U.S. Department of Transportation

The Inspector General

Office of Inspector General
Washington, DC 20590

August 15, 2017

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

The Honorable Frank LoBiondo
Chairman, Subcommittee on Aviation
Committee on Transportation
and Infrastructure
United States House of Representatives
Washington, DC 20515

Dear Chairman Shuster and Chairman LoBiondo:

This letter responds to your March 16, 2017, request that we review the Federal Aviation Administration's (FAA) benefits projection included in its July 2016 Next Generation Air Transportation System (NextGen) Business Case. As you know, NextGen is a multibillion dollar effort aimed at modernizing our National Airspace System (NAS) to provide safer and more efficient air traffic management. In its business case, FAA projected that NextGen will deliver about $161 billion[1] in benefits by 2030, of which the Agency states that $2.7 billion has already been delivered to airspace users and the traveling public.[2]

As agreed with your offices, we are providing information on the: (1) programs FAA included as NextGen programs and whether projected benefits represent a realistic assessment, (2) assumptions behind FAA's benefits calculations, and (3) various groups FAA assumes will benefit and how the benefits are valued. We conducted our work from March to August 2017 by analyzing the business case and supporting documentation, as well as interviewing FAA and industry group representatives. Enclosure 1 to this letter details our scope and methodology, and enclosure 2 includes a glossary of terms used in this letter.

[1] All benefit numbers are in 2015 dollars.
[2] FAA reported in the July 2016 NextGen Business Case that $1.6 billion in benefits had been delivered to airspace users and the traveling public between 2010 and 2014. FAA has updated the benefits delivered to $2.7 billion between 2010 and 2016.

SUMMARY OF RESULTS

FAA's projection of NextGen benefits in its business case is based on numerous NextGen programs and procedural changes, including 64 expected improvements in how air traffic will be managed in the NAS. However, FAA's benefits estimate is overly optimistic given past experience with introducing new capabilities and the use of out-of-date schedules for some key projects. The majority of FAA's estimates are for new capabilities that have not been implemented—yet the Agency's estimate does not take into account many of the challenges in implementing new capabilities at airports and air traffic facilities it has already experienced, such as delays at key sites. While FAA recognizes that its key assumptions are aggressive, the Agency does not provide alternative outcomes or adjust for risks that may impact the delivery of benefits to airspace users. Further, FAA relies heavily on valuing the time saved by passengers (called "passenger value of time") to make a positive business case for NextGen. While passenger value of time is generally accepted and used by the Department of Transportation as a method for calculating benefits, some airline representatives are concerned that FAA's reporting of combined benefits (e.g., passenger time plus fuel savings, etc.) in one, broad category does not give an accurate picture of the benefit for airlines, making it appear that airlines are receiving more substantial benefits than they have achieved to date. As a result of these factors, FAA's business case does not communicate the range of uncertainty or complex factors associated with NextGen implementation to Congress, aviation stakeholders, or the traveling public, which limits the Agency's ability to set realistic expectations for NextGen benefits. FAA is continuing to work with industry to assess potential benefits from NextGen technologies and the steps required to realize them. The Agency also noted, after reviewing our results, that it took a conservative approach for calculating benefits by not including all capabilities in the business case that the Agency expects will provide benefits but have yet to be quantified.

BACKGROUND

FAA's NextGen Business Case is a high-level assessment of the potential benefits of NextGen programs and the anticipated costs to FAA and airspace users. FAA uses its business case to determine whether NextGen programs and projects taken as a whole will provide value to taxpayers and airspace users. Each individual project goes through a separate investment analysis process with a cost-benefit analysis before FAA commits to full-scale implementation. The first NextGen Business Case was published in 2007 by the Joint Planning and Development Office (JPDO),[3] with the most recent and last currently planned one published by FAA in July 2016. FAA's

[3] FAA established the JPDO as mandated by Congress in 2003 to develop a plan for implementing NextGen by 2025. The JPDO was disbanded in 2014. For further details see our report: *FAA Lacks a Clear Process for Identifying and Coordinating NextGen Long-Term Research and Development* (OIG Report No. AV2016094), August 25, 2015. OIG reports are available on our website at http://www.oig.dot.gov/.

July 2016 business case shows benefits starting to accrue in fiscal year 2010 through 2030.

To estimate the benefits of planned NextGen improvements, FAA primarily uses its simulation model—the System Wide Analysis Capability (SWAC). In addition, for operational improvements that FAA does not model, it relies on supplemental benefits estimates from FAA's Program Management Office. FAA also includes the benefits of improvements that have already been implemented mostly using post-implementation operational assessments. FAA then projects future benefits for these improvements and adds that to the overall benefits projection.

