Office of Inspector General

Audit Report

TOTAL COSTS, SCHEDULES, AND BENEFITS OF FAA'S NEXTGEN TRANSFORMATIONAL PROGRAMS REMAIN UNCERTAIN

Federal Aviation Administration

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Memorandum

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

Subject: **ACTION:** Total Costs, Schedules, and Benefits of FAA's NextGen Transformational Programs Remain Uncertain
Federal Aviation Administration
Report Number AV-2017-009

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Assistant Inspector General
for Aviation Audits

JA-10

To: Federal Aviation Administrator

The Federal Aviation Administration's (FAA) Next Generation Air Transportation System (NextGen) is a multibillion-dollar set of initiatives intended to modernize our Nation's aging air traffic system and provide more efficient air transportation. To meet these goals, FAA identified six "transformational" programs that are expected to provide a platform of capabilities necessary to support NextGen.[1] Specifically, these programs will provide new capabilities such as a precise satellite-based surveillance system and digital data communications for air traffic controllers and pilots.

FAA has invested over $3 billion in these transformational programs since 2007 and has faced challenges in implementing them. In April 2012, we reported[2] that FAA's progress in implementing the transformational programs has been limited by a lack of finalized program requirements and that FAA had not established total program costs, schedules, or performance baselines for any of the six transformational programs.

Given the importance of the transformational programs to NextGen, the Chairman and Ranking Member of the Senate Committee on Commerce, Science, and Transportation requested that we update our April 2012 report. Accordingly, our

[1] These programs are: Automatic Dependent Surveillance - Broadcast (ADS-B), System Wide Information Management (SWIM), Data Communications (DataComm), Common Support Services – Weather (CSS-Wx), NAS Voice System (NVS), and Collaborative Air Traffic Management Technologies (CATM-T).
[2] *Status of Transformational Programs and Risks to Achieve NextGen Goals* (OIG Report No. AV-2012-094), April 23, 2012. OIG reports are available on our Web site at http://www.oig.dot.gov/.

audit objectives were to identify (1) formal changes FAA has made to its programs' scope, including costs and schedules, and (2) adjustments in FAA's anticipated benefits with respect to improving the flow of air traffic and reducing Agency costs.

We conducted this audit in accordance with generally accepted Government auditing standards. Exhibit A details our scope and methodology, and exhibit B lists the organizations we visited or contacted.

RESULTS IN BRIEF

Although FAA has made some formal changes to the cost and schedules of the transformational programs since our 2012 report, total costs and timelines remain unclear. One significant change is that FAA has now approved costs and schedules for initial segments of all six programs. For example, FAA approved funding of almost $2 billion for the two phases of the first segment of DataComm—a program that will allow controllers to send digital messages to pilots—and completed the ground system for the Automatic Dependent Surveillance–Broadcast system (ADS-B),[3] with an approved baseline cost of $2.7 billion through 2020. Cost estimates for the transformational programs as currently defined now total over $5.7 billion and extend beyond 2020. However, FAA has not fully identified the *total* costs, planned segments, their capabilities, or schedules for completing the overall transformation for any of the six programs. Moreover, FAA's progress in implementing the programs continues to be hindered by a lack of finalized requirements, as well as by complex integration issues for programs such as DataComm, which must be integrated with automation systems that controllers rely on to separate aircraft. In addition, FAA expects to make several key investment decisions in the next several years for the transformational programs, including ADS-B, the National Airspace System (NAS) Voice System (NVS), and DataComm, that will have significant impacts on the Agency's budget and further increase program costs.

Since our last report, FAA has not adjusted anticipated benefits for its transformational programs, and many benefits remain unquantified, broad, or uncertain for improving the flow of air traffic and reducing Agency operating costs. For example, FAA's ADS-B program currently focuses on the ADS-B *Out* capability, which is mandated for airspace users to equip by January 1, 2020, but ADS-B *Out* will offer only limited benefits to users for the foreseeable future. FAA expects more widespread benefits through the next stage of the program, ADS-B *In*, but these benefits cannot be easily quantified. In fact, FAA has yet to determine exactly when most of the transformational programs will start

[3] ADS-B technology uses the satellite-based Global Position System (GPS) 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.

delivering benefits, and some of the most significant benefits may be difficult to achieve. For example, similar to ADS-B, the majority of benefits for DataComm depend on airspace users purchasing and installing costly new equipment. Many users are reluctant to equip, in part due to FAA's cancellation of an earlier data communications effort,[4] which leaves uncertainty as to when benefits might be achieved. In addition, while the six programs defined in the existing baseline segments will provide new technology or infrastructure to support NextGen, not all six programs will necessarily "transform" the way air traffic is managed as FAA originally envisioned. There is only limited transformation in the early segments and the amount of transformation later in the programs has yet to be determined. While DataComm is expected to change the way pilots receive and execute clearances, other programs are upgrades or replacement programs of existing systems. For example, NVS will replace 11 different types of older voice switches used by controllers to communicate with pilots and other facilities with a single modern voice switch. FAA expects NVS benefits to primarily reduce operating and training costs, but the Agency has yet to quantify the cost reductions.

BACKGROUND

NextGen is a set of initiatives that aim to provide capabilities to enhance airspace capacity, reduce airport delays, and reduce aviation's impact on the environment. In 2008, FAA identified a series of programs intended to achieve the capabilities that would be needed to support NextGen. From these, FAA identified six "transformational" programs that would be required to implement the capabilities and operational improvements necessary for transitioning to the midterm NextGen system (see table 1).

Table 1. FAA's Transformational Programs

Program Name	Program Description
Automatic Dependent Surveillance-Broadcast (ADS-B)	Is expected to make use of satellite-based Global Positioning System (GPS) technology and eventually supplant ground-based radar as FAA's primary surveillance source in determining and sharing precise aircraft location information to controllers for equipped aircraft to reduce separation and improve traffic flow.
System Wide Information Management (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.

[4] FAA's initial effort to develop and implement Data Communications was the Controller-Pilot Data Link Communications (CPDLC) program that FAA initiated in 1999 and canceled in 2003 after significant investment by FAA and one airline partner.

Program Name	Program Description
Data Communications (DataComm)	Is expected to provide 2-way digital communications between controllers and flight crews by reducing radio voice communications, improving accuracy, safety, and reducing time.
NAS Voice System (NVS)	Is expected to replace 11 of FAA's aging analog voice communication systems with a single digital technology. NVS is expected to standardize the voice communication infrastructure among FAA facilities.
Common Support Services – Weather (CSS-Wx)*	Is expected to replace and consolidate a number of weather information distribution systems into one new and more efficient SWIM-based system for weather information distribution throughout the NAS.
Collaborative Air Traffic Management Technologies (CATM-T)	Is expected to provide enhancements to the existing Traffic Flow Management System (TFMS), and balance air traffic demand with system capacity to ensure efficient utilization of the NAS.

* CSS-Wx replaced NextGen Network Enabled Weather (NNEW), and work from this program was transitioned to the System Wide Information Management (SWIM) Common Support Services.

Source: FAA's NextGen Implementation Plan

FAA capital investment programs, such as the transformational programs, generally follow the acquisition lifecycle set forth in the Agency's Acquisition Management System (AMS), which establishes policy and guidance for all aspects of FAA's acquisition process. According to FAA's AMS policy, capital investment programs are generally baselined at the final investment decision milestone, when the Joint Resources Council (JRC) approves the cost and schedule parameters, the specific performance requirements, and expected benefits that a program will accomplish. Congress and the Office of Management and Budget (OMB) use acquisition baselines to track progress with FAA's major investments.[5]

FAA HAS MADE CHANGES TO PROGRAM COSTS AND SCHEDULES, BUT TOTAL COSTS AND TIMELINES REMAIN UNCLEAR

Since our last report, FAA has made some formal changes to the cost and schedules for the transformational programs, such as approving the initial funding for the six programs. However, due to the Agency's segmented implementation approach, FAA has not fully identified the "end-state" for any of the six programs. The FAA planning process creates incremental baselines for segments of the transformation, but does not establish how much these programs will ultimately

[5] According to OMB, program baselines act as a guide throughout the life of an acquisition to (1) provide a basis for measuring performance, (2) identify who is accountable for deliverables, (3) describe the implementation approach and interdependencies, and (4) identify key decision points.

cost, how long it will take to complete them, or what capabilities they will ultimately deliver. Moreover, FAA's transformational programs continue to face risks due to the lack of finalized requirements (particularly for the more advanced and beneficial capabilities), complex integration issues with the automation systems that controllers use to manage traffic, and challenges with keeping key investment decisions on track.

