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November 22, 2010

The Honorable John L. Mica  
Ranking Member  
Committee on Transportation and Infrastructure  
House of Representatives

The Honorable Thomas E. Petri  
Ranking Member  
Subcommittee on Aviation  
Committee on Transportation and Infrastructure  
House of Representatives

*Subject: Integration of Current Implementation Efforts with Long-term Planning for the Next Generation Air Transportation System*

The Federal Aviation Administration (FAA) is the lead implementer and planner for the Next Generation Air Transportation System (NextGen)—an ambitious, multiyear, multibillion-dollar overhaul of systems, procedures, aircraft performance capabilities, and supporting infrastructure that will create an air transportation system that uses satellite-based surveillance and navigation and network-centric operations.<sup>1</sup> NextGen was designed as an interagency effort to leverage expertise and funding throughout the federal government. The Senior Policy Committee—the overall governing body for NextGen, chaired by the Secretary of Transportation—consists of cabinet-level officials from each of the partner agencies.<sup>2</sup>

The initial planning for NextGen, which began with Vision 100<sup>3</sup> in 2003 and was carried out by the Joint Planning and Development Office (JPDO) within FAA, focused on improvements to the air transportation system that would be implemented through 2025. JPDO produced three key planning documents—a Concept of Operations, a NextGen Enterprise Architecture, and an Integrated Work

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<sup>1</sup>Network-centric operations involve the instant sharing of information and data among users, systems, and networks. These operations use infrastructure and information services to provide the critical exchange of digital information for air-to-air and air-to-ground applications as well as applications involving satellite-based information sources.

<sup>2</sup>In addition to FAA, the federal partner agencies are the Departments of Commerce (particularly, its National Oceanic and Atmospheric Administration), Defense, Homeland Security, and Transportation; the National Aeronautics and Space Administration; and the White House Office of Science and Technology Policy.

<sup>3</sup>Pub. L. No. 108-176, Vision 100—Century of Aviation Reauthorization Act (Dec. 12, 2003).

Plan (IWP). Recently, FAA has shifted its focus from the longer term (i.e., beyond 2018) and emphasized improvements that can be implemented in the near term and midterm (2010 through 2018). The shift responds, in part, to concerns expressed by stakeholders and Members of Congress about the lack of progress in FAA's implementation of NextGen, which they view as reminiscent of the schedule delays and other issues that plagued FAA's previous air traffic control modernization efforts. This shift is embodied in FAA's 2010 NextGen Implementation Plan, which responds to priorities put forward by stakeholders for NextGen implementation by the NextGen Mid-Term Implementation Task Force (the Task Force).<sup>4</sup> Members of Congress also have expressed concern that shifting too much focus to the near term may result in FAA's not taking actions that must be taken now to enable capabilities envisioned over the long term.

In April 2010, we testified before the Committee on Transportation and Infrastructure's Subcommittee on Aviation regarding issues related to integrating near-, mid-, and long-term NextGen activities.<sup>5</sup> In July 2010, we reported on NextGen metrics, discussing information related to FAA's goals and milestones for NextGen.<sup>6</sup> This report summarizes and expands on previously reported information, as requested, and addresses (1) the extent to which FAA has clearly identified the NextGen capabilities that it plans to implement in the near, mid, and long term; (2) whether FAA and the Senior Policy Committee have laid out specific performance goals or metrics for delivering NextGen capabilities; and (3) the extent to which FAA has examined long-term NextGen benefits to make a business case for airlines to equip their aircraft with the advanced avionics needed for NextGen operations.

To accomplish our objectives, we drew primarily upon prior reports and testimonies as we have previously described. In those reports and testimonies, we obtained and reviewed information from FAA's NextGen Integration and Implementation Office, Air Traffic Organization, and JPDO about NextGen plans that describe the capabilities that FAA is pursuing as well as reports used to justify NextGen programs before investment decisions are made, and that describe the metrics FAA uses to monitor program implementation and performance. In addition, we reviewed FAA performance reports and other documents that describe FAA's broader performance metrics and additional NextGen performance metrics that FAA is considering. We also reviewed FAA's modeling efforts designed to identify long-term NextGen capabilities, costs, and benefits. We interviewed key officials in these offices and organizations, as well as key staff of the Senior Policy Committee, and several key stakeholders for NextGen, including representatives from airlines; equipment

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<sup>4</sup>RTCA, Inc., *NextGen Mid-Term Implementation Task Force Report* (Washington, D.C.: Sept. 9, 2009).

<sup>5</sup>GAO, *Next Generation Air Transportation System: Challenges with Partner Agency and FAA Coordination Continue, and Efforts to Integrate Near-, Mid-, and Long-term Activities Are Ongoing*, [GAO-10-649T](#) (Washington, D.C.: Apr. 21, 2010).

<sup>6</sup>GAO, *NextGen Air Transportation System: FAA's Metrics Can Be Used to Report on Status of Individual Programs, but Not of Overall NextGen Implementation of Outcomes*, [GAO-10-629](#) (Washington, D.C.: July 27, 2010).

manufacturers; federal partner agencies' RTCA, Inc.;<sup>7</sup> the MITRE Corporation;<sup>8</sup> and others. We augmented and updated this information through additional interviews with FAA officials, a review of FAA's recent NextGen activities, and consideration of the findings of Transportation's Office of Inspector General recent report on long-term challenges facing FAA.<sup>9</sup>

We conducted work for these previous reports from June 2009 through July 2010 and conducted additional work for this performance audit from July 2010 through November 2010 in accordance with generally accepted government auditing standards. These 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 the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

### **FAA Has Generally Identified Near Term and Midterm Capabilities but Is Still Analyzing Long-term Capabilities and Has Yet to Make Key Decisions**

#### NextGen Capabilities Planned through 2018 Reflect Industry and Other Stakeholder Recommendations, but Some Gaps Remain

FAA has generally identified the NextGen capabilities that it plans to implement in the near term to midterm, through 2018. These capabilities are laid out in the 2010 NextGen Implementation Plan, which feeds into FAA's overall national airspace system Enterprise Architecture, which, in turn, is aligned with JPDO's NextGen Enterprise Architecture.<sup>10</sup> Supporting the NextGen Implementation Plan are two more detailed plans—Segment A, which defines detailed activities through 2015, and Segment B, which defines NextGen capabilities through 2018. These two plans detail the specific actions that must take place to implement the identified capabilities. According to FAA, Segment A has been developed, while Segment B is expected to be completed over the next 12 to 18 months. These plans are not made publicly available, but FAA plans to include a description of Segment A in its 2011 NextGen Implementation Plan.

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<sup>7</sup>RTCA is a private, not-for-profit corporation that develops consensus-based recommendations on communications, navigation, surveillance, and air traffic management system issues.

<sup>8</sup>MITRE is a not-for-profit organization chartered to work in the public interest. It manages four Federally Funded Research and Development Centers, including one for FAA. MITRE has its own independent research and development program that explores new technologies and new uses of technologies to solve problems in the near term and in the future.

<sup>9</sup>Department of Transportation, Office of Inspector General, *Timely Actions Needed to Advance the Next Generation Air Transportation System*, Report Number AV-2010-068 (Washington, D.C.: June 16, 2010).

<sup>10</sup>Enterprise architecture—similar to blueprints for a building—provides the structure to relate an organization's mission, vision, and goals to its business processes and the technical infrastructure required to execute them.

In addition, these two plans reflect FAA's responses to recommendations from industry and other stakeholders, developed by the Task Force, which was formed at the request of FAA and included representation from the four major aviation operating communities—airlines, business aviation, general aviation, and the military—as well as participation from air traffic controllers, airports, avionics and aircraft manufacturers, and other key stakeholders. Thus, the Task Force's recommendations represent a consensus view from industry on how to move forward with NextGen. The Task Force recommended that FAA implement those capabilities that the industry identified as maximizing benefits and facilitating a business case for industry investment across five key areas—surface operations, runway access, congestion relief in metropolitan areas, cruise operations, and access to certain airspace—and two crosscutting areas—data communication applications and integrated air traffic management. In developing the 2010 NextGen Implementation Plan and its supporting documents, FAA has continued to work with the Task Force to further refine the recommended actions and priorities.

While FAA has taken a number of actions to respond to the Task Force recommendations and integrate those recommendations in its plans, some gaps remain in FAA's response. In an August 2010 meeting of the Air Traffic Management Advisory Committee, the Chairman recommended that FAA address remaining gaps between the Task Force recommendations and the responses reflected in the NextGen Implementation Plan and publish an updated plan or a document that will detail the changes FAA will make to its plans to address these gaps. FAA directed RTCA to create a new advisory committee for NextGen—the NextGen Advisory Committee—that includes senior industry participants. This committee has been tasked to follow up on this recommendation and be a mechanism for collaboration between FAA, industry, and other stakeholders. More recently, at an October 2010 meeting of the Air Traffic Management Advisory Committee, FAA presented responses indicating steps it will take to address the remaining gaps and reiterated that its responses and actions will be integrated into the 2011 NextGen Implementation Plan.

#### Plans for Longer-term Capabilities Will Continue to Evolve in Response to Cost Considerations and Technology Development

JPDO's Concept of Operations, NextGen Enterprise Architecture, and IWP identify all of the NextGen capabilities envisioned through 2025 and continue to be the key documents that identify long-term capabilities. However, these documents not only identify specific capabilities that FAA plans to pursue, but also contain a wide variety of possible ideas and approaches. Therefore, they are not static documents and will continue to evolve. A recent analysis, commissioned by JPDO, sought to examine the costs, risks, and benefits of the IWP and modeled a variety of scenarios that assumed different levels of ground capability and aircraft capability over the long term. According to this analysis, implementing the highest performance levels envisioned in the IWP for ground and aircraft capabilities by 2025 could increase NextGen's costs significantly beyond the initial cost estimate of \$40 billion (e.g., in some scenarios that require every aircraft to be equipped with extensive avionics in a shorter time frame, estimated costs can go as high as \$160 billion). If the highest performance

levels are implemented over a longer period, by 2035, the cost estimates would be lower, but still would be considerably higher than \$40 billion. This analysis also shows a subset of scenarios within the IWP, developed assuming lower levels of ground and aircraft capabilities, whose cost estimate remains in the \$40 billion range. This analysis continues to be updated and revised, and other possible scenarios will be evaluated. In addition, estimates of long-term benefits associated with various NextGen alternatives continue to be modeled and analyzed. The newly appointed JPDO Director has committed to reexamining the long-term goals of NextGen in light of new realities in the economy and the aviation industry as well as the progress and results of NextGen implementation efforts to date.<sup>11</sup> Furthermore, later this year, FAA will be reporting on additional scenarios through 2025. This analysis looks at examining alternative portfolios of NextGen capabilities that would extend the evolution of NextGen beyond 2018.

Achieving the long-term capabilities envisioned for NextGen will require research and development by FAA, its partner agencies, and the private sector as well as effective transfer of the technology that is ultimately developed. We have previously reported on research gaps,<sup>12</sup> and Transportation's Inspector General recently reported that significant research and development issues remain unresolved, including (1) synchronizing weather-related applications among JPDO, FAA, and Commerce's National Oceanic and Atmospheric Administration; (2) coordinating joint surveillance requirements with Defense and Homeland Security; (3) developing a cross-agency plan for research on the human factors' impact of NextGen on controllers and pilots; and (4) developing cross-agency requirements, standards, procedures, and avionics for introducing unmanned aircraft systems into the NextGen environment. At your request, we have begun additional work on FAA's mechanisms and processes for technology transfer.

### Implementation of Capabilities at All Stages Depends on Decisions That FAA Has Yet to Make

We recently reported that FAA has yet to make many key decisions required to shape and determine the future direction of NextGen.<sup>13</sup> We identified key decisions, such as how to provide incentives for operators to install avionics equipment on their aircraft where a clear business case is not evident, how environmental reviews can be expedited, and how much additional airport capacity will be needed. Absent decisions in these key areas, it is unclear how or whether FAA can achieve its plans

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<sup>11</sup>In addition, the Secretary of Transportation has recently convened the Future of Aviation Advisory Committee, which, according to Transportation's Web site will "provide information, advice, and recommendations to the Secretary on ensuring the competitiveness of the U.S. aviation industry and its capability to address the evolving transportation needs, challenges, and opportunities of the global economy."

<sup>12</sup>GAO, *Next Generation Air Transportation System: Status of Systems Acquisition and the Transition to the Next Generation Air Transportation System*, GAO-08-1078 (Washington, D.C.: Sept. 11, 2008).

<sup>13</sup>GAO-10-649T.

for implementing NextGen capabilities. For example, without a clear strategy and decisions about how best-equipped, best-served air traffic management policies will work in practice;<sup>14</sup> or what financial incentives for equipage, if any, will be offered, it is not clear when or to what extent aircraft operating in the national airspace system will be equipped to take advantage of capabilities being implemented on the ground.