FAA's Benefits Estimate Is Overly Optimistic and Is Based, in Part, on Out-of-Date Project Schedules

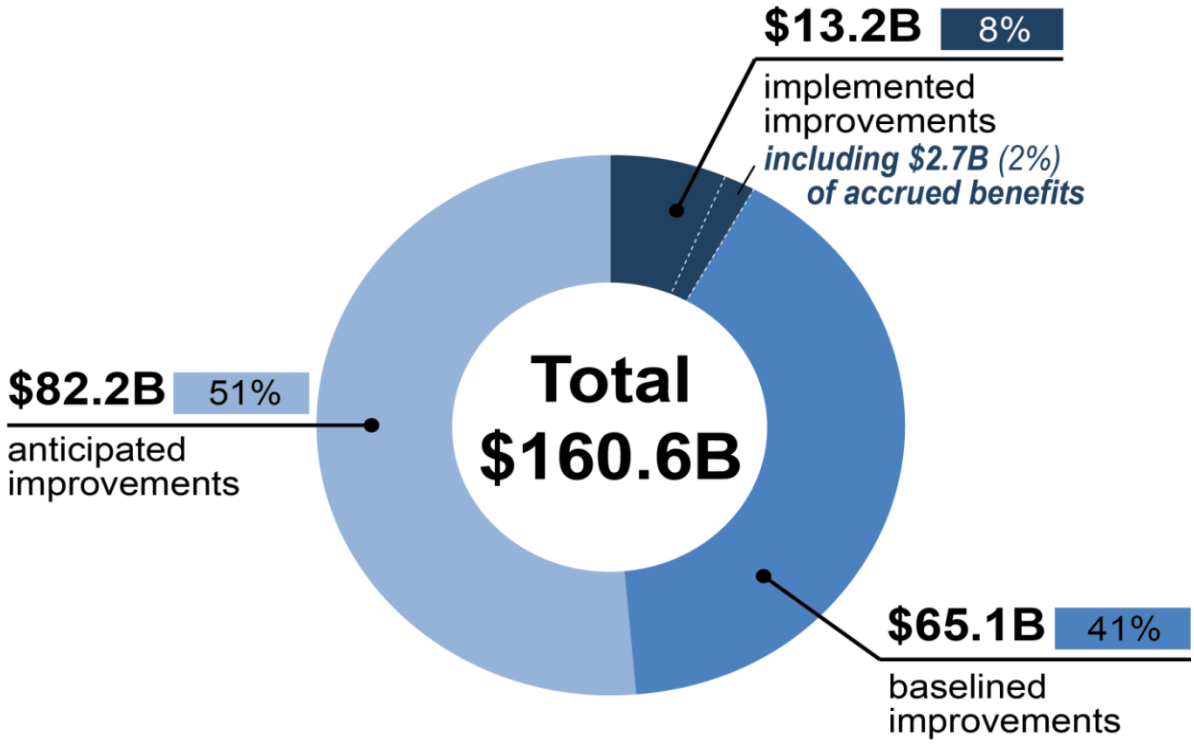
FAA's business case includes 64 operational improvements based on 7 NextGen programs[4] and 4 procedural changes—performance-based navigation (PBN), metroplex airspace redesign, wake recategorization (Wake Recat),[5] and improved multiple runway operations. We found that FAA's benefits estimate is overly optimistic, in part because many of the business case's planned improvements are dependent on key infrastructure programs and related enhancements (e.g., upgraded controller displays) that are ongoing or planned. Thus, a delay in one program could cause a ripple effect in delaying other programs given the interrelated nature of airspace modernization efforts. Such delays will impact the overall benefit estimate because there will be fewer years for the program to generate benefits for airspace users and the traveling public by 2030. Although the business case extends through 2030, FAA states that project delays would only postpone benefits, not eliminate them, because benefits would continue to be realized beyond that date.[6]

FAA develops and presents its benefit projection for NextGen based on three categories of improvements: already implemented, baselined, and anticipated. As shown in figure 1, more than half the projected benefits in FAA's business case are for anticipated improvements from capabilities that FAA has not yet begun to implement. FAA points out that NextGen is focused on improving the infrastructure, and therefore substantial benefits will not occur until the operational system and procedures are implemented. These projections are based on aggressive schedules that may prove challenging to meet based on past experience introducing new capabilities,

[4] These seven programs are: Automatic Dependent Surveillance-Broadcast (ADS-B), Collaborative Air Traffic Management (CATM), Data Communications (DataComm), Time Based Flow Management (TBFM), System Wide Information Management (SWIM), NextGen Weather Processor (NWP), and the Terminal Flight Data Manager (TFDM).
[5] Wake Recat safely reduces the separation between aircraft on arrivals and departures.
[6] Extending the time period will capture more benefits from these programs; however, for each year a program is delayed, there will be reduced benefits because they are discounted as recommended by the Office of Management and Budget.

such as PBN, Time Based Flow Management (TBFM),[7] and Automatic Dependent Surveillance-Broadcast (ADS-B).[8]

Figure 1. Projected Benefits Based on Program Maturity Level, 2010–2030



Source: OIG analysis of FAA data

The following provides further details on the breakdown and our observations on the uncertainty of FAA's projected benefits in each of these categories:

- **Implemented Improvements.** FAA states that NextGen has already delivered $2.7 billion in benefits between fiscal years 2010 and 2016 for implemented improvements, and projects that these benefits will grow to $13.2 billion, or 8 percent of the projected benefits, by 2030. However, a large portion of these benefits assume that air traffic controllers will continue to use new tools for managing traffic, although such techniques have not been consistently applied so far.

