U.S. Department of Transportation
Office of the Secretary
of Transportation

The Inspector General

Office of Inspector General
Washington, D.C. 20590

September 30, 2016

The Honorable Bill Shuster
Chairman, Committee on Transportation
  and Infrastructure
United States House of Representatives
Washington, DC 20515

Dear Chairman Shuster:

Thank you for your letter of July 11, 2016, requesting responses to three key questions to help guide the Committee's oversight of the Federal Aviation Administration's (FAA) efforts to implement the Next Generation Air Transportation System (NextGen). Specifically, you asked (1) the amount FAA has invested in NextGen since fiscal year 2003, (2) the date when NextGen will be completed, and (3) the amount of additional funding that will be required to complete NextGen as compared to initial estimates. We have researched your questions and have provided our responses as follows.

Congress Has Provided Over $7 Billion to FAA Through Fiscal Year 2016 To Invest in NextGen

Since fiscal year 2003, Congress has provided about $7.4 billion to FAA to invest in various NextGen programs (see table).[1] FAA has funded NextGen in all of its major accounts, except for the airport account. These include the Facilities and Equipment (F&E) account, commonly referred to as the capital account, the Research, Engineering, and Development (RE&D) account, and the Operations account. Much of the cost from fiscal years 2004 through 2006 focused on the Joint Planning and

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[1] Investments represent amounts provided by Congress each fiscal year. For the capital account, FAA has 3 years to obligate the funds; thus, a portion of the $7.4 billion funds provided has not been obligated. Fiscal year 2008 was the first year FAA formally requested funds for NextGen. However, some programs, such as the Automatic Dependent Surveillance-Broadcast, received funds before officially becoming a NextGen program.

Development Office (JPDO), created in 2003 to develop plans for implementing NextGen by 2025.[2]

Table. FAA NextGen Funding for Fiscal Years 2003 Through 2016

Type of Major Account	Amount (in thousands)	F&E Program Category	Amount (in thousands)
Facilities & Equipment (F&E)	$6,686,259	Transformational Programs	$4,039,133
Research, Engineering & Development (RE&D)	$552,816	Solution Set/Portfolios*	$1,718,775
Operations	$128,893	Other Programs**	$928,351
Total	**$7,367,968**	**Total**	**$6,686,259**

* Prior to fiscal year 2015, FAA referred to this program category as NextGen solution sets. In fiscal year 2015, FAA began referring to them as portfolios.
**Examples of other programs include time-based flow management and NextGen infrastructure development.
Source: OIG analyses of FAA financial data

As shown in the table, FAA has funded the majority of its NextGen efforts ($6.7 billion) in its capital account. The capital account includes funding for NextGen transformational programs ($4.0 billion), such as the Automatic Dependent Surveillance-Broadcast (ADS-B)—a program expected to allow FAA to transition from ground-based radar to a satellite-based system for managing air traffic—and Data Communications (DataComm)—a program that will allow controllers to send digital messages to pilots.[3] Congress has also provided FAA with $1.7 billion to fund developmental efforts through solution sets and portfolios, such as trajectory based operations.[4] We are currently assessing how FAA has spent these developmental funds and what outcomes have been achieved.[5]

FAA has additional programs that are key to advancing NextGen goals and are often cited in Agency NextGen progress reports. While modernizing systems would have been necessary regardless of NextGen, including them in progress reports makes it unclear which programs are part of NextGen. In particular, FAA cites the En Route Automation Modernization (ERAM) program as critical to NextGen as it will allow controllers to better manage flights from gate to gate. The Terminal Automation Modernization and Replacement (TAMR) is another program considered foundational for NextGen success as it will modernize air traffic systems controllers use to manage

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[2] Funding for the JPDO continued through fiscal year 2013. However, in 2014, Congress, concerned that FAA had not clearly defined the JPDO's role or set expectations for leveraging research at other Federal agencies, eliminated funding for JPDO. For additional details, see our report *FAA Lacks a Clear Process for Identifying and Coordinating NextGen Long-Term Research and Development*, (OIG Report Number AV-2016-094), August 25, 2016. OIG reports are available on our Web site at http://www.oig.dot.gov/.

[3] In addition to ADS-B and DataComm, FAA's transformational programs include System Wide Information Management (SWIM), Common Support Services – Weather (CSS-Wx), NAS Voice System (NVS), and Collaborative Air Traffic Management Technologies (CATM-T).