While FAA Has Defined Cost and Schedules for Initial Segments of All Programs, It Still Lacks Visibility Into Requirements for Full Implementation

Since 2012, FAA has made some progress in defining program costs for the previously baselined programs and has extended the baseline schedules by at least 5 years for all six of the transformational programs. As of March 2015, six transformational programs have received approval from FAA's JRC and have established costs and schedules for at least their first segment. Cost estimates for these segments now total over $5.7 billion, compared to $2.1 billion in 2012 when these programs were less defined (see table 2).

Table 2. Status of FAA's NextGen Transformational Programs

Program	Current No. of Segments		Cost		Schedule	
	Currently Planned	Currently Baselined	2012 Baseline Costs *(in millions)*	Current Baseline Cost Estimates *(in millions)*	2012 Implementation Initial Segment Timeframe *(Start to End)*	Current Implementation Segment Timeframe *(Start to End)*
ADS-B	4	3	$1,711.3	$2,672.4	2007 - 2014	2007 - 2020
SWIM	2	2*	$263.3	$542.3	2009 - 2015	2009 - 2021
DataComm	2	1**	n/a	$1979.5	n/a	2014 - 2023
NVS	2	1	n/a	$294.2	n/a	2012 - 2020
CSS-Wx	2	1	n/a	$120.1	n/a	2015 - 2022
CATM-T	4	3	$162.5	$162.0	2008 - 2016	2008 - 2016
		TOTAL COST:	**$2,137.1**	**$5,770.5**		

* SWIM segments are broken into two elements with three parts (i.e., segment 1 and segment 2a and 2b).
** DataComm segments are broken into separately baselined phases (i.e., segment 1 phase 1, segment 1 phase 2). Segment 1 has two phases that have been baselined.
Source: OIG analysis of FAA documents

As we reported in 2012, FAA has used a segmented approach for developing and implementing its transformational programs. FAA views the transformational programs as interrelated building blocks that will be built upon to meet changing

demands of users, as well as allowing for evolving technology. Under this approach, FAA divides its programs into multiple segments, and funds each segment for a set timeframe or number of milestones, with the goal of minimizing risk in the near term. However, this approach masks how much a program will ultimately cost by breaking program costs up by individual segments and requiring new investment decisions to be made for each segment. This process makes it difficult to track what capabilities or benefits will be delivered, total cost of the program, and when the program will be complete.

The following section provides highlights for each program's status. (See exhibit D for full details of the six programs with regard to implementation status, expected benefits, and costs.)

- **ADS-B—**FAA recently announced completion of the ADS-B ground system with a current approved baseline cost for three segments of $2.7 billion for fiscal years 2014–2020. Airspace users are mandated[6] to purchase and install ADS-B *Out* avionics, the first stage of the program, by January 2020. As we reported in September 2014, ADS-B is proving beneficial in airspace where radar is limited or nonexistent, like the Gulf of Mexico and Alaska. However, the program provides little benefit to large commercial airlines operating in congested airspace, and there is considerable uncertainty regarding whether airspace users will be able or willing to meet the 2020 mandate.

- **SWIM—**FAA has already funded three parts of segments 1 and 2 (segment 1 and segments 2a and 2b) with a current baseline cost of $542 million from 2007 through 2021. Currently, SWIM is providing some benefits to FAA and airspace users who have subscribed to the service, including some large airlines, regarding weather information and aircraft location on runways and taxiways at some airports. The JRC approved a second part of segment 2 (2b) in October 2015 that is intended to help FAA and airspace users make better use of airspace in the vicinity of airports and better use of flight plan information.[7] However, as our work and MITRE's work has shown, transition to SWIM has been uneven and has not gained traction within FAA. This is due in part to the complex path that FAA has taken to implement SWIM, while at the same time maintaining costly legacy systems with no clear end date or transition schedule. The use of SWIM by external stakeholders has begun, but transition away from legacy systems to SWIM within FAA is expected to

[6] In May 2010, FAA published the final rule mandating that most NAS users equip with ADS-B *Out* avionics by 2020, 14 CFR Part 91, Automatic Dependent Surveillance – Broadcast (ADS-B) *Out* Performance Requirements To Support Air Traffic Control (ATC) Service.

[7] The part of SWIM is called the Terminal Data Distribution System (TDDS) and is expect to make more efficient use of the crowded airspace by automating flight information, resulting in improved capacity. The Flight Data Publication Service which currently provides flight data, airspace data, operational data, and general information messages to SWIM users/subscribers in a common data format.

extend until after 2020, and the program will not realize its full range of benefits for enhancing security and reducing Agency costs until then. The SWIM program officials are considering additional segments to address future demands of aviation users as well as evolving technology. As a result, the total number of segments and cost to implement SWIM remain uncertain.

- **DataComm—**FAA has approved funding of almost $2 billion for the first segment (which is broken into two phases—phase 1 for tower and initial en route services and phase 2 for full en route services). FAA's current work is focused on providing departure clearance services at 57 airport towers, which was originally planned for 2019. In response to the NextGen Advisory Committee (NAC)[8] investment priorities, FAA is accelerating the schedule for tower services by almost 3 years and plans to complete the effort by the end of 2016. In addition, FAA is beginning to develop the capability for controllers and pilots to exchange a limited set of digital messages at high altitudes in 2019, including the ability to reroute around thunderstorms. FAA plans do not currently call for implementing data link communications in terminal airspace, which is a complex effort. It is important to keep FAA's DataComm efforts on track because other air navigation service providers, such as NAV CANADA, have already introduced data link communications for high altitude operations.

- **NVS—**In September 2014, the JRC approved a final investment decision to fund[9] the first segment of the program at a baseline cost of $294 million, after a 2 year delay. This includes $62.5 million for the development and demonstration of a prototype and $232 million for the final design and testing of the system between fiscal years 2014 and 2020. 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 Chicago Center fire.[10] However, FAA does not yet know when NVS will be fully implemented or how much it will cost. 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's officials told us that the total cost and schedule to fully implement the program may be determined.

[8] The NAC is a Federal advisory committee established to develop recommendations for NextGen portfolios with an emphasis on the midterm (through 2020), and includes operators, manufacturers, air traffic management, aviation safety, airports, and environmental experts.

[9] A Final Investment Decision is an acquisition milestone decision where FAA through the Joint Resources Council approves an overall investment and the cost and schedule parameters, as well as the specific performance requirements the program is expected to accomplish.

[10] 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.

- **CSS-Wx—**FAA has significantly changed its plans for how the Agency intends to modernize and replace its weather systems—used in all phases of flight—since our last report. FAA had previously planned to use the NextGen Network Enabled Weather program[11] to deliver a common NAS-wide weather picture. This program relied on the 4D Weather Cube,[12] a technology under development by the National Weather Service (NWS). However, the 4D Weather Cube was not technically mature and as a result, FAA shifted to the CSS-Wx program, which is now expected to rely on the SWIM program. Further, to replace the 4D Weather Cube, FAA is now developing the NextGen Weather Processor (NWP)[13]—a more than $189 million effort that is dependent but separate from CSS-Wx. FAA recently approved initial funding for the first segment of CSS-Wx for $120 million to cover developmental efforts in the 2015–2022 timeframe. However, it is uncertain how much of FAA's efforts and previous investments from NNEW can be salvaged for the current effort. The cost and timeframes to replace and modernize FAA's diverse weather dissemination and detection systems are uncertain.