  Specifically, FAA's implemented benefits were derived from 13 of the 64 operational improvements based on NextGen programs or procedural changes,

[7] TBFM is an automation decision support tool to help controllers sequence and space aircraft and enable the use of more efficient approach procedures to airport runways.
[8] ADS-B technology uses the satellite-based Global Position System and is intended to allow FAA to transition from ground-based radar to a satellite-based system for improving surveillance and management of air traffic.

such as ADS-B in the Gulf of Mexico and Alaska, Airport Surface Detection Equipment-Model X (ASDE-X), TBFM, and Wake Recat.[9] As shown in the table, the largest amount of delivered benefits, $1 billion (37 percent), is derived from the TBFM portfolio, which represents a significant shift in how air traffic is managed by the controller workforce (from miles-in-trail to time-based, a key tenet of NextGen).

Table. Benefits for Implemented Improvements, 2010–2016

Completed Improvements	Dollar Value of Benefits *(in millions)*	Percentage of Total
ADS-B		
Alaskan Accidents Reduction	$260	10%
Gulf of Mexico Low-Altitude Efficiency	$7	<1%
SURFACE PORTFOLIO		
Airport Surface Detection Equipment, Model X	$81	3%
TBFM PORTFOLIO		
Traffic Management Advisor and Adjacent Center Metering at 8 locations	$1,017	37%
IMPROVED MULTIPLE RUNWAY OPERATIONS PORTFOLIO		
Dependent Approaches at San Francisco	$121	4%
Converging Runway Display Aid at Boston and Newark	$10	<1%
IMPROVED VERTICAL PROFILES AND LOW-VISIBILITY OPERATIONS		
Initial Tailored Arrivals at 3 locations	$5	<1%
Optimized Profile Descents at 12 locations	$9	<1%
Expanded Low Visibility Operations at LaGuardia	$36	1%
PBN PORTFOLIO		
Advanced PBN Approaches	$0.5	<1%
Transition to PBN Routing for Cruise Operations	$413	15%
Equivalent Lateral Spacing Operations Standard at Atlanta	$561	21%
SEPARATION MANAGEMENT		
Wake Recat - Phase 1 at 4 locations	$198	7%
TOTAL	**$2,719**	**100%**

Source: OIG analysis of FAA data

While FAA has made significant progress in implementing TBFM, this combination of technology and procedures has not yet translated into benefits at all sites. For example, FAA reported time reduction for aircraft operations in the

[9] Although included as NextGen benefits, FAA began developing several of these programs and procedural changes before initiating NextGen. Industry officials have expressed concern with including programs like ASDE-X and Wake Recat as NextGen because they pre-dated NextGen.

air and on the ground across eight airports based on observations from 2011 to 2013, including Las Vegas, where the system actually *increased* delays. In addition, controllers have stopped using the system at the airport in Fort Lauderdale because they do not need it, due to increased capacity from the construction of a new runway.[10] Furthermore, past reviews by our office[11] and FAA,[12] which included the same airports[13] over the same time period, found that airborne metering by TBFM, a technique used by controllers to sequence aircraft,[14] was not used consistently by air traffic controllers, raising questions as to whether $1 billion of benefits has actually been realized by the large airlines. These mixed results highlight the complexity of the NextGen effort and the difficulty in realizing benefits in the operational environment. To better quantify benefits achieved from NextGen improvements, FAA and industry are working together through the Joint Analysis Team—a group of operational and analytical experts.

- **Baselined Improvements.** Baselined improvements consist of programs and initiatives whose business plans and funding have been approved by FAA and, generally, were projected for deployment between 2015 and 2020. These estimated benefits represent 41 percent ($65.1 billion) of the total projected benefits from 33 of the 64 improvements. However, given the limited level of deployment, there is a high degree of uncertainty for these improvements, because unexpected delays, technology issues, budget levels, and other implementation risks—many of which FAA has already faced—can affect both the timeline and amount of benefits achieved.

  FAA's benefits estimates for several of these baselined improvements are based on outdated plans for programs that have already experienced implementation challenges. For example, FAA's assumptions regarding milestones for implementing more efficient flight procedures at busy airports are based on an outdated metroplex schedule from 2014, and some setbacks have occurred that have delayed the overall completion of metroplex. Also, each site has taken longer than originally expected—4 to 5 years instead of 2 to 3 years—due to a range of factors, including scheduling slips due to technical issues with the En Route

[10] Fort Lauderdale represents about $173 million of the TBFM benefits.
[11] *FAA Has Not Effectively Deployed Controller Automation Tools That Optimize Benefits of Performance-Based Navigation* (OIG Report No. AV2015081), August 20, 2015.
[12] TBFM Study Report, April 17, 2014.
[13] Airports in the following locations were included in this analysis: Atlanta, Detroit, Fort Lauderdale, Las Vegas, Newark, New York, Philadelphia, and San Francisco
[14] Airborne metering assigns runways, schedules landing times, computes and allocates airborne delays, and shares its schedule and delay information with en route controllers at their workstations.

Automation Modernization[15] (ERAM) system installation, increased community outreach due to environmental concerns, and issues with procedure design.

Also, FAA's model is based on the assumption that a full metroplex implementation will occur at 31 major airports by 2022; however, there are currently only 12 metroplex sites, involving 19 of these airports with only partial schedules.[16] For example, FAA's model assumes that the Chicago metroplex will be completed in 2019, with benefits accruing starting in 2020; however, FAA currently does not have a schedule for implementing a metroplex initiative in Chicago. According to FAA, if there is no schedule, the Agency uses the best information available to predict when implementation will occur.

Furthermore, FAA's benefits projection assumes that all metroplex implementation will occur as it did in Houston, the first completed metroplex site. However, not all metroplex locations have achieved the same level of expected benefits—as illustrated when implemented in Northern California, which actually resulted in negative benefits of $7.7 million annually. According to the analysis, metroplex did not meet expectations due to a number of factors, such as strong winds and changes in fuel price. To date, none of the implemented metroplex sites have achieved the level of benefits originally projected during initial analysis.

In addition, FAA's model assumes an increase in benefits from a new automated controller tool—Terminal Sequencing and Spacing (TSAS)—to help with sequencing and spacing aircraft near airports, thus increasing the use of advanced PBN flight procedures. FAA's model assumes deployment of this tool in 2018 for 31 major airports; however, FAA's current plan only shows implementing it at 9 locations beginning with the first site in 2019 and extending through 2022. It also assumes that improved sequencing and spacing further out from airports using Ground-Based Interval Management-Spacing (GIM-S) will be fully deployed at facilities supporting 35 airports in 2018; however, the program office's current plans are to implement the enhancement at facilities supporting only 21 airports by 2020. As a result, FAA's business case overestimates the projected benefits from these capabilities.

- **Anticipated Improvements.** Of the three improvement categories, over half ($82.2 billion) of the expected benefits are derived from 18 anticipated improvements. Their implementation is expected between 2020 and 2025. However, according to FAA, these improvements are still only in the early stages of development without approved business plans and funding profiles, making them much more uncertain. For example, one of the operational improvements—

[15] ERAM replaced 40-year old air traffic control hardware and software at facilities that manage high-altitude traffic and will improve air traffic controllers' ability to separate traffic and process flight plans.
[16] The 31 major airports do not inlcude all airports in the metroplex program, such as Houston Hobby and Dallas Love Field.

reduced oceanic separation—relies on solutions that have yet to be defined or committed to, such as space-based ADS-B.[17] Several of the anticipated improvements also rely on ADS-B *In*, with the model assuming aircraft equipage will reach 74 percent by 2030, resulting in an increase in capacity in all high-altitude sectors of 10 percent. However, FAA has not yet finalized requirements for the use of ADS-B *In* capabilities.

While FAA Recognizes That Its Key Assumptions Are Aggressive, the Agency Does Not Provide Alternative Outcomes or Adjust for Risk

While FAA has developed a comprehensive model for estimating anticipated NextGen benefits in its business case, some limitations affect the estimate's potential usefulness. The model FAA used for estimating NextGen benefits is a large-scale effort incorporating numerous components. As with all economic models, the usefulness of FAA's estimate depends on the quality of the underlying assumptions and inputs used and how well it assesses the degree of uncertainty for decision makers.[18] According to Office of Management and Budget (OMB) guidance, a model's assumptions should be made explicit and the uncertainty associated with the underlying data and assumptions should be analyzed and reported.[19]

However, FAA's business case does not explicitly state all the underlying data and assumptions used by its model and their corresponding impact on FAA's benefits estimates. Our review determined that several key assumptions drive FAA's business case analyses, including air traffic growth, airline direct operating costs (e.g., fuel prices), value of saved time for passengers, NextGen project schedules, airline equipage rates, weather, airline fleet forecasts, and airport capacity estimates. According to FAA, the airspace, procedure, and equipage assumptions contained in the business case are aggressive, meaning that FAA assumes on time program implementation and airspace user equipage based on very optimistic schedules and that all improvements will perform as intended and deliver optimal benefits. Conversely, FAA also points out that it took a conservative approach by not including all capabilities in the business case that the Agency expects will provide benefits but have yet to be quantified.

While FAA acknowledges the assumptions behind its estimates are aggressive, FAA representatives have not performed systematic sensitivity analysis[20] on the model, as recommended in OMB guidance. Sensitivity analysis would allow FAA to inform decision makers in Congress and Department which assumptions most impact the model's estimates and to what extent. Although FAA did not conduct this testing, based on FAA's experience with the model as well as analyses of airspace user-

[17] Space-based technology is used by air navigation service providers to track aircraft in oceanic airspace and other areas where radar coverage is limited or not available.
[18] Information based on consultation with the Office of Inspector General's Chief Economist and OMB Guidance.
[19] *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs* (OMB Circular A-94).
[20] Sensitivity analysis is the study of the relative importance of different input factors on the model output.

specific benefits that it developed along with a consultant,[21] the model is very sensitive to the timing of NextGen programs and air traffic forecast growth. However, air traffic forecasts are highly uncertain. As cautioned by the Government Accountability Office in 2016, FAA's traffic estimates have been consistently overestimated and were less accurate the farther out they were forecasted.[22] In addition, the projection fluctuates significantly in each published business case, providing further evidence of how sensitive the model is to changes in the various underlying assumptions. For example, the business case benefits estimate increased from about $106 billion in 2012 to $182 billion in 2013 and then dropped back down to $133 billion in 2014.[23]

Despite the fact that the model is sensitive to numerous factors and a high degree of uncertainty surrounds the model's benefits, FAA's business case provides only a single estimate of the benefits, rather than including alternative outcomes, or "what if" scenarios (e.g., if the expected traffic growth does not materialize). Given the variety of techniques used to estimate benefits and the high degree of uncertainty, producing benefits estimates for a range of scenarios would substantially improve the value of information available to decision makers regarding NextGen benefits. While the business case report discusses some of the uncertainties associated with the benefits estimate, providing a single number, as FAA does now, gives the appearance of a high level of certainty and confidence. The estimates are based on every element being on schedule and delivering the most optimistic benefits envisioned. In contrast, in the airspace user-specific analyses that were performed separately from the business case, FAA provided a range of benefits based on alternative assumptions resulting in a low, expected, and high benefit case.

Furthermore, FAA has not adjusted its model for risk as it does for individual program cost-benefit analyses, nor does it consider alternative means of improving operations. For example, the cost-benefit analysis for the TBFM program's individual business case includes risks that may cause delays or performance shortfalls, such as insufficient network bandwidth, integration issues with other air traffic systems, and air traffic controller acceptance of the new system. However, FAA did not incorporate these risks into its overall NextGen business case. In addition, while OMB guidance states that analyses should include alternative means of achieving program objectives, the business case only considers the full NextGen program as described in FAA's recent plan for modernizing the NAS.[24] A more complete business case would include

[21] McKinsey & Company, a management consulting company.
[22] *Aviation Forecasting: FAA Should Implement Additional Risk-Management Practices in Forecasting Aviation Activity* (GAO Report No. GAO-16-210), March 2016.
[23] FAA explained the large jump in benefits in 2013 was due to a significant increase in the per-hour value of passenger time. Changes in the benefit estimate across business cases is also due to changes in program schedules, the improvements included, and adjustments to the model design.
[24] FAA, *The Future of the NAS*, June 2016.

different levels of NextGen implementation or potential alternatives for comparison, as was done by the JPDO in 2009.[25]

The Value of Passenger's Saved Time Plays a Large Role in the NextGen Business Case

FAA's NextGen business case includes estimates of benefits for airspace users (e.g., airlines) and the traveling public. In addition to direct airline operating costs, such as fuel savings, the estimate includes societal benefits to passengers, the environment, and safety. Metrics used to compute these societal benefits include reduced carbon dioxide emissions per flight, saved time for passengers, and reduced injuries and fatalities. In addition, the model includes some FAA cost avoidance benefits.[26]

To calculate the total amount of benefits in dollars, FAA estimates monetary values in the following categories: improvements in system capacity, including reductions in flight, taxi and gate times, and fuel use resulting from reduced delays; reductions in canceled flights; additional scheduled flights that are enabled by increased airport capacity; and improvements through reduction in flight times and fuel use due to more direct and efficient routes.

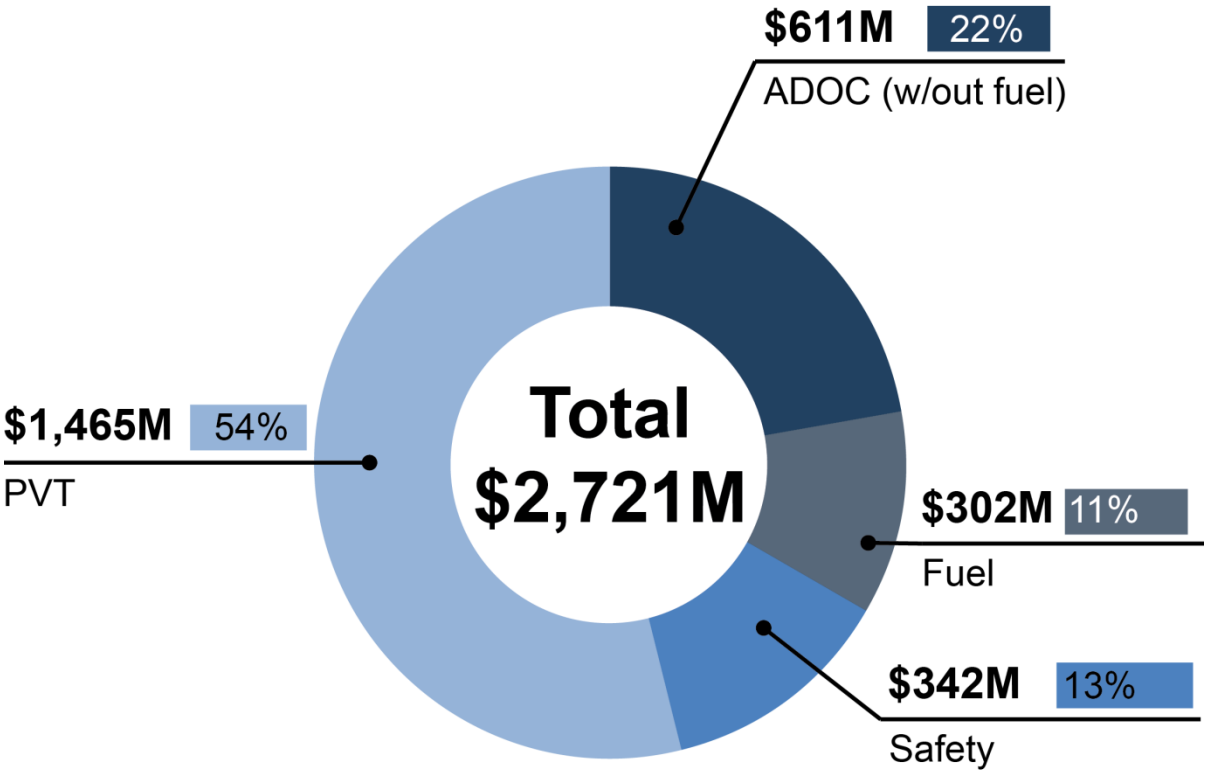
To evaluate the monetary value of changes in flight times, FAA applies its standard method of using two measures: airline direct operating costs (ADOC) and passenger value of time—an economic measure of a passenger's value of the use of their time. This method is applied to any change in flight time—whether due to reductions in delays or improvements in flight efficiency. Based on the latest Department of Transportation guidance, FAA's business case assumes each hour of passengers' time is worth $47.30 in 2015, with a 1.6 percent real growth rate each subsequent year. FAA combines these passenger value of time estimates with the number of passengers to calculate a value of reduced flight time for passengers.