[4] Trajectory based operations focus on more precisely managing aircraft from departure to arrival with the expected benefits of reduced fuel consumption, lower operating costs, and reduced emissions.

[5] OIG Audit Announcement, "FAA's Management of NextGen Pre-Implementation Funding," June 9, 2015.

traffic near airports. In addition to the programs already explicitly under the NextGen umbrella, to date FAA has spent $2.7 billion on ERAM and $2.6 billion on TAMR and continues to invest in additional enhancements for ERAM to support future capabilities. If ERAM and TAMR are added to the NextGen portfolio, the amount invested would be in the $12 billion range.

NextGen's Completion Date Remains Unclear Due to Shifting Priorities and Undefined Final Requirements for Major System Acquisitions

According to a recent FAA plan for modernizing the National Airspace System (NAS),[6] the Agency is on target to meet its original high-level objectives for NextGen by 2025. However, the plan is a high-level document with broad timeframes and lacks specifics on implementation dates, locations, sequencing, and priorities. Furthermore, determining the actual completion date for NextGen is difficult due to several factors that continue to change, including FAA's vision for NextGen, priorities for long- and near-term capabilities, and final requirements for major NextGen systems.

- **A Changing Vision of NextGen.** As the National Research Council reported last year,[7] NextGen has been redefined, and FAA's original vision will not be fully implemented in the foreseeable future. Instead, the NextGen FAA is working towards today primarily emphasizes replacing and modernizing aging equipment and systems—a shift that is important but not a fundamental change in the way FAA manages air traffic. According to FAA's recent plan, the Agency has deferred six NextGen elements originally envisioned for the midterm to beyond 2030, including "Big Airspace," a concept to improve arrivals and departures in major metropolitan areas by sequencing aircraft further out from the airport and at higher altitudes.[8] As we reported in August 2016, MITRE identified gaps[9] between FAA's plan for NextGen and what can reasonably be accomplished in the shorter timeframe of 2020.[10]

- **Shifting Priorities and Focusing on Near-Term Operational Capabilities.** FAA shifted its NextGen focus to implementing four high-priority capabilities in the near term based on 2013 recommendations from the aviation industry.[11] These include

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[6] The Future of the NAS, June 2016.

[7] National Research Council, *A Review of the Next Generation Air Transportation System. Implications and Importance of System Architecture,* 2015.

[8] The other five areas deferred to beyond 2030 are high altitude exclusionary airspace, future NextGen facilities, dynamic airspace, staffed NextGen towers for large air traffic control towers, and automated conflict resolution.

[9] These gaps include automation for controllers for merging and sequencing aircraft in terminal airspace; use of flight plan information to determine which routes best meet airspace user needs based on aircraft equipment and performance capabilities; and complex, data-linked clearances to enable precise metering and four-dimensional trajectory management in both high altitude and terminal airspace. MITRE Corporation, *NextGen Independent Assessment and Recommendations*, October 2014.

[10] MITRE Corporation, *NextGen Independent Assessment and Recommendations*, October 2014.

[11] NAC, *NextGen Prioritization: A Report of the NextGen Advisory Committee in Response to Tasking from the Federal Aviation Administration*, September 2013.

(1) advancing performance-based navigation (PBN),[12] (2) improving access to closely spaced parallel runways, (3) enhancing airport surface operations, and (4) developing data communications capabilities between the cockpit and air traffic control. FAA has reported progress in all four areas, including implementation of wake recategorization, a capability that allows more aircraft arrivals and departures at airports with closely spaced parallel runways. However, delays continue in all four areas, particularly in implementing new PBN procedures. For example, PBN has been delayed due to community concerns regarding aircraft noise—a high-risk issue due to the public's heightened level of interest at airports implementing similar procedures. Another risk to maximizing the benefits of PBN routes is the lack of enhanced automated controller tools for all phases of flight. Effective risk management is key to ensuring that prioritized capabilities can be implemented in a timely manner. We are currently assessing FAA's process for identifying and mitigating risks to implementing the four prioritized capabilities and plan to issue a report later this year.[13]

- **Undefined Final Requirements for Major NextGen Systems.** FAA continues to face challenges in identifying the requirements and corresponding schedules for new capabilities associated with the six transformational programs. For example, we reported in September 2014[14] on issues with FAA's schedule for ADS-B, and our ongoing work shows FAA's schedule for ADS-B continues to evolve. This is largely due to uncertainties regarding ADS-B *In* capabilities and the display of information in the cockpit, which is the more advanced and most beneficial part of the program. FAA's focus has been on ADS-B *Out*, which airspace users are mandated to equip for by January 2020. However, ADS-B *Out* will provide few benefits to airspace users except in airspace where radar is limited or nonexistent, like the Gulf of Mexico and Alaska. FAA is also considering moving toward space-based ADS-B for use in oceanic airspace,[15] which will introduce additional requirements to the program, particularly for integration with other systems.

