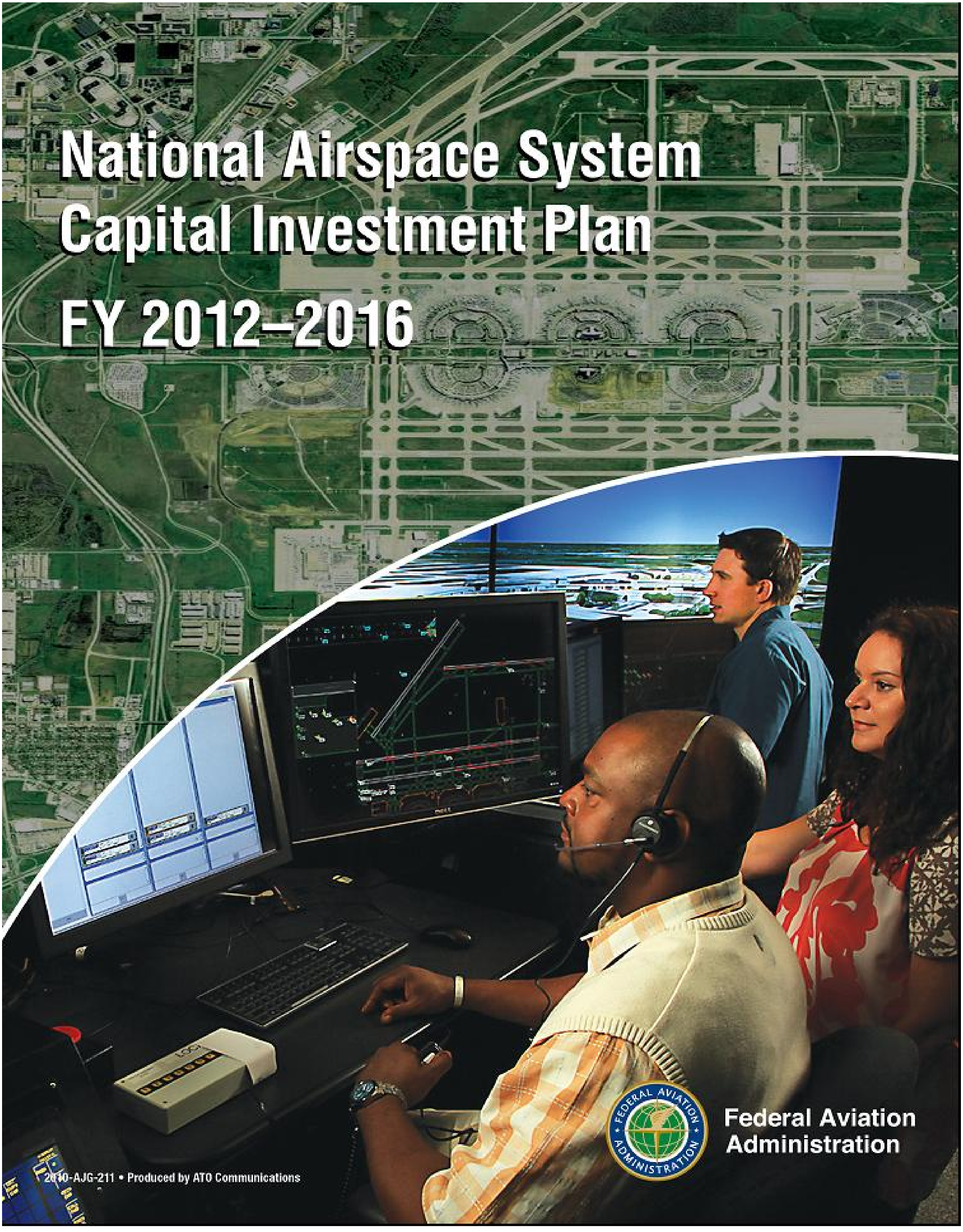


National Airspace System Capital Investment Plan

FY 2012–2016

Federal Aviation Administration

2010-AJG-211 • Produced by ATO Communications

Table of Contents

Table of Figures

(Page intentionally left blank)

Executive Summary

The Federal Aviation Administration (FAA) Capital Investment Plan (CIP) is prepared annually as required by provisions in legislation. In addition to addressing the legislated requirements, the CIP is a valuable tool for meeting the internal need for managing complex modernization of the National Airspace System (NAS). It assists FAA management in balancing the pace of modernization with available resources, focuses investments on meeting strategic goals, and allows the integration of program planning necessary to manage interdependencies and product deliveries. The CIP describes planned capital investments for the next five years consistent with the amount requested in the annual budget submission.

The planned project accomplishments shown in the CIP are consistent with the President's Fiscal Year (FY) 2012 budget request and out-year funding estimates. These out-year funding amounts are changes from the 2010 CIP and require a re-plan of our modernization program. Our planning allows us to remain on track to deliver the FAA's core framework for Next Generation Air Transportation System (NextGen) implementation, particularly the capabilities requested by the aviation community. These core elements include improving surface operations, freeing up metroplex congestion and implementing Automatic Dependence Surveillance-Broadcast (ADS-B) ground infrastructure, progress that focuses on delivering capabilities to operators and benefits to the public. This CIP slows the deployment, however, of certain transformational NextGen capabilities, such as Data Communications and the NAS Voice System, and it defers some research and development activities. It also defers construction activities of NextGen facilities.

We have only had time to do a preliminary adjustment to funding levels and planned accomplishments. Rather than defer sending the CIP, we are sending this version which is based on the planning that was completed late last fall. In most cases it is a reasonable representation of the work that needs to be done to improve air traffic control. The FAA goals to increase capacity and improve efficiency remain the same, so the operational improvements should remain stable. The major changes will be to the scheduled implementation of these improvements. We will prioritize our investments to focus on those operational improvements that have industry support and the potential for early benefits.

The detailed analysis needed to update implementation schedules and the enterprise architecture roadmaps will take several months. We must review the service roadmaps and modify them, as necessary, to adjust the implementation schedules for operational improvements. The next step is to identify which systems are needed to support the planned timelines shown in the service roadmaps. The enterprise architecture roadmaps will be adjusted to show the progression from the current NAS to its planned future configuration. We plan to complete this work in time for it to be included in the Fiscal Year (FY) 2013-2017 CIP.

In addition to financing NextGen, NAS investment must continue to maintain the reliability and availability of systems used for current operations. We anticipate that significant levels of investment will continue to be allocated to sustaining current infrastructure to prevent failures and maintain the reliability and efficiency of current operations.

Federal Aviation Administration National Airspace System Capital Investment Plan for Fiscal Years 2012–2016

1 Introduction

1.1 The Capital Investment Plan

The Federal Aviation Administration (FAA) Capital Investment Plan (CIP) describes the planned investment in the National Airspace System (NAS) for the next 5 years. A provision in annual appropriations laws requires us to transmit to the Congress a comprehensive capital investment plan for the FAA which estimates funding for each budget line item for 5 years. The total funding for each year is limited to the funding targets included in the President's Budget Request.