- **CATM-T—**FAA's CATM-T program was well established before the transformational programs and pioneered the use of the Traffic Flow Management System (TFMS)[14] and the use of the Collaborative Decision Making[15] process since the 1990's. These efforts are the primary planning and execution methods for air traffic management in the NAS that link the FAA Command Center and airline operations centers. The CATM-T program allows 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 (special use airspace). FAA's current cost estimate for the NextGen-related second and third segments is $162 million, with a fourth segment awaiting a final investment decision. However, FAA officials stated that CATM-T will continue to evolve as new requirements become available, and FAA has now begun planning for a fifth segment.

[11] The NNEW program was expected to enable NAS stakeholders a common, universal access to aviation weather data using the NOAA's 4-Dimension Weather Cube (4D Weather Cube).

[12] NOAA's 4D Weather Cube Data Cube was envisioned as a virtual data cube that will combine weather data and information from disparate data contributors and locations. From this Cube, end users (e.g., air traffic managers and pilots) will be able to obtain a common weather picture of the National Airspace System (NAS).

[13] NextGen Weather Processor (NWP) is a NextGen weather program that establishes a common weather processing infrastructure. NWP will subsume weather product generation for systems such as Weather and Radar Processor (WARP), Corridor Integrated Weather System (CIWS), and Integrated Terminal Weather System (ITWS).

[14] Traffic Flow Management is the management the flow of air traffic in the NAS based on airspace capacity and demand.

[15] Collaborative Decision Making (CDM) process is a joint government/industry initiative that FAA has adopted that involves stakeholders with FAA subject matter experts, all with unique and varied experience and expertise, in a joint decision-making process that has the goal of producing better development and implementation of decisions for managing the NAS on a day-to-day basis and for future improvements and enhancements.

While segmenting programs can be a valuable strategy to help manage large, complex efforts, FAA's segmentation approach for the transformational programs has drawbacks. Specifically, FAA's guidance to program managers on segmentation, as outlined in the Agency's AMS, is overly broad, limiting its effectiveness. As a result, each individual program manager segments each program differently regardless of technical maturity or risks facing the program. For example, some transformational programs, like NVS, identify segments at a high level with multiple investment decisions (e.g., segment 1 and segment 2). Other programs, such as DataComm, subdivide segments into additional phases (e.g., segment 1 phase 1, segment 1 phase 2, and segment 2 phase 1), and SWIM is split into phases (e.g., segment 1, segment 2a and 2b). Also, the segments are not tied to the number of systems to be procured or to locations, but rather to future capabilities that have yet to be fully defined and often require significant development. This approach impacts FAA decisionmakers' and external stakeholders' ability to accurately and consistently measure the progress of a program, especially in relation to other programs.

In addition, FAA has not decided how many segments the transformational programs will ultimately have or what benefits they will provide. As program requirements continue to evolve for the six programs, the efforts represent open-ended financial commitments with uncertain end states. Several program office officials stated that they do not view transformational programs as having end-states but as building blocks which FAA will continue to grow the programs in order to meet changing demands of users as well as allowing for technology evolution. As a result, this open-ended approach makes it difficult for FAA and decisionmakers in Congress and the Department to assess future budget requirements or evaluate progress toward meeting NextGen's more advanced and beneficial capabilities.

Cost and Schedule Risks Remain Due to a Lack of Final Requirements and Complex Integration Issues

FAA's progress with the transformational programs continues to be impacted by the lack of finalized program requirements, particularly for the more advanced and beneficial capabilities. For example, as we reported in September 2014,[16] FAA's cost and schedule for ADS-B continue to evolve largely due to uncertainties regarding ADS-B *In* capabilities—which is the more advanced and beneficial part of the ADS-B program. Specifically, FAA has not yet finalized requirements for the use of ADS-B *In* capabilities and is still developing procedures necessary to enable pilots and controllers to use ADS-B *In* to improve capacity in congested airspace. It is unclear if and at what pace FAA will seek to advance ADS-B *In.* As

[16] *ADS-B Benefits Are Limited Due to a Lack of Advanced Capabilities and Delays in User Equipage* (OIG Report No. AV-2014-105), September 11, 2014.

we noted in our report, the more advanced uses of ADS-B *In* may require changes to air and ground components of the system. Another example is the CSS-Wx program. In 2014, MITRE reported[17] that FAA does not have a mature concept or requirements for integrating weather information into air traffic controller automation systems and decision-making tools.

In addition, important cost and schedule risks remain due to complex integration issues between the transformational programs and key FAA modernization efforts. For example, in implementing CSS-Wx, FAA will face complex integration issues linking with three different legacy weather systems—Weather and Radar Processor (WARP), Corridor Integrated Weather System (CIWS), and Integrated Terminal Weather System (ITWS)—to distribute weather information through SWIM. Other examples of integration issues are with ADS-B, DataComm, SWIM, and CATM-T, all of which rely on enhancements to the En Route Automation Modernization (ERAM) system to provide new capabilities to FAA air traffic facilities and airspace users. FAA considers the $2.7 billion ERAM program to be the backbone for NextGen that allows controllers (who manage high-altitude air traffic) to better manage flights from gate to gate. Consequently, ERAM is critical to the success of the transformational programs.

However, delays in implementing ERAM in the 2009–2013 timeframe impacted the timing and integration of the transformational programs, including DataComm and SWIM. In addition, a series of failures with ERAM have raised concerns about the overall design of the system, which have been noted in the National Research Council (NRC)[18] report. A key risk for DataComm's en route services—where the majority of the program's benefits are projected—is integration with ERAM. FAA currently plans to spend $400 million to modify ERAM so that controllers can display properly equipped aircraft on their air traffic automation systems as well as send and receive data link messages with pilots. Until DataComm is operational in the en route environment, FAA cannot, for example, reroute aircraft around thunderstorms by digital messaging, as planned, because these enhancements must be tested before they can be implemented.

Delays in Making Key Investment Decisions Could Pose Further Risks to Transformational Programs

The uncertainty about the cost and schedule of transformational programs—as well as the number of segments they will contain—is further highlighted by the fact that FAA expects to make a number of key NextGen-related investment decisions through 2020. Specifically, between 2015 and 2017, FAA is expected to

[17] MITRE, *Assessment of Next Generation Air Transportation System (NextGen), Establishing Reasonable Expectations Based on Progress and Community Ability to Transform*, March 26, 2014.
[18] National Research Council Report – Transformation in the Air: A Review of the Next Generation Air Transportation System: Implications and Importance of System Architecture, 2015.

make five investment decisions related to the costs, schedules, and requirements for ADS-B, DataComm, NVS, SWIM, and CATM-T. Some have been delayed, and others are pending. Table 3 highlights the status of some key decisions.

Table 3. Select Transformational Program Key Investment Decisions (2015–2020)

Key Decision	Due Date	Actual Completion
SWIM Final Investment Decision (FID) - Segment 2B Planning	June 2015	Delayed and Completed October 2015
CATM-T FID - Work Package 4	September 2015	Delayed – TBD
DataComm FID - Full En Route Services	December 2015	Delayed and Completed August 2016
ADS-B FID - ADS-B In Applications Planning	June 2016	Pending
NVS FID - Deployment of Operational Systems	September 2017	Pending

Source: OIG analysis of FAA documents

Prolonged delays in making key investment decisions impact FAA's ability to develop reliable budget projections and longer term capital investment. Currently, one investment decision with the transformational programs is clearly connected to the NextGen investment priorities recommended by the NAC—the DataComm decision for full en route services—which was delayed and just recently approved in August 2016. FAA plans to make another investment decision related to DataComm, which was originally planned for the 2018 timeframe but has now moved beyond 2020 for future segments (segment 2). FAA does not plan to make another decision on the CSS-WX program until the 2019 timeframe, reflecting the uncertainty facing the program about requirements and complex integration issues.

In addition, FAA will need to make trade-offs among the transformational programs and new capital programs that are just getting started given the current fiscal environment. These new programs include the almost $900 million Terminal Flight Data Manager, which will, among other things, introduce electronic flight strips to replace paper strips at airport towers, and the NextGen Weather Processor that will provide new weather capabilities with an initial program baseline cost of $189 million. Thus far, FAA has not designated either program as a transformational program even though they are expected to introduce new capabilities that do not exist today. Also, FAA requested initial funding in its fiscal year 2017 budget for the Next Generation Surveillance and 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.[19] The cost of this effort is unknown but could have significant budget implications for the transformational programs.

FAA HAS NOT ADJUSTED EXPECTED PROGRAM BENEFITS, AND MANY BENEFITS REMAIN BROAD, UNQUANTIFIED, AND POTENTIALLY DIFFICULT TO ACHIEVE

As we reported in 2012, it remains uncertain when the transformational programs will start delivering benefits to achieve NextGen goals, such as enhancing capacity and reducing the Agency's operating costs. Some expected benefits that require significant stakeholder investment may be difficult to achieve. Finally, while FAA's transformational programs provide the basic infrastructure for modernization, it is unclear when or if they can introduce new capabilities that can fundamentally change how air traffic is managed.

Expected Benefits From Transformational Programs Have Yet To Be Fully Quantified

FAA has not adjusted its anticipated transformational program benefits since our last report. Moreover, many of FAA's envisioned transformational program benefits to stakeholders remain years away from being realized (see table 4).

[19] Multi-function Phased Array Radar (MPAR) is a technology that has been used by the Department of Defense (DoD) since the 1960s. FAA is working with other agencies, including DoD 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.

Table 4. FAA's Expected Benefits From Transformational Programs

	Improved efficiency & increased capacity	Enhanced safety	Enhanced surface safety & decreased fuel burn, emissions, & noise	Improved weather observations	Increased capacity in low visibility & night conditions	Increased user-preferred routing	Reduced NAS operating costs	Other anticipated program benefits
ADS-B	✓	✓	✓		✓	✓		Reduce separation, improve situational awareness
SWIM				✓	✓	✓	✓	Access to real-time aeronautical, flight, and weather information to users, reduced operating costs
DataComm	✓	✓	✓			✓		Pre-Departure clearance capability in 57 towers by end of 2016 & en route in the 2019 timeframe
CSS-Wx				✓		✓		Improved weather information availability through SWIM-based weather information distribution
NVS					✓		✓	Lower operating and training costs, voice over IP capability
CATM-T	✓		✓			✓	✓	Continuing traffic flow management enhancements

Source: OIG analysis of FAA program documentation

For example, ADS-B's Airport Surface Surveillance capability was expected to play an important part in improving safety on the Nation's busy runways and taxiways by enhancing the situational awareness of pilots in the cockpit.[20] However, FAA suspended ADS-B demonstrations[21] using aircraft and airports equipped with surface situational awareness technology[22] indefinitely due to significant accuracy, integrity, and frequency problems with the satellite-based

[20] In essence, ADS-B could provide a "second set of eyes" for pilots and provide alerts to prevent accidents and incidents with other aircraft or vehicles, which would also address a longstanding National Transportation Safety Board recommendation.

[21] *FAA Operational and Programmatic Deficiencies Impede Integration of Runway Safety Technologies* (OIG Report No. AV-2014-060), June 26, 2014.

[22] Pilots were using ADS-B information display on moving displays installed on electronic flight bags. Controllers in towers were using ADS-B information displayed on the Airport Surface Detection Model –X, a ground based radar and display system.

system. As a result, it is uncertain if or when ADS-B can be used to help prevent accidents on crowded airport runways and taxiways.

The DataComm effort is expected to improve safety and boost controller productivity by shifting some routine voice traffic to digital text messaging. As previous FAA reports[23] show, the productivity enhancements could be substantial from DataComm technology and could shed important light on how much additional traffic the existing controller workforce—with a current staffing level of 14,000—could safely handle with a key NextGen technology. However, FAA has not yet fully quantified the expected benefits of this technology or the impacts on the size of controller workforce or the number of airspace sectors.

In terms of SWIM, FAA is having difficulty realizing the full range of benefits of SWIM due in part to changes in the program's execution. In the past, FAA provided airspace users with direct access to information, including flight information and applications, in a ready-to-use format. However, due to cost concerns, FAA changed its approach and now expects airspace users to individually develop their own unique applications and interfaces to airline and FAA systems for SWIM. For example, stakeholders no longer have access to the Route Availability Planning Tool, which was available from FAA and helped airline operations centers improve the flow of air traffic. This is a key reason why airspace users have been resistant to embrace SWIM as the primary means to share information throughout the NAS.

Expected Benefits for Other Key Programs Could Prove Difficult To Achieve Given the Significant Stakeholder Investments Required

The two largest and most expensive transformational programs—ADS-B and DataComm, with a current value of $4.7 billion in FAA investments alone—depend on significant stakeholder investments in new or updated avionics to obtain expected benefits. As the NRC recently pointed out, FAA does not fully control NextGen—many stakeholders have to actively choose to acquire elements of the system, with the exception of ADS-B *Out*, where FAA has mandated that airspace users purchase and install new avionics. For NextGen to realize its full benefits, airspace users must decide to make costly investments not only in avionics but in pilot and crew training. In the past, airline stakeholders have prioritized aircraft improvements focused on items that touch the passenger (e.g., new seats and entertainment systems) or significant items that reduce operating costs (e.g., new engines for fuel savings). This rationale is based on industry business models that typically dictate a quick return on investment of 18 months to 3 years.

[23] FAA Joint Planning and Development Office (JPDO) report, *FY 2009 Portfolio Analysis Report.*

As we have noted in previous reports, airspace users continue to express reluctance to invest and equip with NextGen technology due to skepticism in FAA's ability to achieve its plans and clearly define and deliver benefits. Currently, according to FAA, there are approximately 7,000 commercial and 160,000 general aviation aircraft operating in the NAS. Users are not likely to equip unless they are confident that FAA can deliver the technology and implement operational improvements that have an economic payoff on a reliable schedule in the near-term.

For ADS-B and DataComm, FAA is using two different approaches for gaining stakeholder commitment to purchase and install new equipment:

- **ADS-B—**FAA issued a rule in May 2010 that mandates airspace users to equip with ADS-B *Out* avionics for most classes of airspace by January 1, 2020. However, at the time the rule was published, avionics were not developed or certified that could meet the standards set forth in the rule. Given the cost to upgrade and equip aircraft and legitimate concerns about a lack of benefits, many in the aviation community argued that incentives would be needed to help spur ADS-B equipage. However, FAA has not established a large-scale incentive program for commercial aircraft to support the ADS-B effort. Instead, FAA has entered into several agreements with U.S. airlines to develop procedures and validate benefits for both ADS-B *Out* and *In* applications. FAA has provided $49 million to purchase and install ADS-B avionics on a limited number of commercial aircraft, but the Agency does not expect all elements of demonstrations to be completed until 2017 or later. In June 2016, FAA announced a $500 rebate[24] that is scheduled to begin in fall 2016 for up to 20,000 aircraft for piston engine general aviation aircraft owners to purchase and install *ADS-B Out* avionics within a year after the start date.

  As MITRE cautioned in its 2014 report, it is unlikely that the aviation community can meet the 2020 mandate, given the current low rate of airspace user equipage. Since that time, airlines have developed plans to meet the 2020 mandate. As of August 2016, according to FAA's data, only 651 out of 7,000 (or about 9 percent) of commercial aircraft have equipped with rule-compliant avionics, and concerns have been raised by industry about the availability of ADS-B avionics as well as repair station time slots to install the avionics to meet the mandate. In addition, 15,657 general aviation aircraft out of approximately 160,000 (or about 10 percent) have equipped with ADS-B avionics. FAA's data indicate that almost 5,000 aircraft (both commercial and

[24] FAA's General Aviation ADS-B Rebate Program began in September 2016 and will offer a $500 incentive to encourage the first 20,000 eligible owners of less-expensive general aviation aircraft equip with the required avionics that comply with the January 1, 2020 ADS-B *Out* mandate.

general aviation) are not properly transmitting the ADS-B signal correctly due to installation issues or other problems.

In addition, due to difficulties with implementing a requirement involving GPS position source accuracy, and integrity required to meet the mandate, commercial stakeholders appealed to FAA for more time. FAA agreed to postpone the requirement and has granted a 5-year exemption until December 2024 to fully meet requirements for ADS-B *Out*.[25] The full implications of this exemption are unclear, but it could further postpone decisions regarding when FAA can decommission ground-based radars or allow aircraft to fly closer together at high altitudes in domestic airspace—two major anticipated benefits of ADS-B.

- **DataComm—**In contrast to ADS-B, DataComm is voluntary, and FAA has not yet mandated that operators purchase and install data link avionics.[26] The current program is not FAA's first effort to deliver digital communications to the cockpit. FAA pursued a similar program in the past,[27] but the Agency abandoned the effort in 2003 due to a lack of clearly defined benefits as well as technical and cost growth issues.

  The current DataComm effort enjoys industry support, and is a top NAC investment priority. Unlike ADS-B, which requires entirely new avionics, the DataComm effort is relying on an existing data link technology[28] that is already in use today for flights over oceans (where voice communications are poor). This has boosted stakeholder support and is expected to reduce risk with the more advanced NextGen operations called for in FAA's NextGen plans. In addition, FAA has established an $80 million equipage fund that is expected to help equip 1,900 aircraft by 2019. FAA reports that over 900 aircraft have taken part in the program. A demonstration program has allowed some airlines to realize some benefits, such as quicker departures from tower services when airlines can transmit information about rerouting aircraft before they take-off.

  The current DataComm program is expected to deliver significant benefits to airspace users beginning in 2019—the bulk of anticipated benefits are in the en

[25] For increased accuracy and integrity for GPS position sources, ADS-B *Out* requires a significant number of stakeholders to purchase additional avionics in the form of new GPS position sources.
[26] To participate in the DataComm effort, airspace users must purchase and install avionics to meet certain minimum equipage requirements, including FANS 1/A, CPDLC, VDL mode 2 radios, and a Flight Management System.
[27] *Observations on FAA's Controller-Pilot Data Link Communications Program* (OIG Report No. AV-2004-101), September 30, 2004.
[28] FAA's DataComm program requires users to have the Future Air Navigation System 1/A system (FANS 1/A) to use DataComm.

route environment, where FAA plans to send messages digitally so pilots can reroute aircraft around thunderstorms.[29]

The Transformational Programs Are Now Mostly Air Traffic Infrastructure Efforts, Rather Than Projects That Fundamentally Change the Way Air Traffic Is Managed

FAA originally identified the transformational programs as core efforts that would fundamentally change the way the Agency would manage air traffic, communicate with pilots, and exchange data with airspace users. However, our review has found that, at least until 2020, most of the transformational programs will not transform how air traffic is managed in the NAS. Moreover, there has been significant ambiguity both within FAA and the aviation community about expectations for NextGen, including the transformational programs' role in delivering new capabilities.

As the NRC reported in May 2015, the original transformational vision for NextGen is not what is being implemented today. Instead, the NextGen FAA is working towards today primarily emphases replacing and modernizing aging equipment and systems—a shift that is important but not a fundamental change in the way FAA handles air traffic. However, as our work and MITRE's 2014 assessment showed, the transformational programs are in different stages of development or deployment, and the majority will not be in position to be widespread in use by until 2020 or after.

While FAA does expect the transformational programs to provide the basic infrastructure for new capabilities that can eventually change the way air traffic is managed, it is unclear when those new capabilities can be introduced or at what cost. For example, two programs—NVS and CATM-T—are actually replacements or upgrades of existing systems and do not yet represent new ways of managing air traffic or accommodate new airspace users. Specifically:

- **NVS** will provide a more modern voice over internet protocol[30] capability. One new feature of NVS is expected to provide greater flexibility to shift communications from one air traffic facility to another in the event of system failure or crisis—an issue that came up during the Chicago Center fire incident. However, it is uncertain when this capability will be implemented to enhance the security, flexibility, and resiliency of air traffic operations. In addition, NVS is expected to play a key role in integrating UAS technology, a concern noted in the 2014 MITRE report. However, much work remains to address

[29] FAA is working to develop standards to support future air-to-ground data communication requirements associated with the Aeronautical Telecommunications Network that are also critical to harmonize with international efforts.

[30] Voice over Internet Protocol (VoIP) is a technology that allows you to make voice calls using a broadband Internet connection instead of a regular (or analog) phone line.

UAS requirements for the new voice switch system. Primarily, NVS will standardize the voice communication infrastructure among FAA facilities and is expected to save FAA maintenance and training costs, but the Agency will not begin to calculate projected savings until 2017. Nevertheless, once implemented, NVS will be used in essentially the same way as the system it replaces, and the extent to which it provides greater flexibility to the air traffic control system has yet to be determined.

- **CATM-T**, which has not always been a transformational program, is an ongoing enhancement effort, provides a suite of new capabilities to FAA's existing Traffic Flow Management System. While these new capabilities are important, they do not yet fully address stakeholders' needs for using new traffic flow management processes and will continue to evolve into the future.

CONCLUSION

FAA's transformational programs represent significant and growing investments to modernize the Nation's aging air traffic transportation system. However, they continue to face uncertainty with respect to costs and what benefits they will deliver. Managing the development and implementation of these programs and their integration into the NAS is complex and requires effective program management and risk mitigation. While FAA has made progress since 2012, particularly with the initial segments of the first four transformational programs, much work still remains to fully realize the expected benefits and set realistic expectations for the transformational programs. FAA must establish the planned scope and sequence of all segments, determine total costs, better define program end-states, and provide plans for delivering the expected benefits of NextGen initiatives. Until then, the Agency will continue to experience challenges in communicating the value of its NextGen investments to stakeholders, and will face continued risks in meeting its NextGen transformational goals.

RECOMMENDATIONS

In our April 2012 report on the status of NextGen transformational programs, we made four recommendations regarding finalizing requirements, identifying the total cost and timeline, and mitigating implementation risks. FAA concurred with and is taking steps to address our recommendations. Two of these recommendations have been closed. However, our review of FAA's actions has found that many of the problems previously identified still exist, and we are providing the following recommendation to the Federal Aviation Administrator to better address these issues:

1. Develop and implement Agency-wide guidance for a uniform approach to segmentation that provides a common format to aid the management of multiple, complex, and interrelated programs needed to achieve NextGen capabilities for transforming the NAS.

AGENCY COMMENTS AND OFFICE OF INSPECTOR GENERAL REPONSE

We provided our draft report to FAA for comment on August 15, 2016, and received FAA's formal response on September 9, 2016, which is included as an appendix to this report. FAA did not concur with our recommendation, and we are requesting that the Agency reconsider its response.

Regarding our recommendation for developing a uniform approach to segmentation, FAA stated that it does not need a new nomenclature to substantively affect the nature of its investments, change the management of those investments, or reduce the overall risk. However, the intent of our recommendation is to help FAA project managers improve the execution of complex acquisitions to assist in developing and implementing new technology into the NAS—not to develop a new nomenclature for their efforts. As we note in our report, FAA's guidance to program managers is overly broad and lacks a uniform approach to using segmentation, which has resulted in each program manager adopting a different approach regardless of the technical maturity or the risks facing a program. This makes it difficult to evaluate the progress of the programs or the impact of a program's progress in relation to other programs—an important factor given the complex integration issues of NextGen and the introduction of new capabilities into the NAS. While we recognize that each program is different, having a more common approach to segmentation will aid project managers as well as decisionmakers and will strengthen the current budget and planning process for FAA programs.

In addition, FAA disagreed with some of our report's statements. We have been monitoring and reporting on FAA's progress on planning and implementing NextGen since 2003. We recognize that FAA has made progress with the transformational programs, including the completion of the ADS-B ground infrastructure, and the accelerated implementation of DataComm in airport towers. However, FAA disagreed with five of our statements. Our specific responses to FAA's statements are listed below:

- **Lack of finalized program requirements.** FAA disagreed with our statement that progress in implementing the transformational programs is hindered by a lack of finalized requirements, as well as complex integration issues. However, as we note in our report, a lack of finalized requirements is an ongoing issue

and a cost driver for ADS-B *In*, NVS, and CSS-Wx efforts, as well as future segments of CATM-T and DataComm, where FAA will seek to harmonize with the international aviation community. We first raised concerns about the lack of finalized requirements in our 2012 report on the transformational programs, and we recommended that FAA finalize requirements at that time. FAA concurred but has not completed actions on the recommendations (see exhibit C). Furthermore, the transformational programs face complex integration issues, particularly with systems controllers use to manage and separate aircraft. As noted in our report, FAA cannot realize the anticipated benefits for DataComm, for which the majority of the benefits are projected to be in the high-altitude environment, until the Agency modifies ERAM to display properly equipped aircraft on controllers' scopes as well as to send and receive digital messages. This effort is not expected to be completed until 2019. Also as noted in our report, FAA faces complex integration issues with the CSS-Wx effort, which must link with three different existing weather systems.

- **Program segmentation.** FAA disagreed with our statement that segmentation can mask how much a program will ultimately cost. We recognize that segmentation can be useful, but it can also have drawbacks. A case in point is the new NAS Voice System, with an initial cost estimate of $294 million. This cost estimate does not include the cost to implement the system or work that remains to address UAS and NAS resiliency requirements. Similarly, the costs associated with DataComm (with a current cost baseline of almost $2 billion) do not yet reflect final requirements to harmonize with European standards or efforts to exchange messages in the terminal environment.

- **DataComm benefits.** FAA disagreed with our statement that the majority of benefits for DataComm depend on airspace users purchasing and installing new equipment, which many are reluctant to do, leaving uncertainty as to when benefits might be achieved. As we note in our report, DataComm is a NAC investment priority, and we recognize that DataComm has an incentive program in place to encourage airlines to equip with avionics to use the services. FAA has provided $80 million to equip 1,900 aircraft by 2019. However, there are over 7,000 aircraft in the commercial fleet, and FAA currently does not plan to offer additional incentives at this time. As we noted in our report, the majority of anticipated benefits for DataComm are in the high-altitude environment, for which initial operations are now planned to begin in the 2019 timeframe. Some airspace users have voiced skepticism in DataComm and are reluctant to equip due in part to FAA's aborted earlier digital messaging effort, Controller-Pilot Data Link Communications, for which some users installed avionics prior to FAA subsequently canceling the program. Since DataComm is not mandated, airspace users will make

investment decisions about the technology based on when benefits will be available and when they can make the business case for equipage.

- **Transition to SWIM.** FAA disagreed with our statement that the transition to SWIM has been uneven and has not gained traction within FAA. As noted in our report, some airspace users have subscribed and begun using SWIM services; however, the transition to SWIM has been uneven. This is due in part to the complex path that FAA has taken to implement SWIM, while at the same time maintaining costly legacy systems with no clear end date or transition schedule. Currently, FAA's data show that there are only 16 FAA internal users, including airports and some capital programs using SWIM in some form. As we note in our report, widespread internal use of SWIM capabilities will not likely occur until after 2020. This postpones the anticipated security and cost reduction benefits until that timeframe. The SWIM program office has stated that it plans to continue to add new services, enhance existing capabilities, provide access to new data, and upgrade the SWIM infrastructure. As a result, the SWIM program office has started the process of refining and identifying future requirements for a new segment and will begin to work toward establishment of new costs and schedules in 2017.

  FAA also states that SWIM is meeting its commitments to users and is providing services to customers. FAA states that SWIM is exchanging terabytes of data between internal FAA systems and external users. However, the volume of the data is not the issue, quality is the issue. As we point out in our report, SWIM's approach is to provide a raw data feed to users rather than providing refined applications. This requires users to develop their own unique applications to use and benefit from the data, which can be costly. Airspace users have argued that as long as they can still access desired data from existing legacy systems for which they already have applications to use, then the transition to SWIM is not a priority.

- **ADS-B equipage.** FAA disagreed with our statement that considerable uncertainty remains as to whether airlines will meet the 2020 mandate for equipping with ADS-B *Out*. While we acknowledge that most airlines have developed plans to comply with the mandate, a number of obstacles remain. These include a limited number of certified avionics as well as limited installation facility capacity to install the avionics. FAA data show that as of August 15, 2016, only 651 out of approximately 7,000 commercial aircraft (about 9 percent) and 15,657 of 160,000 general aviation aircraft (about 10 percent) have purchased and installed ADS-B avionics. FAA information also indicates that almost 5,000 (both commercial and general aviation) aircraft that have equipped cannot properly broadcast the ADS-B signal as required due to, among other things, installation problems. Therefore, the pace of airline

and general aviation equipage remains a watch item for Congress, FAA, and airspace stakeholders.

We remain committed to working with FAA to identify opportunities to improve its implementation of key NextGen programs and welcome further discussion with the Agency regarding our findings in this report.

ACTIONS REQUIRED

As stated above, we are requesting that the Agency reconsider its response to our recommendation. We request that the Agency provide us its revised response within 30 days of the date of this report in accordance with DOT Order 8000.1C.

We appreciate the courtesies and cooperation of FAA representatives during this audit. If you have any questions concerning this report, please call me at (202) 366-0500 or Nate Custer, Program Director, at (202) 366-5540.

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cc: DOT Audit Liaison, M-1
FAA Audit Liaison, AAE-100

EXHIBIT A. SCOPE AND METHODOLOGY

We conducted this audit between October 2014 and August 2016 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.

At the request of the Chairman and Ranking Member of the Senate Committee on Commerce, Science, and Transportation, we examined FAA's plans and progress in implementing the six transformational programs since our April 2012 report. Accordingly, our audit objectives were to identify any (1) formal changes FAA has made to its programs' scope, including costs and schedules, and (2) adjustments in FAA's anticipated benefits with respect to reducing Agency costs and improving the flow of air traffic. We also provided an updated status on FAA's implementation of the four recommendations we made in our April 2012 report.

To determine any formal changes FAA has made to its programs' scope, including cost and schedules, we interviewed FAA officials and analyzed various planning and funding documents for each of the six transformational programs (ADS-B, SWIM, CSS-WX, CATM-T, NVS, DataComm). We submitted and analyzed the results of detailed questionnaires and one-page program status sheets to the six transformational program offices to determine current status of each program. Additionally, we met with key program officials for each individual program. We leveraged information from our prior OIG work on NextGen transformational programs, ADS-B, and SWIM in order to update information that addresses our stated objectives. We performed analyses of the National Airspace System (NAS) Capital Investment Plan (CIP), FAA's NextGen Implementation Plan, and FAA's President's Budget Submissions. Additionally, we performed analyses of FAA's Final Business case Analysis Reports for each of the programs, FAA JRC Investment and Acquisition Program Baseline (APB) documents, and industry reports from MITRE, the NextGen Advisory Committee (NAC), and the National Research Council (NRC). In order to better understand progress made on recommendations by FAA since our April 2012 report, we sought clarification and demonstration on how the Integrated Master Schedule is being used to track the performance of the NextGen transformational programs.

To determine adjustments in FAA's anticipated benefits with respect to reducing Agency costs and improving the flow of air traffic, we interviewed key FAA program officials at FAA Headquarters in Washington, DC, in addition to DataComm capability demonstration sites at Memphis Air Traffic Control Tower

in Memphis, and Newark Air Traffic Control Tower in Newark. We also met with and interviewed airline representatives, avionics manufacturers, and other industry stakeholders during DataComm, SWIM, and NVS demonstration site visits to Louisville, Memphis, Newark, Melbourne, and Chicago.

EXHIBIT B. ORGANIZATIONS VISITED OR CONTACTED

Federal Aviation Administration

CATM-T Program Officials	Warrenton, VA
ADS-B Program Officials	Washington, DC
NextGen Office Officials	Washington, DC
NVS Program Officials	Washington, DC
CSS-WX Program Officials	Washington, DC
SWIM Program Officials	Washington, DC
DataComm Program Officials	Washington, DC
Washington Air Route Traffic Control Center	Leesburg, VA
Memphis Air Traffic Control Tower	Memphis, TN
Newark Air Traffic Control Tower	Newark, NJ

Other Organizations

MITRE Corporation	Washington, DC
RTCA Inc.	Washington, DC
American Airlines	Dallas, TX
JetBlue Airlines	Long Island City, NY
Southwest Airlines	Dallas, TX
United Airlines	Chicago, IL
Harris Corporation	Melbourne, FL
United Parcel Service	Louisville, KY
FedEx	Memphis, TN
Boeing	Seattle, WA
European Union Delegation LNO	Washington, DC

EXHIBIT C. STATUS OF RECOMMENDATIONS FROM OUR APRIL 2012 REPORT

Recommendation	FAA Comment	Status – Target Action Date	Basis for Closure
1 – Develop and set milestones for baselining each segment of the transformational programs through their end-state and identify the capabilities and benefits that will be delivered for each segment.	Concur in Part	Closed - 10/20/15	FAA stated that its current approach is to baseline individual segments as they are developed. FAA's rationale is that many of these programs will span over 10 years or more into the future and are identified in the Agency's enterprise architecture. As a result, these programs will continue to mature and evolve. FAA plans to rely on a segmented approach and it is not possible to predict how many segments will be required or what the end state will be for the transformational programs. FAA argued that the intent of our recommendation can never be met as long as FAA continued to use a segmented approach. Given the uncertainty facing the transformational programs, we agreed to close the recommendation.
2 – Define and finalize the transformational programs' NextGen requirements.	Concur	Open 03/31/16	FAA submitted its NextGen Segment Implementation Plan, as evidence of meeting of our recommendation for defining and finalizing requirements for the transformational programs. However, the NextGen Segment Implementation Plan discusses capabilities in very broad terms and the requirements for ADS-B In, the NAS Voice System, CSS-WX effort, and the advanced applications of DataComm continue to evolve and represent major cost drivers to the programs and risk to successful implementation. Therefore, this recommendation remains open pending further discussion with FAA officials.
3 – Synchronize program requirements between the Transformational Program Offices and NextGen Integration and Implementation Program Office to ensure Agency NextGen goals are aligned with the transformational programs' plans and to avoid schedule delays.	Concur	Open 03/31/16	FAA provided the NextGen Segment Implementation Plan as evidence that it has synchronized program requirements and that it would be reviewed and updated on an annual basis. As previously noted, requirements for ADS-B In, the NAS Voice System, CSS-WX, and the advanced applications of DataComm continue to evolve and represent major cost drivers to the programs and risk to successful implementation. Therefore, this recommendation remains open pending further discussion with FAA officials.
4 – Establish an integrated master schedule framework, policy, and standard operating procedures that include the Segment Implementation Plan and the transformational programs, and a timeline for maturing this capability.	Concur	Closed – 7/28/15	FAA developed an Integrated Master Schedule (IMS) database and demonstrated how it takes input from the programs that is provided on a regular basis and how the IMS showed the impact on other programs and adjusted milestones. However, FAA is not using the IMS as we intended to manage the implementation of the transformational programs.

For more details, see *Status of Transformational Programs and Risks To Achieving NextGen Goals* (OIG Report No. AV-2012-094), April 2012.

EXHIBIT D. FAA'S TRANSFORMATIONAL PROGRAMS – BENEFITS AND STATUS

Program Description	NextGen Expected Benefits	Current Status	Costs
Automatic Dependent Surveillance – Broadcast (ADS-B)			
ADS-B is a satellite-based surveillance technology that combines the use of satellites, aircraft avionics and ground-based systems to provide more accurate information about aircraft location for pilots and air traffic controllers.	• Provides more precise information that will allow for reduced aircraft separation (e.g., Gulf of Mexico where radar coverage is not available). • Enhanced surface traffic management by reducing taxi times and enhancing safety by provide real-time traffic information to pilots, controllers, and airlines. • When ADS-B *In* information is displayed in the cockpit, it can enhance pilots' situational awareness, assist in spacing and merging, and lead to delegated self-separation for pilots.	• FAA completed the ADS-B ground infrastructure in April 2014 with 634 deployed ground stations. • ADS-B is providing benefits in non-radar airspace in places like the Gulf of Mexico. • FAA has yet to conduct "end-to-end" testing of air and ground elements of ADS-B systems to ensure the system can perform as well as or better than radar in congested airspace. • The requirements for ADS-B *In* continue to evolve and it is unclear if and at what pace FAA will pursue the technology.	• $2.7 billion baselined (for segments 1-3). • Congress has provided FAA with approximately $22 million to integrate *space-based* ADS-B with Agency systems controllers use to manage oceanic traffic and safely reduce distance between aircraft. JRC decisions were planned for June 2016 and September 2016. • The costs to rely on space based ADS-B for oceanic services are unknown.
System Wide Information Management (SWIM)			
SWIM will provide for a more agile exchange of information through a secure, NAS-wide information web infrastructure that will connect FAA systems with other agencies and airspace users.	• Reducing the number and types of NAS interfaces and systems to reduce FAA costs. • All parties—FAA, airlines, and airports—will have access to the same information, without directly connecting to another system, giving users the ability to make real time decisions and improving use of existing capacity and improve security.	• The SWIM program is making progress with the implementation of several of the initial capabilities (Weather and Flight Data). • FAA is continuing to add new SWIM capabilities in 2016. • Extensive use of SWIM by FAA systems is not expected is not expected until 2020 or later.	• Total for the program to date is $542.3 million. • $306.5 million baselined for the first segment. • $116.2 million baselined for segment 2A. • $119.6 million for segment 2B.

Program Description	NextGen Expected Benefits	Current Status	Costs
Data Communications (DataComm)			
DataComm will provide data link communication services between pilots and air traffic controllers by providing a human link between ground automation systems and flight deck avionics.	• Reduced impact of ground delay programs. • Reduced communication errors. • Improved controller and pilot efficiency through automated exchange of information. • Increased controller productivity, but impact on the size of the controller workforce has yet to be quantified. • Enabled NextGen services (e.g., enhanced re-routes, trajectory operations).	• FAA is working to accelerate plans to provide departure clearance services at 57 airport towers by the end of 2016. This is consistent with the NextGen Advisory Committee investment priorities. • Initial en route services planned for first site Initial Operating Capability for July 2019 but full en route services are not expected until after 2022.	• Initial phase of the first segment baselined at $741.5 million through 2019. • A second phase of the first segment for en route and services baselined at $1238.2 million through FY 2023.
NAS Voice System (NVS)			
NVS is a new air traffic control infrastructure that will provide network-capable switches and control data and voice communication paths.	• Uses a network-enabled system of switches to connect the communication lines between pilots, controllers, and facilities. Replaces obsolete hardware and software; provides an architecture that supports future growth. • Replacement of the 11 different voice switching systems (in both the Terminal and En Route environments) is expected to reduce maintenance and parts inventory costs.	• FAA has funded the development of the prototype systems for testing and design work. • However, FAA does not yet know how many systems it will procure or if the system will address the requirements for integrating UAS operations into the National Airspace System (NAS) or improving resiliency. • NAS wide use of the new NVS is not expected until 2020 at the earliest.	• The current cost is baselined at $294 million, but cost to fully implement the new voice system throughout the NAS is unknown.