Additionally, although FAA's Joint Resource Council approved a final investment decision in September 2014 to fund the NAS Voice System (NVS),[16] it only covers the first segment for the development of the prototype, and FAA has not established when it will fully implement the system. The new voice switch technology is expected to help integrate Unmanned Aircraft Systems (UAS) and enhance resiliency of air traffic facilities in response to events like the 2014 fire at the

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[12] PBN is a blanket term for more precise GPS-based navigation methods that allow optimal routing in all phases of flight.
[13] OIG Audit Announcement, "FAA's Progress With Implementing High-Priority NextGen Capabilities," November 3, 2015.
[14] *ADS-B Benefits Are Limited Due to a Lack of Advanced Capabilities and Delays in User Equipage* (OIG Report Number AV-2014-105), September 11, 2014.
[15] Space-based ADS-B allows air traffic surveillance over oceans, mountains, and remote areas without the limitations of ground-based air traffic surveillance systems such as radar or ground-based ADS-B, which are impeded by terrain or remote locations where installation of ground-based surveillance systems is impractical.
[16] The NVS will replace 11 different types of facilities with a single modern voice switch.

Chicago Air Route Traffic Control Center.[17] However, much work remains to address UAS and NAS resiliency requirements for the new voice switch system. The next segment is scheduled for another final investment decision in fiscal year 2017, which will establish the number and location of systems the Agency will procure, at which point Agency officials told us that the total cost and schedule to fully implement the program may be determined.

The Amount of Additional Funding Needed To Complete NextGen Is Uncertain

FAA originally estimated that NextGen would cost about $40 billion—$20 billion from the Federal government and $20 billion from system users. However, in 2009, a JPDO-commissioned analysis cautioned that the NextGen capabilities planned for 2025 could cost the Government and airspace users significantly more, with costs potentially reaching over $100 billion.[18]

In FAA's July 2016 business case,[19] the Agency projected that NextGen would cost over $35 billion through 2030—$20.6 billion for FAA and $15.1 billion for airspace users.[20] However, our work has shown that there are a number of uncertainties. For example, FAA has not fully identified the total costs or number of segments for the six NextGen transformational programs. Additionally, there are other factors that will materially impact the overall cost of NextGen as well as the near- and long-term modernization and maintenance of the NAS. These include controlling cost growth when acquiring new major systems, identifying and preventing cybersecurity risks, improving NAS resiliency, and integrating UAS.

- **Controlling Costs When Acquiring New Major Systems.** Given the current fiscal environment, FAA may need to make a trade-off among the transformational programs for NextGen and new capital programs that are just beginning. These new programs that will impact FAA's capital account include (1) the Terminal Flight Data Manager, which will, among other things, introduce electronic flight strips at airport towers with an estimated cost of almost $900 million, and (2) the NextGen Surveillance and the Weather Radar Capability and Back-Up Surveillance Capability, which is expected to replace radars that are 20 to 40 years old and incorporate new technology to track UAS. The cost of this effort is unknown but could have significant budgetary implications. FAA is currently evaluating different technologies, including one that is capable of tracking aircraft, as well as small UAS

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[17] On September 26, 2014, an FAA contract employee deliberately started a fire that destroyed critical FAA telecommunications equipment at FAA's Chicago Air Route Traffic Control Center.

[18] JPDO, FY 2009 Portfolio Analysis Report. The study examined the costs, risks, and benefits of the JPDO Integrated Work Plan targeted for 2025.

[19] Update to the Business Case for the Next Generation Air Transportation System Based on the Future of the NAS Report, July 2016.