The planned activities for CIP projects are consistent with both the President's fiscal year (FY) 2012 budget request and our projected future year estimates. Several factors determine how funding estimates for budget line items are developed. Funding for a large capital investment project is based on the amount that fulfills commitments in the acquisition contract, and it also includes the associated project support costs. For infrastructure improvements, the estimated funding is either the estimated cost for specific locations or the annual amounts allocated to upgrade existing facilities and equipment based on facility condition surveys.

1.2 Strategic Planning and the CIP

The FAA's strategic plan is being used to relate the capital projects to our goals, objectives and performance targets. The strategic plan articulates the most important goals for improving our performance in delivering aviation services. These goals guide us in upgrading NAS systems and adjusting operating procedures to meet the demands that future growth places on the system. Our strategic goals are supported by objectives, strategies, and initiatives that identify actions we need to take to meet the associated performance targets. Each objective has measurable performance targets that allow us to measure our progress in meeting the overall goals. We regularly compare our actual performance to the established targets to determine whether our strategies and initiatives are successful and quickly make adjustments when they are not producing the expected results.

The FAA strategic plan covers four goal areas:

- **Increased Safety—**To achieve the lowest possible accident rate and constantly improve safety;
- **Greater Capacity—**Work with local governments and airspace users to provide increased capacity in the United States airspace system that reduces congestion and meets projected demand in an environmentally sound manner;
- **International Leadership—** Increase the safety and capacity of the global civil aerospace system in an environmentally sound manner; and
- **Organizational Excellence—**Ensure the success of the FAA's mission through stronger leadership, a better trained and safer workforce, enhanced cost-control measures, and improved decision-making based on reliable data.

We tie our capital investments to the strategic plan by identifying the goal they support. Many FAA projects will contribute to more than one goal, objective, or performance target; however, the project linkages in the CIP (appendices A and B) connect each project to the single goal, objective, and performance target for which that project's contribution is most significant. In the summary tables in appendix A, several projects appear under each performance measure. This is because many projects are interdependent, and one project may not be successful in meeting a performance target without completing other supporting projects. Also, in the complex system used for air traffic control, system improvements must address several different operating conditions to reach the overall performance target, and often it takes multiple projects to address each of the variables, which individually contribute to overall system efficiencies.

To better explain how a project contributes to a strategic goal we include a section titled, "Relationship of Program to FAA Strategic Goal, Objective, and Performance Target" in Appendix B that gives more specific information about how each project helps meet a Strategic Plan goal.

1.3 Management Process for Selecting Modernization Projects

In addition to relating capital investment to agency strategic goals, FAA management uses a disciplined process for determining funding amounts for modernization projects. For the budget year, there is a rigorous method for evaluating and approving funding for projects. To obtain approval, many projects are required to develop a business case that estimates both project cost and benefits. A Capital Investment Team composed of representatives from budget and finance, and, as appropriate, representatives of ATO vice-presidents and other FAA organizations, reviews this business case and other factors to determine whether the project should be funded. Initial approval to proceed with a program is made by one of the three FAA executive levels designated as the Investment Decision Authority (IDA). The largest and most sensitive programs are approved by the highest level IDA which is the Joint Resources Council (JRC) consisting of FAA's top executives. The IDA for significant ATO programs can be the FAA Executive Council (EC) and decisions on small programs are delegated to ATO vice-presidents or FAA associate administrators. The JRC approves or requests changes in a baseline cost and schedule estimate prepared by the integrated product teams. As appropriate, baselines may be established and approved by the EC and ATO vice-presidents. The cost baselines play an important role in formulating future budgets. Information Technology projects for elements of FAA outside the ATO must also be approved by the Information Technology Executive Board (ITEB). Details on how the overall process for Acquisition Management System approval works can be found at http://fast.faa.gov.

Appendix D, requested by the Government Accountability Office, lists major programs and identifies those that have experienced baseline changes and describes the impact of those changes. There are several reasons for increases in a project's baseline. If available annual funding is below the established baseline, the project schedule will have to be extended, which results in increased costs. Shifting labor costs to future years requires inflation adjustments to labor rates, and the labor hours used often increase and exceed the baseline estimates. The other common reasons for baseline increases are that the project encounters technical problems that require additional engineering design and production time, or issues discovered during field installation that require more elaborate site preparation.

To manage projects to stay within the established baselines, project oversight continues after the initial approval. The JRC conducts regular program reviews of progress and assesses the project's potential to deliver the planned benefits within the estimated cost envelope. Projects that are over cost and/or behind schedule can either be restructured or cancelled. We update the Capital Investment Plan financial baseline to reflect these decisions to continue or cancel programs.

Appendices B and C detail 5 years of capital investments, but this Introduction includes roadmaps that have schedule information with a longer time horizon. The roadmaps are an integral part of planning for the future and indicate that modernization of the air traffic control system will continue well into the future. The Service Roadmaps in Section 3 show the schedule for Next Generation Air Transportation System (NextGen) operational improvements and system upgrades that will continue through 2025. Section 4 contains the infrastructure roadmaps that system engineers have developed to show the hardware and software changes needed to implement those improvements. These roadmaps are an essential part of the Enterprise Architecture that support a broader system engineering focus on ensuring that modernization efforts are integrated. They also identify the interactions among those systems to ensure that as modern systems replace the older systems, the air traffic control system will continue to function smoothly during the transition.

1.4 Important Factors Affecting Planning for the Future

1.4.1 Economic Considerations

In addition to supporting increased demand and improving the efficiency of air travel by implementing NextGen, it is important to recognize the impact of our Nation's air transportation industry on economic growth. A study by the Air Traffic Organization (ATO) Performance Analysis and Strategy Service Unit, "The Economic Impact of Civil Aviation on the U.S. Economy," published in December 2009, estimated that aviation accounted for over $1.3 trillion in economic activity in 2007, which is 5.6 percent of the total U.S. economic activity. The spending on aviation-related economic activity supported an estimated 12 million aviation-related jobs, and U.S. air carriers transported over 40 billion revenue ton-miles of air cargo. A reliable worldwide aviation network is essential for today's economy. Domestic and international commerce rely on the access and passenger and freight capacity it provides to cities around the world to sustain economic growth.

In addition, civil aviation has a significant impact on the economy of every state in the Union as shown in Figure 1 below. Each state provides unique opportunities for the aviation industry to invest and do business whether it is transportation services or manufacture of aircraft and supporting equipment. Since aviation provides a vital link for people, goods, and services to move throughout the nation and globe, it contributes to overall state economies which collectively increase the national economy. It also creates opportunities for local economic development and national economic growth. From a low of 0.3 percent contribution to State GDP in Delaware to a high of 16.1 percent in Hawaii, it is clear that the aviation industry is a significant part of most state's economic well-being.

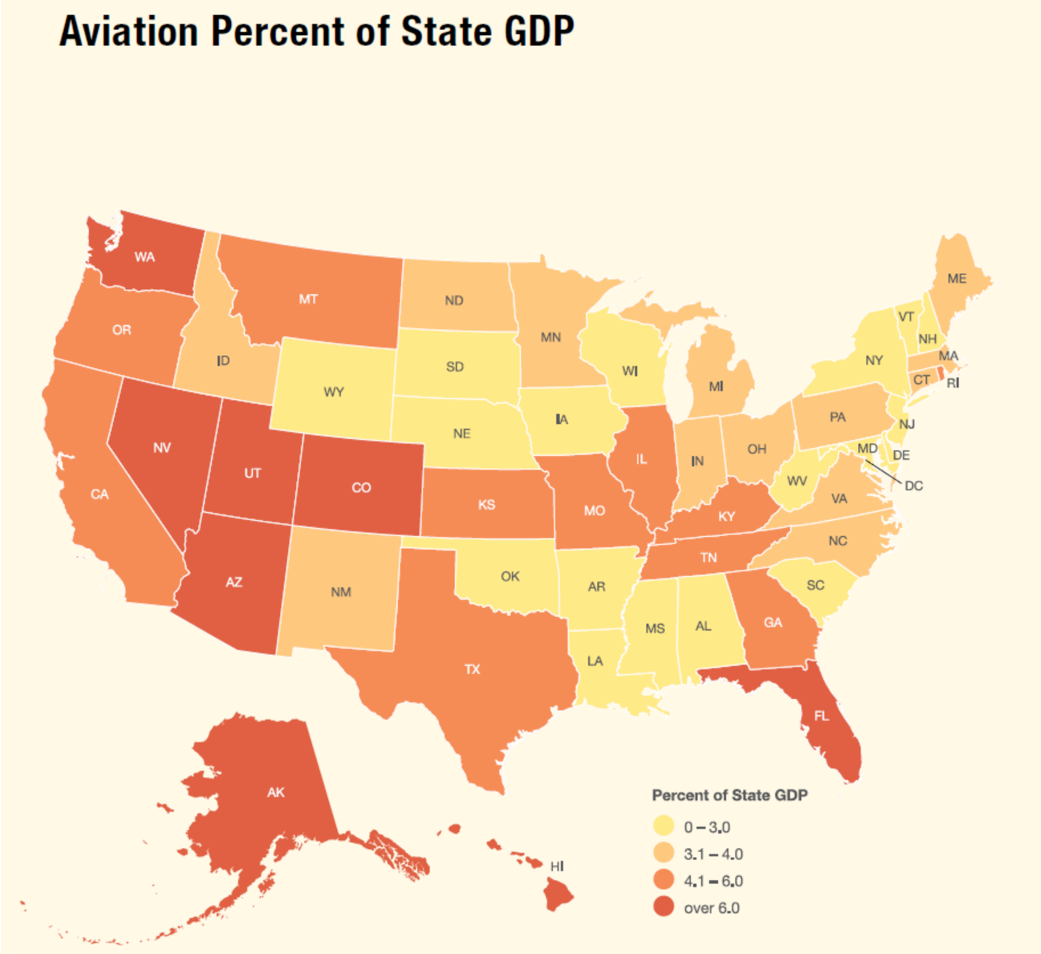


Figure 1 **Aviation Percent of State Gross Domestic Product**[1]

---

[1] Source: "The Economic Impact of Civil Aviation on the U.S. Economy", December 2009.

1.4.2 Air Travel Demand

The demand for air travel is closely related to changes in the economy. As Figure 2 shows the growth trend in revenue passenger miles (RPM) over the last 30 years corresponds positively with the growth in Gross Domestic Product (GDP). The U.S. inflation-adjusted (real) economic output long-term growth trend has supported the continuing increases in the number of passengers and the miles traveled. There are some deviations in both GDP and RPM growth, which are caused by abnormal events, such as the terrorist attacks of September 11, 2001 and the current continuing adjustments in the financial sector. Full data is not available for 2010, but economic growth has resumed. It is at a slower pace than past recoveries, but the pace of long term economic growth is expected to increase because population growth, increases in productivity, and introduction of new technology will promote economic growth. This will result in continued future growth in air travel, which normally leads to more aircraft operations, and translates into increased workload for the FAA. It also translates into more pressure on the core airports to handle additional operations. Significant increases in operations at these airports could increase delays, and we must implement the advanced NextGen capabilities to provide the improved services to handle this growth.

A recent study by the National Center of Excellence for Aviation Operations Research (NEXTOR) Universities estimates the total cost of delay in the current national aerospace system and the potential for increases in these costs in the future. The direct cost of delay in 2007 for domestic airlines and passengers was estimated at $28.9 billion. The indirect cost of delay measured by reduced efficiency and productivity of the U.S. economy was estimated to be nearly $4 billion. The research concludes that, “One can certainly expect that new aviation technologies and procedures, including those associated with Next Generation Air Transportation System (NextGen), coupled with appropriate government policies and infrastructure investments have the potential to reduce the identified costs [of delays] by a very large percentage.”

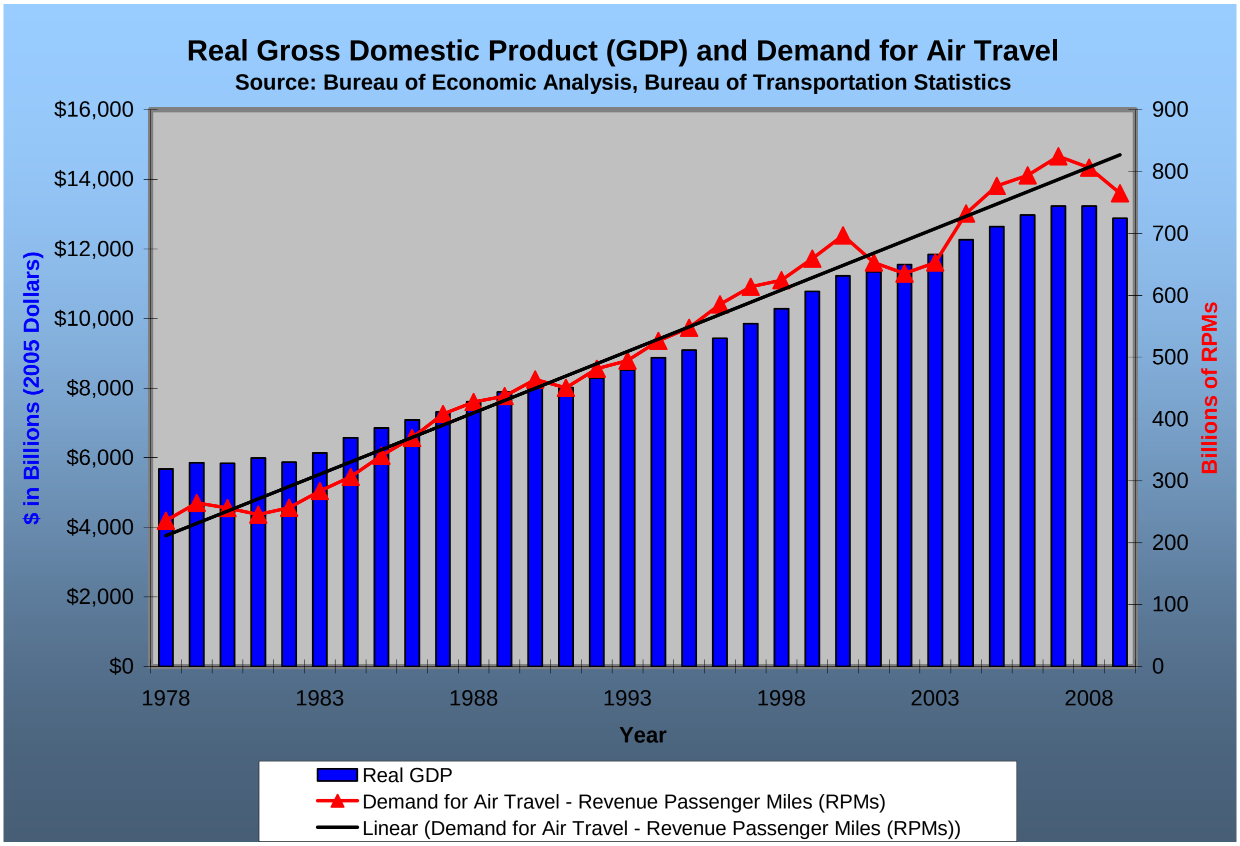


Figure 2 Air Travel Demand Growth Compared to Growth in GDP

1.4.3 Growth in Operations

In FY 2010, preliminary data show that air carrier operations are recovering from the effects of the significant downturn in the economy. Some of the sluggishness is due to air carrier's efforts to adjust their capacity to match demand. Once carriers have exhausted their ability to absorb demand with increased load factors and larger aircraft, operations should begin to increase. The economy is growing, and the Administration's economic forecast is for 3.4 percent annual growth in 2012.

The nature of the past downturn suggests that recovery will be slower than it was in past downturns and the strength of the recovery will be more muted. However, we must plan for the forecasted long term growth when we are considering capital investments. Congestion and delays will increase if the FAA does not complete modernization in time to use airspace capacity more efficiently in future years.

An ongoing effort to increase airport capacity also affects the need for capital investment, especially at the congested airports, which are experiencing significant delays. There are two projects currently active at Chicago O'Hare and Fort Lauderdale to expand capacity. Over the last decade, 23 airfield projects have been started or completed at 20 of the busiest airports, and these projects will provide those airports with the potential to accommodate 1.9 million more annual operations, decrease average delay per operation at these airports by about 5 minutes. These busy airports are critical to overall NAS performance because they handle about 75 percent of airline passengers.

When local airport authorities build new runways or otherwise expand capacity, the FAA must add supporting equipment and develop procedures to make that capacity fully usable. New runways often require that airspace around the airports be reconfigured to accommodate new approach and departure patterns. This frequently requires installing new navigational aids and precision landing systems to help pilots in the approach patterns for the runways. To achieve the full benefits of precision approach guidance systems, the FAA must install approach lights, and position visibility sensors along the runway so that precision guidance can be used down to the lowest visibility approved for that airport. Some airports need new surveillance systems to cover expanded departure and approach patterns. We also need capital investment to expand air traffic control facilities and add additional controller positions to handle the increased complexity of terminal airspace after a new runway is opened.

2 Key Considerations in Capital Planning

Capital investments normally require extensive planning and development time. They often take several years to implement because the systems being purchased are technologically complex and require development of both new software and hardware. New systems require extensive testing to ensure that they meet the reliability standards to be used for air traffic control. Thus, project managers must plan for the operating environment forecast for many years in the future rather than assuming systems that can handle the present level of operations will be adequate. To help project managers assess the future operating environment, the FAA prepares an annual detailed forecast of future aviation activity.

Capital planning also requires carefully balancing investing so that adequate funding is provided to both sustain the highly reliable performance of the current air traffic control system and develop the more capable system that will handle future growth. We must ensure that current operational facilities and equipment deliver reliable and accurate services until our investments in new technology are ready to deliver the operational improvements to provide increased capacity and efficiency.

2.1 Sustaining Current System Performance

The air traffic control system requires very high reliability and availability. Once an aircraft is airborne in controlled airspace, maintaining its separation from other aircraft for the entire flight from takeoff to landing depends on reliable operation of FAA communication, navigation and surveillance systems. Each system in the NAS has a high level of redundancy to support system reliability that will minimize service disruptions, and the FAA must replace equipment regularly to reduce the potential for system failures and prevent deterioration in system performance.

There are nearly 60,000 NAS operational facilities that support Air Traffic Control (ATC) and over 500 large buildings that house major ATC functions. The FAA currently allocates a significant portion of the Facilities and Equipment expenditures to upgrade and replace facilities and equipment that have degraded over time. Uncorrected problems with buildings or the equipment inside can cause expensive disruptions in air traffic control.

2.2 Making Interim Upgrades to Existing Equipment

In addition to replacing critical facilities and equipment that have been damaged or are experiencing declining performance, the FAA must also upgrade equipment to stay current with manufacturer upgrades. Since many ATC systems now rely on commercial-off-the-shelf hardware and software, we must keep pace with changes as manufacturers release them. Normally each upgrade depends on installation of previous releases, and our skipping an upgrade can often lock us into an obsolescent configuration that we can no longer upgrade.

Electronic components and computer systems become obsolete, and sometimes we must replace them because manufacturers no longer produce repair parts. In other cases, when we replace obsolescent components in one type of equipment, we may need to change parts in connected equipment that sends information to or receives information from that obsolescent part. Examples of systems that the FAA must continually upgrade are the radios controllers use to communicate with pilots and the voice switches that allow controllers access to the many voice channels that they use to communicate with pilots and each other.

The FAA also replaces equipment to reduce operating costs. The payback period for some new equipment can be as short as 1 or 2 years, so it can be economical for the FAA to replace equipment in the short term while designing and testing NextGen systems. When the equipment reduces energy consumption, it has the added benefit of lowering emissions, which is receiving more attention lately. Funding for these projects will continue until the savings no longer exceeds the cost.

2.3 NextGen Investments

NextGen is an umbrella term for the ongoing, wide-ranging transformation of the United States' national airspace system (NAS), including our national system of airports, to ensure future safety, capacity and environmental needs are met. NextGen will allow us to fundamentally change the way we manage air traffic by combining new technologies for surveillance, navigation, and communications with workforce training, procedural changes, and airfield development.

The fiscal year 2012 budget includes $590 million to deploy transformational programs including Automatic Dependent Surveillance - Broadcast (ADS-B), Data Communications (DataComm), NextGen Network Enabled Weather (NNEW), NAS Voice System (NVS), Collaborative Air Traffic Management Technologies (CATMT) and System Wide Information Management (SWIM). These core technologies will allow us to introduce new capabilities promised for NextGen. They provide the communication, navigation, and surveillance technology to support the more sophisticated information flows that are necessary to implement NextGen operations.

The FAA requests an additional $515 million over and above the funding for the transformational programs to develop procedures and technology to support the NextGen solution sets (i.e., trajectory-based operations and the six others described in section 3). Future investments in improved communications, navigation, surveillance, and automation systems will support transition to a more capable air traffic control system, which will result in more efficient use of available capacity, as well as reducing the cost of air travel and reducing its environmental impact.

This CIP shows that we are carefully planning a responsible transformation of the existing air traffic control system to a newer system with far greater capabilities while maintaining the current system at peak operational performance.

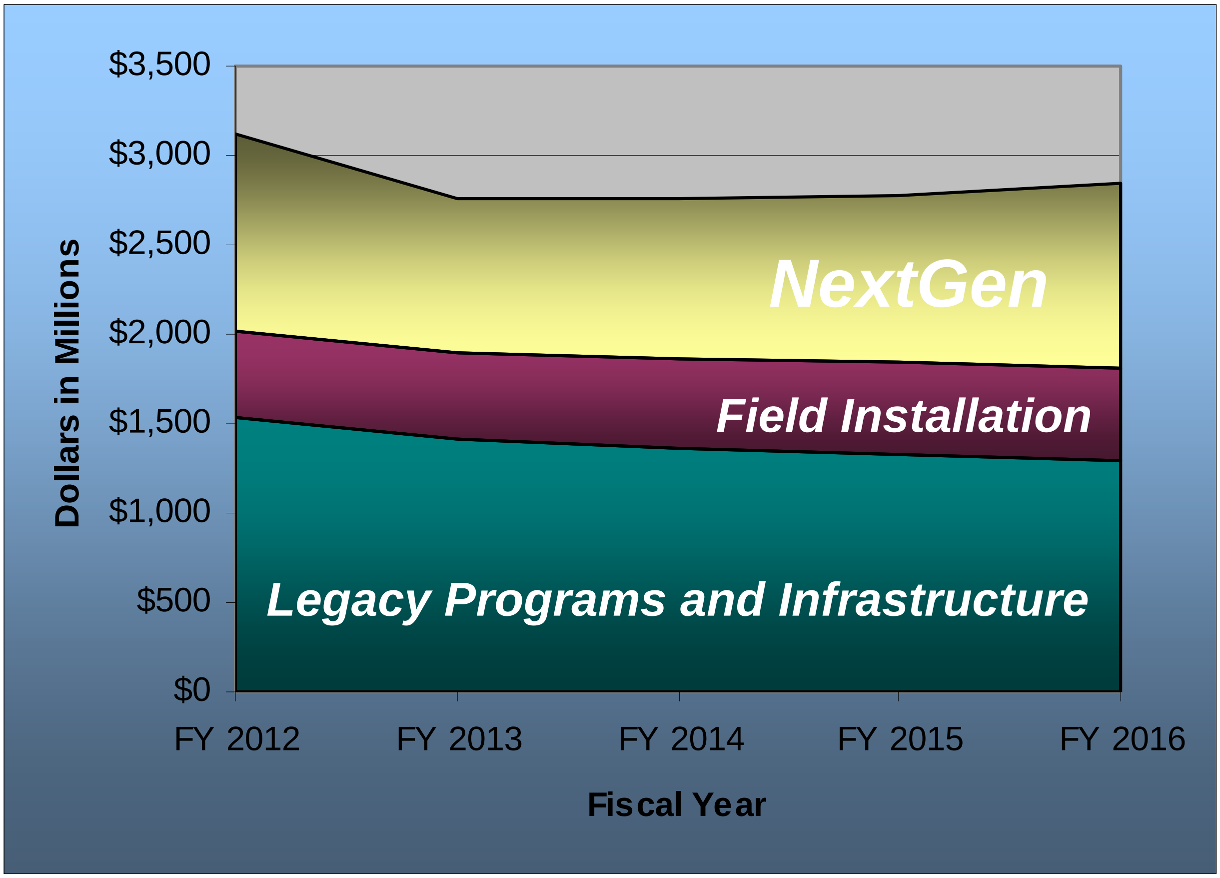


Figure 3 **NextGen Portfolio Relative to the Total Capital Request**

3 Next Generation Air Transportation System

The FAA has begun evaluating and demonstrating improvements to the existing air traffic control system to keep pace with expected future demand. Passenger bookings are increasing for some air carriers and air freight tonnage is increasing. In the short term, this demand is being met by increased load factors and replacement of smaller regional aircraft with larger aircraft. If growth reappears as expected, increased operations will be necessary to support the demand, and our current air traffic control system is neither scalable nor flexible enough to meet significant increases in future demand.

Some current efforts to introduce NextGen capabilities include:

- incorporating the ability to handle ADS-B surveillance data into terminal and en route automation systems;
- improvements to Conflict Alert systems for en route controllers,
- designing procedures that offer the most benefits to aircraft that equip to make use of NextGen improvements,
- evaluation of surface management techniques at Memphis and Orlando,
- installation of new runway visual range sensors and distance measuring equipment to increase the number of landings airports can accommodate
- prototype demonstrations of the Tower Flight Data Management System, and
- Preparation of NextGen test beds at three locations

Our planning for NextGen investments, as reflected in this Plan, allows us to remain on track to deliver the FAA's core framework for NextGen implementation, particularly the capabilities requested by the aviation community. These core elements include improving surface operations, freeing up metroplex congestion and implementing ADS-B ground infrastructure, progress that focuses on delivering capabilities to operators and benefits to the public. Highlighted below are more details about these core elements of NextGen.

- **Surface Movement Improvements**

By installing surface monitoring systems and integrating the information into automation support and sharing that information with aircraft operators, we can decrease taxi delays and fuel consumption. Taxi route instructions can be issued from automation systems and aircraft conformance to those instructions can be tracked to ensure ground operations are more efficient by reducing the time to taxi to the runway.

- **Metroplex Airport Operations**

In addition to improving efficiency of ground operations at major metropolitan area airports as noted above, several steps can be taken to reduce approach path length and improve runway utilization. Development of Required Navigation Performance (RNP) approach procedures creates shorter approach paths for equipped aircraft. Improvements that support higher utilization of closely spaced runways allow a larger number of arrivals and departures in limited visibility conditions. Restructuring airspace around these large airports can increase the efficient sequencing of aircraft and promotes fuel efficient procedures and shorter approach paths.

- **Automatic Dependent Surveillance**

Funding of the nationwide implementation of ADS-B will continue. Using this system will improve the accuracy of position information available to controllers resulting in better use of available airspace and increased safety for general aviation operations. ADS-B already provides a major improvement in air traffic safety and efficiency over the Gulf of Mexico, and advanced applications will support efforts to allow pilots to self separate in areas with limited radar coverage.

The roadmaps in this CIP reflect the scope of the NextGen initiatives as contained in the 2010 planning cycle, but once the service roadmaps and enterprise architecture roadmaps are revised over the next several months, it likely there will be an adjustment in scheduled activities.

NextGen solution sets described in this section identify specific operational improvements that will enhance system capacity and efficiency. Integration efforts have been ongoing to identify the capital improvements necessary to meet these timelines (the roadmaps in section 4 show the 2010 approved estimate for progression from the current system to NextGen capabilities). Sections 3.1 through 3.7 describe the mid-term operational improvements and initiatives that will require funding in the FY 2012 and future budgets.

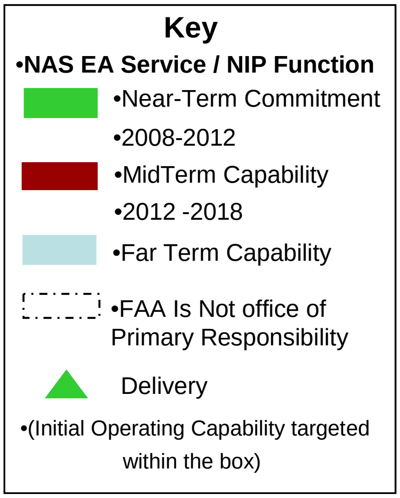


Figure 4 Service Roadmap Legend

3.1 Initiate Trajectory Based Operations

Summary Description:

Trajectory-Based Operations (TBO) will improve efficiency of operations. Aircraft will be assigned to fly negotiated trajectories, which allows airspace to be used more efficiently. Computer automation—ground and airborne—creates these trajectories, and the trajectories are exchanged with aircraft by DataComm, a data link system that can automatically transmit data from FAA facilities to aircraft and receive return messages. ADS-B continually updates the aircraft position, so the controller can determine whether the aircraft will remain free of conflicts with other aircraft and restricted airspace. Key elements in making TBO work are the accurate exchange of complex information that DataComm provides and FAA's ability to negotiate via DataComm with pilots on how to maneuver if they have to deviate from their approved trajectory. This solution set focuses primarily on en route cruise operations, although all phases of flight will benefit from TBO.

Timeline:

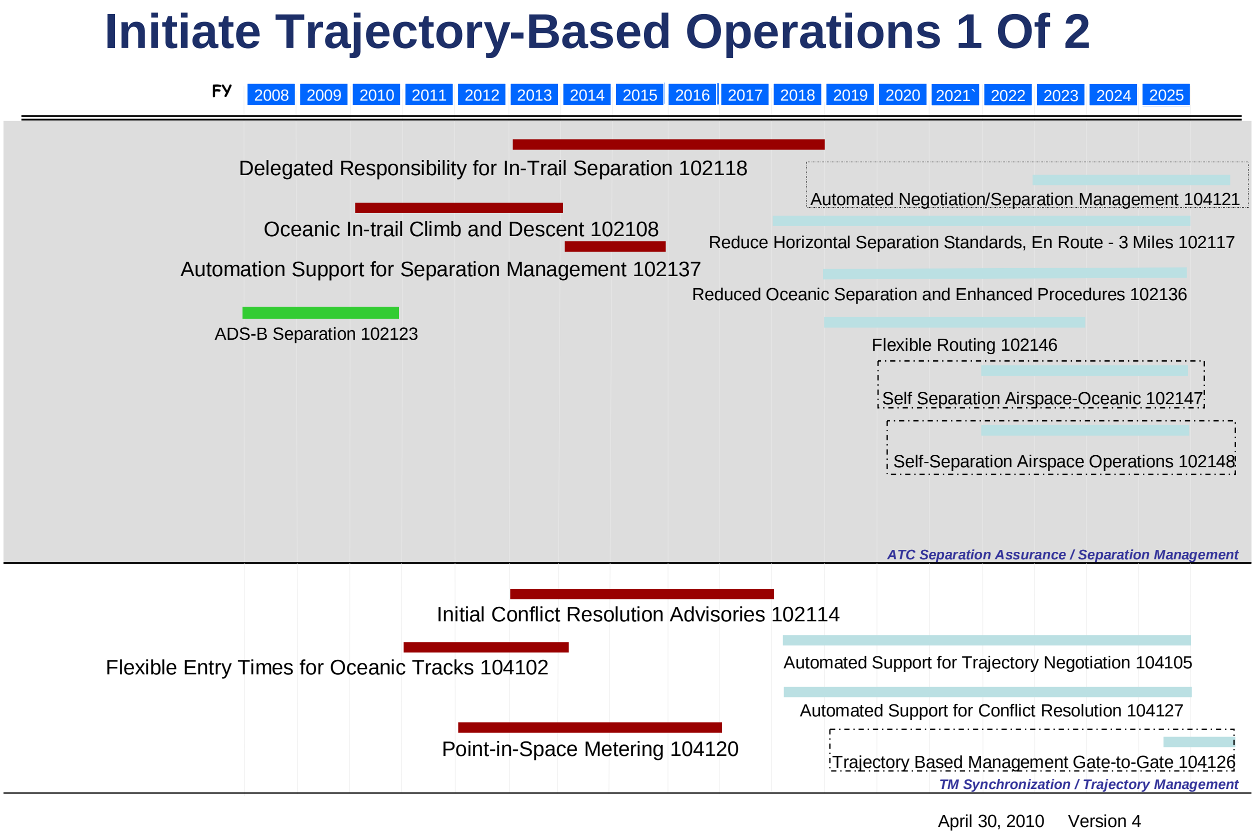


Figure 5 Trajectory Based Operations (1)

Operational Improvements

This section describes the mid term-planned operational improvements associated with TBO. In Figure 5, the ATC Separation Assurance/ Separation Management services area, planned improvements are the following:

1. Delegated Responsibility for In-Trail Separation would allow pilots, when authorized by the controller, to maintain safe spacing with other aircraft. The aircraft would have to be equipped with Cockpit Display of Traffic Information (CDTI) and Automatic Dependent Surveillance – Broadcast (ADS-B). The CDTI would display surrounding aircraft to pilots. Air traffic control facilities would have to be equipped with the En Route Automation Modernization (ERAM) Mid-term work package and ADS-B display capability so controllers could monitor separation.
2. Oceanic In-Trail Climb and Descent, when authorized by the controller, would allow aircraft to safely reduce separation from the aircraft in front of them for quicker entry to their desired altitude on climb and fly more optimal descent profiles on arrival to save fuel. The aircraft would have to be equipped with ADS-B and ADS-C (a system similar to ADS-B that is used in oceanic airspace) and Controller Pilot Data Link Capability (CPDLC) and meet Required Navigation Performance 4 (RNP 4). FAA investments would include upgrades to ATOP (an oceanic air traffic automation system) and CPDLC capabilities.
3. Automation Support for Separation Management would provide controllers with the tools to manage aircraft with differing navigation capabilities and provide safe separation when following aircraft are affected by the wake turbulence of an aircraft in front of them. The ERAM D-position upgrade and system enhancements will have to be operational.

In the TM Synchronization/Trajectory Management services area the planned improvements are the following:

1. Initial Conflict Resolution Advisories are an enhancement to the existing conflict probe software to provide rank-ordered advisories to the controller to better accommodate pilot requests for trajectory changes. FAA facilities must be equipped with the ERAM D-position upgrade and system enhancements; the upgraded Weather and Radar processing system (WARP); the 4-dimensional Weather Cube; and in the latter stages the NextGen weather Processor, which will replace WARP.
2. Flexible Entry Times for Oceanic Tracks will allow aircraft to reach their preferred trajectories sooner, which will minimize fuel burn. The FAA will have to upgrade the Dynamic Ocean Track System (DOTS) or develop the 4D Oceanic Trajectory Management (OTM4D) system and the accelerated Terminal Data Link System (TDLS) to support this capability. The DOTS analyzes weather data and calculates the most efficient tracks for oceanic flights, and the TDLS provides automated departure clearances to aircraft.
3. Point-in-Space Metering uses scheduling tools to ensure smooth flow of traffic and efficient use of airspace. The FAA will invest in Collaborative Air Traffic Management (CATM) upgrades; the ERAM D-position upgrade and system enhancements; and the Time Based Flow Management (TBFM) tool to implement this capability. Pilots are assigned a specific trajectory and scheduled times to reach specific points on the assigned

trajectory. This maximizes use of airspace by reducing the need to alter aircraft flight paths to maintain separation.

Timeline:

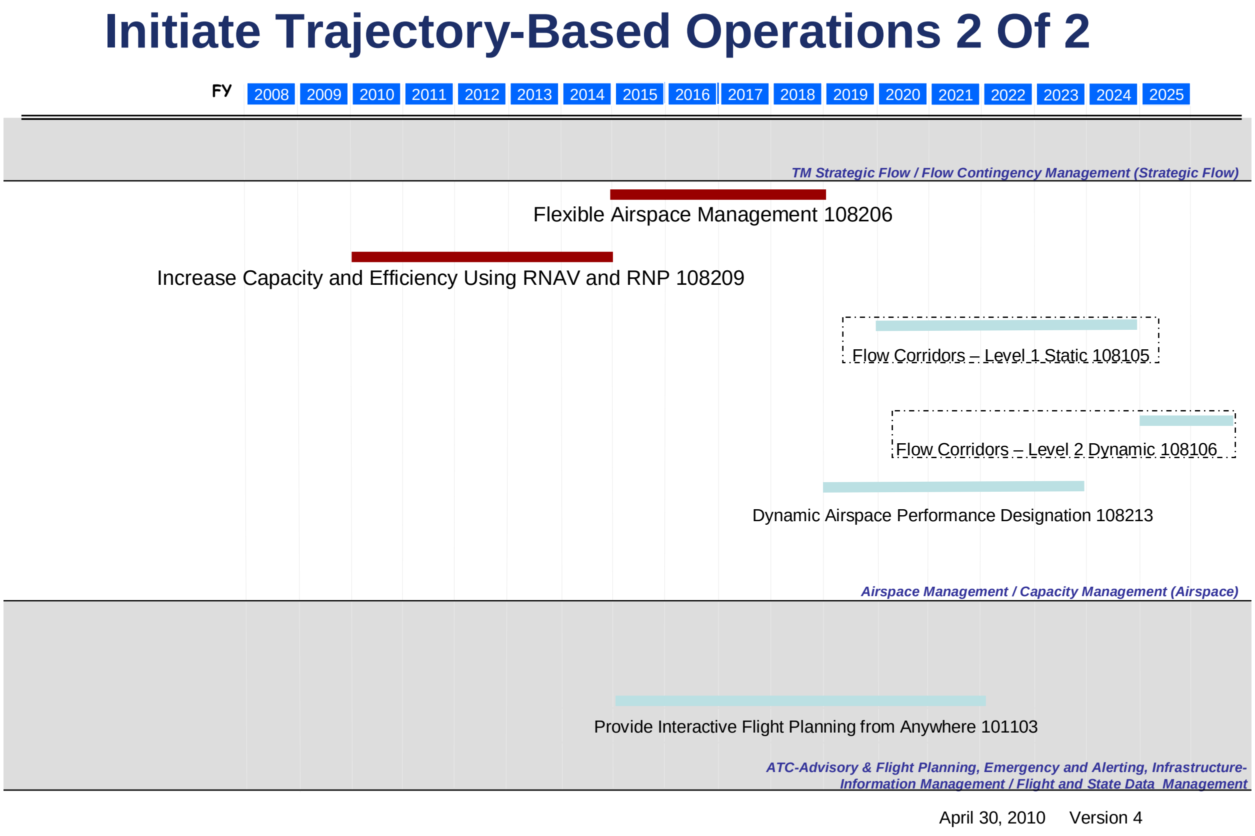


Figure 6 Trajectory Based Operations (2)

In Figure 6, the Airspace Management/Capacity Management service area's planned mid-term improvements are:

1. Flexible Airspace Management upgrades automation to support reallocation of aircraft status information to different controller positions and, in some cases, to different facilities. These improvements will allow facility managers to better match the volume of traffic with available staffing. The FAA investments to implement this capability include the Airspace Information Management (AIM) system; CATM work packages 2 and 3; the ERAM Mid-term work package; terminal automation upgrades; Time Based Flow Management (TBFM); the NextGen Weather Processor; and the NAS Voice System.
2. Increase Capacity and Efficiency Using Area Navigation (RNAV) and Required Navigation Performance (RNP) would expand the number of approach and departure

routes at airports for those aircraft equipped with highly accurate aircraft navigation systems and qualified pilots. The FAA would have to invest in CATM work package 2; ERAM release 2 and the ERAM D-position upgrade and system enhancements; WARP and Integrated Terminal Weather System (ITWS); the 4D weather cube and additional Distance Measuring Equipment (DME) systems. More accurate weather information allows the FAA to reduce the length of diversions to alternative flight paths when they are needed to avoid severe weather.

3.2 Increase Arrivals and Departures at High Density Airports

Summary Description:

This solution set addresses improving use of available capacity at airports:
- With large numbers of operations;
- That have multiple runways with both airspace and taxiing interactions; and
- In close proximity to other airports that have the potential for airspace interference.

Operational issues make it difficult for an airport to achieve its maximum arrival or departure capacity. If the arrival stream to an airport contains a mixture of small and large aircraft, maximizing runway capacity is not possible. Differences in aircraft arrival speed or the effect of wake turbulence from large aircraft require increased separation between aircraft. Wake turbulence from a large aircraft requires controllers to increase separation to 5 miles or more between the two aircraft when a small aircraft is following a larger aircraft. Multiple runways at an airport can also complicate movement of aircraft on the ground and create restrictions on the number of takeoffs from available runways. In major metropolitan areas, multiple major hub airports that have overlapping terminal airspace must share that airspace, and significant restrictions on terminal operations result, when winds dictate that an approach path used for the active runways at one of the airports limits the use of approach paths for certain runways at nearby airports. Operational improvements in this solution set address some of these limitations in order to make more efficient use of the available runways

Timeline:

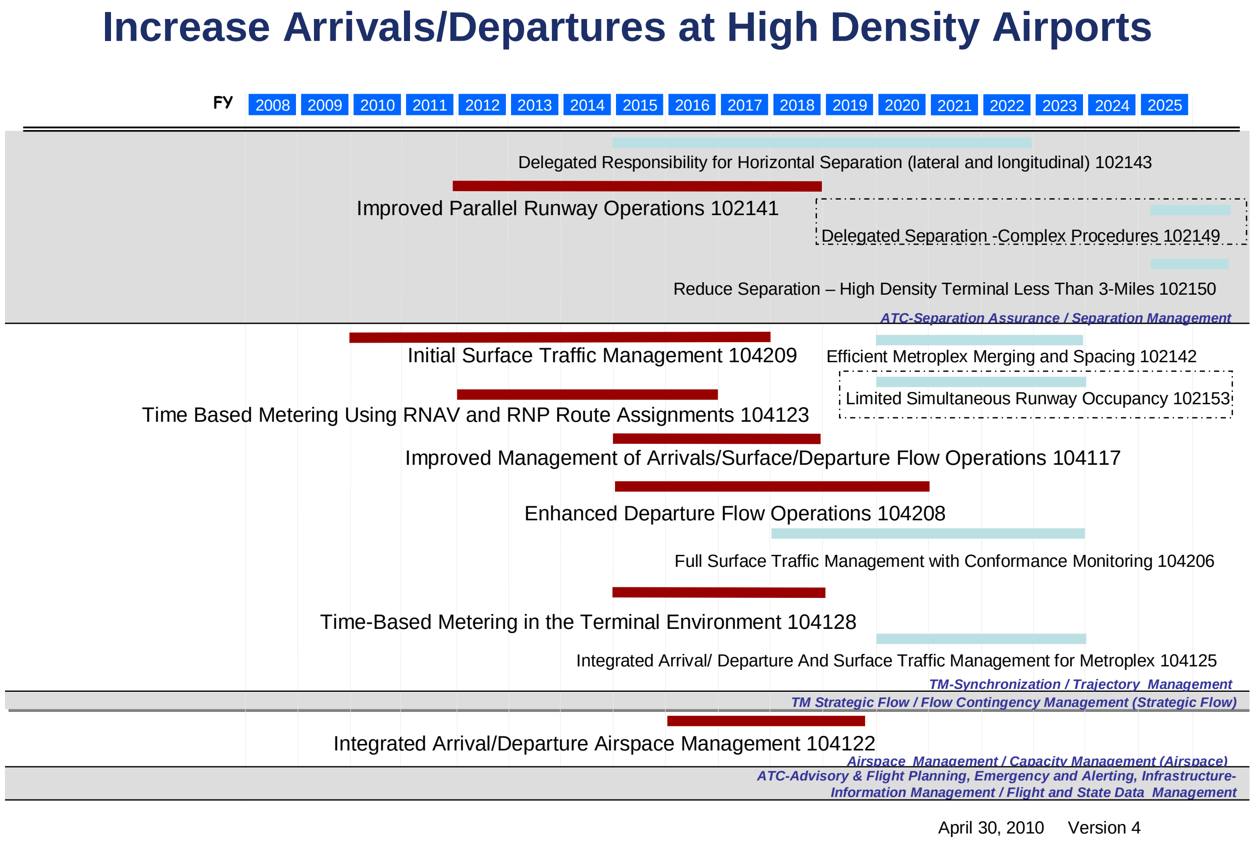


Figure 7 Increase Arrivals/Departures at High Density Airports

Operational Improvements

This section describes the mid-term planned improvements associated with Increase Arrivals/Departures at High Density Airports. In Figure 7 the ATC Separation Assurance/Separation Management service area's planned improvement is:

> Improved Parallel Runway Operations which will explore concepts to recover lost capacity by reducing separation standards for two aircraft approaching side by side to closely spaced parallel runways. When parallel runways are less than 4,300 feet apart, special procedures are required to maintain separation for aircraft approaching the two runways side by side. Depending on the amount of runway separation, these procedures can be for dependent (terminal controller must adjust separation) or independent (ATC shares separation responsibility with the flight deck) operations in lower visibility conditions. Investments planned are an upgraded terminal automation system, the NextGen Weather Processor, the Integrated Terminal Weather System, the Ground Based Augmentation System for GPS, and the Parallel Runway Monitor.

In the Traffic Management Synchronization/Trajectory Management services area, the planned improvements are the following:

1. Initial Surface Traffic Management uses automation tools for departure scheduling to improve flow of surface traffic at high-density airports. Automation provides surface sequencing and staging lists for departures and predicts departure delays. By better scheduling departures from the gate, the time between leaving the gate and takeoff is reduced resulting in fuel and time savings. Investments that support this capability are: Time Based Flow Management (TBFM), Tower Flight Data Manager (TFDM), Airport Surface Detection Equipment, and the System Wide Information Management (SWIM) segment 2.
2. Time Based Metering Using RNAV and RNP Route Assignments allows more efficient use of runways and airspace in high-density airport environments. For those aircraft that are equipped to fly more precise routes and conform to time metering, arrival and departure paths are shortened to save fuel and minimize delays. Investments that support this capability include the ERAM Midterm work package; TBFM; Weather and Radar Processor; 4D Weather Cube; and Distance Measuring Equipment. These investments allow the FAA to establish and use these routes.
3. Improved Management of Arrivals/Surface Departure Flow Operations integrates advanced arrival and departure flow management with advanced surface operations to improve overall airport capacity and efficiency. Arrival and departure scheduling tools and 4D trajectory agreements are used to make collaborative real-time adjustments to aircraft sequencing to optimize use of airport capacity. Investments that support this capability are: Collaborative Air Traffic Management (CATM) work package 2, TFDM, NextGen Weather Processor, and DataComm segments 1 and 2. Automation equipment will be upgraded to incorporate Traffic Management Initiatives, current weather conditions, airport configuration, airline planned gate assignments, requested runways, wake turbulence vulnerability; and flight performance profiles.
4. Enhanced Departure Flow Operations incorporate taxi instructions, surface movement information, and aircraft wake category in decision support tools. Clearances are developed, delivered, monitored and provided in digital data or textual format to the flight deck display. Surface decision support and management systems use ground and airborne surveillance and a scheduling and sequencing system to develop and maintain schedules of departing aircraft to optimize runway use and facilitate transmission of other operational information.
5. Time Based Metering in the Terminal Environment optimizes use of terminal airspace and surface capacity. Automation develops trajectories and allocates time-based slots for various points within the terminal environment, using RNAV routes enhanced surveillance, and data communications. It extends current metering capabilities into the terminal environment and supports end-to-end metering and trajectory-based operations. It also supports capabilities designed to expand the use of terminal separation standards in transition airspace, and builds the foundation for future advanced airborne-based applications that will use ground-based automation to maintain the sequence of aircraft into and out of high density terminal locations.

In the Airspace Management/Capacity Management services area, the planned improvement is the following:

> Integrated Arrival/Departure Airspace Management to take advantage of terminal procedures and separation standards in adjacent en route airspace to increase flow and introduce additional routes and flexibility. Investments that support this capability are the CATM Work Package 3; the ERAM Midterm work package; the TBFM Work Package 3; the advanced terminal automation system; TFDM; Distance Measuring Equipment (DME); and Surveillance Interface Modernization. Airspace redesign will allocate additional airspace to accommodate expanded terminal procedures and more routes to increase capacity.

3.3 Increase Flexibility in the Terminal Environment

Summary Description:

This solution set concentrates on improvements in the access, situational awareness, and separation services that airports of all sizes may require. Unlike the high-density solution set that focuses on increased sophistication of traffic management to manage demand at large airports, this solution set reflects the common needs that all airports have: precision landing guidance, surface situational awareness, and improved management of flight data.

Flexible terminal operations will serve a mix of Instrument Flight Rules (IFR)/Visual Flight Rules (VFR) traffic, with aircraft types ranging from airline transport to small general aviation aircraft. