Overall NextGen Implementation or Outcomes*, [GAO-10-629](#) (Washington, D.C.: July 27, 2010). This report assessed FAA's progress in developing performance goals and metrics against criteria established by GAO, *Tax Administration: IRS Needs to Further Refine Its Tax Filing Season Performance Measures*, [GAO-03-143](#) (Washington, D.C.: Nov. 22, 2002).

and Outreach Office. We also interviewed NAC officials. To evaluate the consistency and meaningful output that would be provided by the NextGen key performance areas, metrics, and measures, we compared and analyzed information that was provided in FAA agency-wide reports and metrics documentation, the NextGen Performance Snapshot website, and the FAA reauthorization act.⁹ We reviewed FAA reports, NextGen business case documentation,¹⁰ and the publicly available information on NextGen implementation and expected benefits. We also interviewed industry stakeholders, including representatives from airports, airlines, and equipment manufacturers to assess the extent to which available information builds confidence and buy-in toward full NextGen implementation. Finally, we compared available information with best practices for performance plans.¹¹

We conducted this performance audit from November 2011 through April 2013 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

⁹Pub. L. No. 112-95, § 214, 126 Stat. 50 (2012).

¹⁰RTCA, *NextGen Equipage: User Business Case Gaps, A Report of the NextGen Advisory Committee in Response to Tasking from the Federal Aviation Administration* (Sept. 2011) and FAA, *The Business Case for the Next Generation Air Transportation System* (Washington, D.C.: Aug. 2012).

¹¹GAO, *The Results Act: An Evaluator's Guide to Assessing Agency Annual Performance Plans*, [GAO/GGD-10.1.20](#) (Washington, D.C.: Apr. 1, 1998).

Appendix II: FAA Performance Areas and Metrics

The following table provides the description of FAA performance areas and metrics. Although some of the performance metrics contained in this table have been established, FAA may continue to refine these metrics to ensure that the measurements align with agency targets and goals. FAA also has a few new metrics under development, and the agency is working to identify a technically feasible way to implement them.

Table 2: FAA NextGen Performance Areas and Metrics

Performance area	Performance metrics	Description of the measures
Environment	Noise Exposure Renewable Jet Fuel NAS-Wide Energy Efficiency Emissions Exposure (e.g., carbon dioxide)	The types of measures include the number of people exposed to significant noise (DNL 65 decibels), the amount of carbon dioxide and other emissions, and the amount of fuel usage across the NAS.
Safety	Commercial Air Carrier Fatality Rate General Aviation Fatal Accident Rate System Risk Event Rate (SRER) Runway Incursions Rate (A&B) Hazard Risk Mitigations Commercial Space Launch Incidents World-wide Fatal Aviation Accident Rate	The types of measures include the rate of accidents and fatalities, losses of standard separation, rate of runway incursions, and the number of aviation fatalities worldwide and within the NAS.
Efficiency	Taxi-In Time Taxi-Out Time Average Gate Arrival Delay Average Gate-to-Gate Times Distance at Level Flight from Top of Descent to Runway Threshold Flown versus Filed Flight Times for Key City Pairs Average Distance Flown between Key City Pairs Number of Arrival and Departure Delays Number of Operations NAS On-Time Arrivals	The types of measures include the average difference between the actual gate out and wheels off times, the distance flown while maintaining a level altitude from when an aircraft begins its descent until it reaches the runway threshold, average distance flown between city pairs, number of departure and arrival operations, and percentage of on-time arrivals at airports across the NAS.
Capacity	Average Daily Capacity for All Hours Average Daily Capacity for Reportable Hours Actual Rates versus Published Rates Runway Pavement Condition Adjusted Operational Availability	The types of measures include the average daily capacity of airports, actual number of arrival and departures compared to published rates, the condition of paved runways included in the National Plan of Integrated Airport Systems, and the availability of facilities and services at core airports.
Cost effectiveness	The Administration's unit cost of providing air-traffic control services	The unit cost for providing air-traffic control services per operation in the NAS.

Source: GAO analysis of FAA Data.

Notes: The performance areas were developed by ICAO and adopted by the FAA. Their associated metrics were evaluated and approved under an agency-wide harmonization effort in December 2012. This table does not include all 7 NextGen performance areas nor all the established and preliminary

Appendix II: FAA Performance Areas and Metrics

metrics that were either adopted or under development by FAA. Some NextGen performance area and metric information that is on the NextGen Performance Snapshot website is not included in this table.

Appendix III: GAO Contact and Staff Acknowledgments

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Staff Acknowledgments

In addition to the individual named above, Ed Laughlin, Assistant Director; Russ Burnett; Jessica Bryant-Bertail; Aisha Cabrer; Tim Guinane; Bert Japikse; Delwen Jones; Molly Laster; and Josh Ormond made key contributions to this report.

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