Transportation's Inspector General recently identified additional key decisions that will affect the long-term direction of NextGen. Such decisions include the division of responsibility between pilots in the cockpit and controllers on the ground, the level of automation and degree of human involvement in future air traffic control procedures, and the scope of facilities consolidation that FAA may pursue. According to FAA, the agency's NextGen planning through 2018 has maintained the role of the human as the ultimate decision maker, and FAA does not anticipate the roles of pilots and controllers to fundamentally shift or be fully automated. Any other shift in automation or roles between controllers and pilots is subject to long-term research, and decisions about the level of automation could result in changes to research and development efforts currently under way. However, according to FAA, such shifts are currently not anticipated.

### **FAA and the Senior Policy Committee Have Not Established Performance Goals and Metrics for NextGen**

While FAA has identified capabilities, modeled potential benefits from those capabilities, and identified broad performance areas for NextGen, the agency has yet to identify clear goals for the performance of these capabilities or to settle on a set of metrics for measuring their performance relative to any goals. For example, NextGen capabilities are expected to improve performance in a number of areas, such as increasing capacity to accommodate future demand, reducing delay, and improving environmental performance. FAA has modeled the potential benefits in these areas from implementing capabilities identified in the NextGen Implementation Plan through 2018 and has estimated that—under certain assumptions—implementing these capabilities will reduce delays by about 21 percent, compared with doing nothing (although the model estimates that the average delay will nonetheless be greater than it is today), and save more than 1.4 billion gallons of fuel. However, FAA has not established these outcomes as goals for NextGen or identified how implementing NextGen capabilities will help lead to their achievement. In addition, the Senior Policy Committee, which is the overarching governing body for NextGen, has not established any specific milestones for delivering NextGen capabilities, nor has it set specific NextGen implementation goals or metrics for FAA or any of its other federal partner agency members. According to the Senior Policy Committee's

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<sup>14</sup>Best-equipped, best-served policies are those in which higher levels of service, or priority service, is provided to those aircraft equipped with the necessary avionics. One example of a best-equipped, best-served concept would be for airplanes equipped with the necessary avionics to be able to accept clearances and changed flight plans automatically, which would provide an efficiency benefit to the equipped airplane, reduce controller workload, and save the system money. However, several practical considerations will need to be worked through for this to take place. For example, controllers will need to have a clear method for determining which aircraft they are currently controlling actually have the requisite equipment to receive the automatic clearances.

liaison, now the new Director of JPDO, the Senior Policy Committee is working to set high-level goals and milestones, but no clear progress has been made to date.

Without goals and metrics, FAA could pursue and implement capabilities that fail to produce the desired results. Currently, for example, FAA lacks goals and metrics for its development of performance-based navigational routes<sup>15</sup> that focus on reducing delays and saving fuel, and stakeholders have complained that these routes provide relatively little benefit to aircraft operators. Instead, FAA measures its performance in this area by counting the number of procedures that it develops each year. Stakeholders argue that this performance measure has created an incentive for FAA to focus on procedures that are easier and quicker to develop than other procedures that might have greater benefits. If, by contrast, the agency measured its performance by the reductions in flying times and fuel use that operators derived from using the procedures, then the agency would have an incentive to focus on developing procedures with those types of benefits.

We recently recommended to FAA that it work with industry and other stakeholders to develop outcome-based performance metrics and goals for NextGen broadly and for specific NextGen portfolios, programs, and capabilities and share them with the Congress.<sup>16</sup> We recommended that FAA develop a timeline and action plan to agree with stakeholders on a list of specific goals and outcome-based performance metrics for NextGen. The Task Force also made related recommendations for the development of performance metrics and made recommendations specific to FAA's approach to developing performance-based navigational procedures. FAA has recently taken several actions that begin to respond to these recommendations and areas of concern. For example, in response to the Task Force, FAA is creating teams that will include FAA and industry to evaluate performance-based navigation procedures at individual airports. FAA has created two such prototype teams in Dallas and Washington, D.C. In addition, the new NextGen Advisory Committee has been tasked with collaborating with FAA on establishing high-level performance measures for NextGen.