According to FAA's analysis, the largest anticipated benefits for NextGen are derived from reduced delays—specifically, from the value of time passengers save by avoiding delays. Passenger value of time makes up over half of the $2.7 billion in already accrued benefits and two-thirds of the total forecasted $161 billion in benefits (see figure 2). If passenger value of time is removed from the calculation, FAA's projection of the amount of delivered benefits to airlines, business jet, and general aviation operators would be reduced to $914 million.

[25] JPDO, *FY 2009 Portfolio Analysis*. The study examined the costs, risks, and benefits of implementing various levels of NextGen.

[26] The programs are DataComm, SWIM, Aeronautical Information Manual, TFDM, and NWP. For example, TFDM reduces paper and printer costs and system consolidation. However, it does not include any benefits from possible facility consolidation.

Figure 2. Estimated Delivered NextGen Benefits by Type, 2010–2016



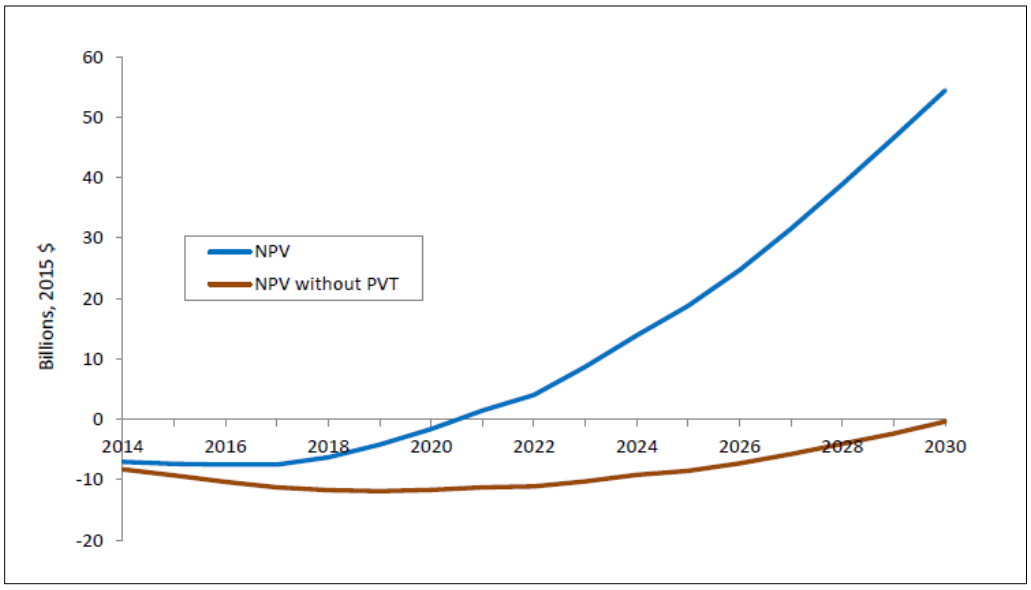
Source: OIG analysis of FAA data

As figure 2 shows, passenger value of time is a critical element of making a positive business case for NextGen. Passenger value of time is generally accepted and is used by the Department of Transportation as a method of calculating benefits. However, some airline representatives have expressed concerns that FAA's reporting of combined benefits (e.g., passenger time plus fuel savings, etc.) in one amount does not give an accurate picture of the benefit amounts for airlines, making it seem like the airlines are receiving more substantial benefits. There are also different methods in how small increments of passenger time are valued. For example, when calculating benefits for operational improvements, Transport Canada does not include increments of less than 5 minutes in its calculations, whereas the NextGen business case captures smaller increments of time savings.

The significant role of passenger value of time in presenting a positive business case for NextGen is further illustrated when considering NextGen's net present value (NPV). NPV is the value of benefits when reduced by a discount rate (to help account for the change in the value of money over time) and then subtracted from the costs. OMB guidance states that NPV is the standard criteria for determining if a program is justified because it puts the benefits and costs into a common value for comparison

purposes. To calculate the NPV, OMB guidance recommends applying an annual 7 percent discount rate to benefits that accrue to the general public and the private sector but to use the current interest rate on U.S. Treasury securities to discount benefits to the Government. FAA uses a conservative approach, discounting all future benefits by 7 percent and then subtracting the costs, which puts the total NPV of NextGen at $54 billion. However, as shown in figure 3, according to FAA's own business case report, the NPV is negative $377 million in 2030 without passenger value of time included.

Figure 3. Net Present Value of Benefits With and Without Passenger Time Savings



Source: FAA's July 2016 NextGen Business Case

According to FAA, both NextGen's benefits as well as its NPV will increase over time. FAA states that because most of the anticipated improvements are scheduled to be implemented in 2022 or later, only a small portion of their expected benefits are included in the business case. FAA states that benefits of NextGen investments, both with and without passenger value of time, are expected to increase after 2030. It should also be noted that while flight delays are predicted to be fewer with NextGen improvements than without them, according to the business case, passengers should still expect to experience more delays by 2030 than they do currently.

Finally, FAA's projected benefits estimates may be impacted by double-counting—i.e., including the same benefits in more than one part of the model. FAA stated that it takes steps to avoid double-counting of benefits and removes NextGen programs that are cancelled or deferred. However, during our review, FAA discovered that double-counting had occurred when FAA added benefits from the program office. Specifically, FAA added benefits of $445 million at nine airports for the TSAS

system, which is an essential part of the TBFM program. However, FAA had already included TSAS in the model; therefore, as much as $445 million was double-counted. During our review, FAA stated that it also found an offsetting error. FAA stated that although advanced and efficient Required Navigation Performance was listed in the business case, FAA did not include benefits in the model. According to FAA's analysis, this would add back in at least $640 million, offsetting the $445 million noted above. Additionally, there are other NextGen programs that FAA has not quantified or included in the business case that Agency officials contend would increase the benefits, such as other PBN flight procedures and improved predictability from other NextGen improvements.

We did not perform a detailed review to identify double-counting, but we noted that there is a risk for double-counting when adding in benefits from different programs that seek to enhance capacity or reduce delays. FAA officials also noted that they could possibly find more if they performed a more detailed review. According to FAA, there is no formal quality control/assurance process or independent third-party review of the model to prevent outdated schedules and double-counting from being included in the business case.

CONCLUSION

FAA is currently not planning to publish another business case unless there is a new concept of operations for NextGen or a major shift in the benefits. However, as we have noted, FAA's model is very sensitive to the timing of NextGen projects and assumptions that drive the model. Some of the underlying assumptions and data were not up-to-date, and it is unclear how benefits will be affected in the event of changes in the forecasted growth in air traffic or of extended delays to key programs. As a result, FAA's business case does not communicate the range of uncertainty or complex factors associated with NextGen implementation to Congress, aviation stakeholders, or the traveling public, which limits the Agency's ability to set realistic expectations for realizing NextGen benefits. FAA is continuing to work with industry to assess potential benefits from NextGen technologies and the steps required to realize them.

We provided FAA representatives with the results of our review and incorporated their comments as necessary. 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

Enclosure 1. Scope and Methodology

We conducted our work from March through August 2017. We met with FAA to obtain informal comments on the results of our review and incorporated feedback as appropriate. We analyzed the July 2016 business case report, met with representatives from FAA's NextGen Systems Analysis and Modeling Division, and obtained business case supporting documents to determine: (1) the programs FAA included as NextGen programs and whether projected benefits represent a realistic assessment, (2) the assumptions behind FAA's benefits calculations, and (3) the various groups FAA assumes will benefit and how the benefits are valued.

We obtained updated information as necessary for areas that have changed since the July 2016 report. For example, FAA is now reporting $2.7 billion of benefits already delivered, up from the $1.6 billion in the report. We also met with MITRE[27] to obtain additional information on inputs to the benefits calculations. MITRE provides FAA key inputs, such as the impact of NextGen program improvements on airport capacity over time.

We identified the NextGen programs that are included in the projection of benefits by reviewing the 2016 NextGen Business Case and meeting with the Office of NextGen. To determine whether it is a realistic assessment, we focused our review on the key NextGen programs or operational improvements that have the greatest impact on the benefits calculations. We compared the program schedules and equipage rates used by the model to plans from program offices.

To assess the underlying assumptions used in FAA's model, we reviewed FAA's compliance with OMB guidance and best practices for assumptions. We also reviewed a prior Government Accountability Office audit report on the Terminal Area Forecast and the Aerospace Forecast. In addition, we determined whether the assumptions and inputs to the model are traceable to criteria, including discount rate for net present value, fuel prices, and cost of carbon dioxide. Further, we assessed whether FAA follows modeling best practices from OMB, such as performing sensitivity analyses to determine how certain assumptions and variables affect the model's benefit estimate and assessing the model's level of uncertainty. Finally, OIG's Chief Economist reviewed the model's methodology and assumptions to determine any weaknesses in the model's design.

We identified the various groups FAA assumes will benefit and the assumptions made concerning how the benefits are valued. We also reviewed the users' business cases developed by an aviation consultant and FAA. Further, we met with representatives from Airlines for America and the National Business Aviation Association to get their

[27] MITRE Corporation manages FAA's federally funded research and development center.

perspectives on the 2016 NextGen Business Case and whether they concur with the projected benefits for their members. We also determined the steps FAA takes to prevent double-counting of benefits, a concern raised by the requestors. Furthermore, we determined whether the model has been reviewed and validated by a third party.

Enclosure 2. Glossary of NextGen-Related Terms

Airport Surface Detection Equipment–Model X (ASDE-X): A ground-based radar and display system to allow air traffic controllers to track surface movement of aircraft and vehicles.

Automatic Dependent Surveillance–Broadcast (ADS-B): ADS-B technology uses the satellite-based Global Position System and is intended to allow FAA to transition from ground-based radar to a satellite-based system for improving surveillance and management of air traffic.

Automatic Dependent Surveillance–Broadcast In Cockpit (ADS-B In): A capability that allows for the display of flight information in the cockpit, such as allowing pilots to "see" other aircraft.

Collaborative Air Traffic Management Technologies (CATM-T): A program intended to allow airlines and FAA traffic managers to manage demand and capacity for airports, including the impacts of bad weather, congestion, and airspace used jointly by civil and the Department of Defense.

Data Communications (DataComm): Expected to provide 2-way digital communications between controllers and flight crews by reducing radio voice communications, improving accuracy, safety, and reducing time.

En Route Automation Modernization (ERAM): ERAM replaced 30-year old air traffic control hardware and software at facilities that manage high-altitude traffic and will improve air traffic controllers' ability to separate traffic and process flight plans.

Ground-based Interval Management-Spacing (GIM-S): A Time Based Flow Management (TBFM) enhancement that includes two separate capabilities that work together to help improve the flow of traffic further away from the airport. GIM-S adds two capabilities to TBFM: (1) Speed Advisory, which provides air traffic controllers a required aircraft speed needed to arrive at a specific location at a scheduled time; (2) Extended Metering, which provides more accurate delay times to controllers. GIM-S was developed primarily to advance ADS-B and achieve benefits for the program.

***Joint Planning and Development Office (JPDO*)**: FAA established the Joint Planning and Development Office as mandated by Congress in 2003 to develop a plan for implementing NextGen by 2025. The JPDO was disbanded in 2014.

Metroplex: An initiative intended to improve the efficiency of airspace that affects multiple airports near large metropolitan areas by implementing high value performance-based navigation (PBN) procedures and airspace changes.

National Airspace System (NAS): The airspace, navigation facilities, and airports of the United States along with their associated information, services, rules, regulations, policies, procedures, personnel, and equipment. It includes components shared jointly with the military.

Net Present Value (NPV): The value of benefits adjusted by a determined discount rate and then subtracted from the costs.

Next Generation Air Transportation System (NextGen): A wide-ranging series of improvements that are intended to transform the air transportation system, encompassing new air traffic management technologies and procedures, airport infrastructure improvements, and environmental and security-related enhancements.

NextGen Weather Processor (NWP): A NextGen weather program that establishes a common weather processing infrastructure.

Performance-based Navigation (PBN): PBN delivers new flight routes that primarily use satellite-based navigation aids and on-board aircraft equipment to navigate with greater precision and accuracy. As such, PBN can provide significant benefits, such as more direct flight paths, improved on-time airport arrival rates, greater fuel savings, and reduced emissions and noise.

Required Navigation Performance (RNP): RNP is a form of PBN that adds onboard monitoring and alerting capabilities for pilots, and is expected to deliver the highest accuracy of navigation, thereby allowing aircraft to fly more precise flight paths.

Space-Based ADS-B: Space-based technology is used by air navigation service providers to track aircraft in oceanic airspace and other areas where radar coverage is limited or not available.

System Wide Analysis Capability (SWAC): A fast-time simulation model that estimates expected operational benefits of NextGen improvements for the NAS.

System Wide Information Management (SWIM): SWIM is expected to enable a more cost-effective, real-time data exchange and sharing among users of the NAS

using a standard message data set and common interfaces to improve information exchange among various systems.

Time Based Flow Management (TBFM): An automation decision support tool to help controllers sequence and space aircraft and enable the use of more efficient approach procedures to airport runways.

Terminal Flight Data Manager (TFDM): A decision support tool for airport surface management, including creating virtual departure queues, data sharing with flight operators, and electronic flight strips.

Terminal Sequencing and Spacing (TSAS): A new tool to help air traffic controllers merge and sequence aircraft in the airspace closest to airports.

Wake Turbulence Recategorization (Wake Recat): Wake Recat safely reduces the separation between aircraft on arrivals and departures.