[20] We have not performed an evaluation of FAA's business case for NextGen.

and weather, with the same accuracy and updated rate as ADS-B, without requiring airspace users to purchase and install new equipment.[21]

- **Identifying and Preventing Cybersecurity Risks.** FAA's air traffic control system has been designated a national critical infrastructure system by the Department of Homeland Security. Currently, over one-third of FAA's air traffic control systems, such as ERAM, rely on Internet Protocol (IP) based networking technologies for communication, making them increasingly vulnerable to cyber-based threats. This transition from a proprietary, relatively isolated air traffic control system to one that uses IP technologies creates ongoing challenges for FAA and its contractors, who own and operate safety-critical systems for FAA, including ADS-B. We have completed audits on information technology security aspects of ADS-B[22] and ERAM[23] and are currently conducting an audit on the security of ERAM.[24] The costs for identifying cyber vulnerabilities, preventing them, and mitigating their effects are uncertain. As we noted in a recent report,[25] there are opportunities for FAA to leverage the Department of Defense's cyber efforts to better secure the NAS.

- **Improving NAS Resiliency.** Unexpected events and emergencies that disrupt air traffic control can have a long-lasting and devastating impact on the Nation's economy, airlines, and passengers. In response to the Chicago Center fire, FAA initiated an evaluation of how planned NextGen capabilities could enhance the resiliency and continuity of NAS operations for all air traffic services. According to FAA officials, the evaluation was expected to support updated contingency and continuity services deployed between now and 2017. However, the evaluation, which was due in March 2016, has not been completed. Moreover, officials in FAA's Temporary Operational Contingency Office stated in June 2016 that they have been unable to set up meetings with the various NextGen program officials to discuss the role of NextGen in mitigating the impact of future Air Traffic Control-Zero events—the inability to provide any air traffic control services to airspace users. FAA officials stated they will continue to work on this effort and will provide another update when notable progress occurs. Until the review is complete, the necessary infrastructure upgrades and the full cost of enhancing resiliency efforts will be difficult to determine.

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[21] Multi-Function Phased Array Radar is a technology that has been used by the Department of Defense since the 1960s. FAA is working with other agencies, including the Department of Defense, on a potentially joint implementation. FAA does not have a current cost estimate, but in 2012 determined it could cost between $6 billion and $15 billion. FAA is currently developing an updated cost estimate that is expected to be completed in a year.

[22] *FAA Is Making Progress in Addressing ADS-B's Security Issues, but Weaknesses Still Exist* (OIG Report Number FI-2015-015), December 10, 2014.

[23] *FAA Has Not Adequately Implemented Security Requirements for Its En Route Automation Modernization System* (OIG Report Number FI-2013-028), December 19, 2012.

[24] OIG Audit Announcement, "FAA's En Route Automation Modernization Program Information Security Controls," April 13, 2016.

[25] *FAA Lacks a Clear Process for Identifying and Coordinating NextGen Long-Term Research and Development*, (OIG Report Number AV-2016-094), August 25, 2016.

- **Integrating Unmanned Aircraft Systems.** As we reported in 2014,[26] FAA has not provided adequate automated tools to controllers for managing UAS traffic, largely because FAA's air traffic control equipment was not developed with UAS operations in mind. For example, ERAM cannot yet adequately manage UAS flight plans because the plans contain an unusually large amount of navigational data. This forces controllers to implement manual and time-consuming "work-arounds" for handing off UAS between facilities and airspace sectors. In response to our recommendation, FAA is assessing the requirements for automated tools to assist air traffic controllers in managing UAS operations in the NAS with a target completion date of September 30, 2017. Additionally, NVS is expected to play a key role in integrating UAS technology, but much work remains to specifically address UAS requirements and the resultant cost implications for the new voice switch system and other air traffic systems.[27]

Further, the costs for airspace users to equip with NextGen technologies also remain uncertain. The two largest and most expensive transformational programs—ADS-B and DataComm—depend on significant stakeholder investments in new or updated avionics. FAA's current $15.1 billion estimate for airspace users does not consider costs to take aircraft out of service or costs for pilot and crew training.

We have several ongoing NextGen reviews, which will include an assessment of FAA's efforts to implement the transformational programs for NextGen[28] and near-term priorities. We will keep the Committee apprised of our results. If you have any questions or need further information, please contact me at (202) 366-1959 or Matthew E. Hampton, Assistant Inspector General for Aviation Audits, at (202) 366-0500.

Sincerely,

Calvin L. Scovel III
Inspector General

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[26] *FAA Faces Significant Barriers To Safely Integrate Unmanned Aircraft Systems Into the National Airspace System* (OIG Report Number, AV-2014-061), June 26, 2014.
[27] Research and Analysis Report: Operational Implications and Proposed Infrastructure Changes for NAS Integration of UAS, September 2014.
[28] OIG Audit Announcement, "Status of NextGen Transformational Programs," September 22, 2014.