### **FAA Has Yet to Fully Assess Long-term Benefits to Support a Business Case for Airlines to Equip Their Aircraft with Advanced Avionics**

FAA has yet to fully assess long-term benefits to help make a business case for aircraft operators to equip with advanced avionics. Nonetheless, each of FAA's NextGen acquisitions, as a matter of course, is approved by the Joint Resources

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<sup>15</sup>Performance-based navigation includes such things as Area Navigation (RNAV), which enables aircraft to fly on any path within coverage of ground- or space-based navigation aids, permitting more access and flexibility for point-to-point operations; and Required Navigation Performance (RNP), which, like RNAV, enables aircraft to fly on any path within coverage of ground- or space-based navigation aids, but also includes an onboard performance-monitoring capability. RNP also enables closer en route spacing without intervention by air traffic control and permits more precise and consistent arrivals and departures.

<sup>16</sup>[GAO-10-629](#).

Council, and justified to the council on the basis of an assessment of all of the direct costs and benefits that can reasonably be estimated to flow from the investment, both to FAA and to operators.<sup>17</sup> For example, the justification for the ADS-B<sup>18</sup> acquisition program assessed the benefits to FAA from improving the efficiency of its operations and reducing its radar maintenance costs and the benefits to aircraft operators, such as reduced waiting times, flight times, and fuel use. While FAA did develop estimates of operators' costs to equip aircraft, determining the costs for any particular operator relative to the benefits that operator would receive (i.e., whether there is a business case for any single operator to invest in the avionics needed) was not an explicit part of FAA's investment decision-making process. It is important to note that given the competitive nature of the airline industry, it would not be appropriate for FAA to consider the circumstances of individual operators in making decisions about improvements to the national airspace system.

In terms of supporting a business case for operators to equip with the necessary avionics, FAA has yet to develop a strategy to address this issue. Two key decisions are whether all scheduled aircraft need to be equipped at all locations and when aircraft should be equipped with various technologies. In addition, although FAA has established a working group to explore best-equipped, best-served focus areas, it has yet to make any specific decisions about how it will put its best-equipped, best-served policy into practice. In our past work, we have emphasized that FAA must align aircraft-equipping rules and incentives in a way that minimizes the government's costs and maximizes the overall benefits of NextGen.<sup>19</sup> We also have previously reported that, in some cases, the federal government may deem financial or other incentives desirable to speed the deployment of new equipment, and that the decision to offer incentives will depend on the technology and its potential to provide an adequate and timely return on public and private investment. In particular, FAA must focus on delivering near-term operational benefits to users of the airspace by completing activities that will capitalize on users' past investment in aircraft avionics. Efforts to develop more-efficient procedures, redesign airspace, develop performance standards, and reduce aircraft separation standards will help build trust and confidence in FAA's ability to deliver benefits to users and provide incentives for users, especially commercial airlines, to invest in additional equipment for their aircraft.

As we have previously discussed, FAA and JPDO are currently modeling the costs and benefits associated with various future equipage levels, types of equipage

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<sup>17</sup>Within FAA, the Joint Resources Council is an executive body consisting of associate and assistant administrators, acquisition executives, the chief financial officer, the chief information officer, and legal counsel. The council makes agency-level decisions, including those that determine whether an acquisition meets a mission need and should proceed. The council also approves changes to a program's baseline, budget submissions, and the national airspace system's architecture baseline.

<sup>18</sup>Automatic Dependent Surveillance Broadcast is a satellite-based information broadcasting system that is designed, along with GPS-based navigation technologies, to enable more precise control of aircraft during en route flight, approach, and descent.

<sup>19</sup>[GAO-10-649T](#).



capabilities, and levels of ground capabilities implemented. This work will provide important information to stakeholders and decision makers about the benefits that can be achieved at various equipage levels and can help inform a strategy for achieving a desired level of equipage. This work is still in the preliminary stage.


### **Agency Comments**

We provided a draft of this report to FAA for review and comment. FAA provided technical corrections, which were incorporated into the report.

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As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 10 days from the report date. At that time, we will send copies to the appropriate congressional committees, the Secretary of Transportation, and other interested parties. In addition, the report will be available at no charge on GAO's Web site at <http://www.gao.gov>.

If you or your staffs have any questions about this report, please contact me at (202) 512-2834 or [dillingham@gao.gov](mailto:dillingham@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 include Andrew Von Ah (Assistant Director), Kevin Egan, Bert Japikse, Brandon Haller, and Dominic Nadarski.



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