Exhibit D. FAA's Transformational Programs – Benefits and Status

Program Description	NextGen Expected Benefits	Current Status	Costs
Common Support Services – Weather (CSS-WX) – Formerly known as NextGen Network Enabled Weather (NNEW)			
CSS-Wx, formerly known as NextGen Network Enabled Weather (NNEW), will provide SWIM-based weather distribution for FAA weather programs.	• CSS-Wx will replace legacy FAA weather distribution systems and will provide weather information using SWIM. • Is expected to provide a single source for FAA's published aviation weather information in standardized formats into the NAS. • Is expected to publish and distribute improved weather products provided by the NextGen Weather Processor (NWP), the National Oceanic and Atmospheric Administration (NOAA), and other legacy FAA weather sources. • Will make weather information available for the FAA's NextGen enhanced decision-support tool. • Improve collaboration between FAA and airlines by having common access to virtual weather database	• FAA has re-thought its NextGen weather efforts and recently baselined the program in March of 2015 for initial development. • CSS-Wx initial segment which consists of design, selection of hardware, and development of system and software, to include integration, testing and development. • FAA does not have a mature concept of requirements for integrating weather information into air traffic control automation or decision-making tools.	• FAA baselined CSS-Wx and the NWP in March 2015 for $120.1 million and $189 million respectively through FY 2022. • The total cost to implement the program remains unknown.
Collaborative Air Traffic Management Technologies (CATM-T)			
Collaborative Air Traffic Management Technologies (CATM-T) provides software enhancements to the existing Traffic Flow Management (TFM) system.	• The primary objective of CATM-T is to further enhance the modernized TFM system and continue deployment of new capabilities in support of Collaborative Decision Making (CDM) between FAA and airlines. • CATM-T provides new functions and enhanced capabilities to the TFM system via software releases to improve NAS traffic flow prediction and overall system capacity.	• Recent problems with ERAM have delayed incorporation of required software enhancements to the system that are necessary for new CATM-T improvements to be completed, such as Airborne Re-Route, which was part of work package 2.	• CATM-T has been baselined at $162 million for second and third segments. • The program is currently planning for 5 segments but additional segments are likely. • As a result, total program cost is uncertain.

Exhibit D. FAA's Transformational Programs – Benefits and Status

EXHIBIT E. MAJOR CONTRIBUTORS TO THIS REPORT

Name	Title
Nate Custer	Program Director
Joseph Hance	Project Manager
Kiesha Butler	Senior Auditor
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Abraham Kim	Analyst
Justin Valanty	Auditor
Arthur Shantz	Technical Advisor
Audre Azuolas	Writer-Editor
Amy Berks	Senior Counsel

Federal Aviation Administration

Memorandum

Date: September 9, 2016

To: Matthew E. Hampton, Assistant Inspector General for Aviation Audits

From: H. Clayton Foushee, Director, Office of Audit and Evaluation, AAE-1

Subject: Federal Aviation Administration's (FAA) Response to Office of Inspector General (OIG) Draft Report: NextGen Transformational Programs

FAA disagrees with many of the draft report findings and statements because the OIG did not provide sufficient and appropriate evidence to justify its findings and conclusions. Specifically, the Agency offers the following comments:

- The OIG's finding that the "FAA's progress in implementing programs is hindered by a lack of finalized requirements, as well as complex integration issues for programs," is incorrect. The FAA follows the Office of Management and Budget (OMB) Circular A-11 for the development and implementation and acquisition of complex programs. The NextGen Concept of Operations defined in the Future of the National Airspace System (NAS), the NextGen Business Case, the NAS Enterprise Architecture (EA) and the NextGen Segment Implementation Plan (NSIP) provide the FAA's long-term planning and budget projections from which all programmatic actions are then derived and presented to the Joint Resource Council (JRC) for approval in useful segments.
- The FAA disagrees with the OIG's statement that a segmented "approach masks how much a program will ultimately cost." The total cost of an investment program is not masked—the JRC reviews the entire program cost estimate. The segmented approach enables the agency to better anticipate future program planning and affordability. This approach was adopted to achieve both near-term successes and reduce risk over the long-term. Additionally, in response to a recommendation from an OIG audit report[1] issued earlier this year, FAA includes all baselined costs of programs in its annual System Acquisition Baseline Performance Report. This includes the cost for active and completed segments to show a total cost for each program. As follow-on segments are approved and baselined they will be added to the report.
- The draft report cites, "the majority of benefits for DataComm depend on airspace users purchasing and installing costly new equipment, which many are reluctant to do, leaving uncertainty as to when benefits might be achieved." Again, this is incorrect. As of

[1] FAA Reforms Have Not Achieved Expected Cost, Efficiency, and Modernization Outcomes (AV-2016-015). https://www.oig.dot.gov/sites/default/files/FAA%20Organizational%20Structure_Final%20Report%5E1 -15-16.pdf

August 2016, there are over 1,700 Data Comm capable aircraft operating in the NAS. This number does not include other aircraft that can participate in the program such as International, General Aviation (GA), and the Department of Defense who can realize the benefits of Data Comm at no cost for equipage. The program efforts to incentivize equipage have been a great success and the initiatives are ahead of plan to achieve the 1900 aircraft equipped target by 2019.

- The draft report states that "the transition to SWIM has been uneven and has not gained traction within the FAA." To the contrary, SWIM is providing the services to the customers per the acquisition baseline commitments. SWIM is exchanging terabytes of data between internal FAA systems and with external customers.
- The draft report cites that there is "considerable uncertainty as to whether airlines will be able or willing to meet the 2020 mandate" for ADS-B. All ground systems are in place and industry has been clear through the Equip 2020 initiative, and at the NextGen Advisory Committee (NAC) that they are committed to conforming to the rule. The airlines have demonstrated this commitment by individually briefing their equipage plans to the other NAC members. With respect to GA equipage, DOT developed an incentive program for the most difficult to equip planes, and we are using this incentive as a way to test and jumpstart the installers' capacity for handling the volume of aircraft required to equip. Again, the OIG does not provide evidence to quantify how it arrives at this "considerable uncertainty" determination.

Based upon our review of the draft report, we do not concur with the recommendation because it is unnecessary. FAA NextGen Transformational Program investments are made in accordance with OMB Circular A-11 and provide a business case that demonstrates to the Agency, OMB, and Congress, that disciplines of good project management are being employed to define and manage the cost, schedule and performance goals of the project and that it is worthy of public investment. Additionally, FAA plans and documents its investments in the NAS EA and the NSIP.

Fundamentally, the benefits must outweigh the cost which we demonstrate for each useful segment of any program presented to the JRC for approval. Further, we demonstrate the overall benefit of the NextGen effort outweighs its cost in the NextGen Business Case. We do not believe FAA needs a new nomenclature to substantively affect the nature of its investments, change the management of those investments or reduce the overall risk.

We appreciate this opportunity to offer additional perspective on the OIG draft report. Please contact H. Clayton Foushee at (202) 267-9000 if you have any questions or require additional information about these comments.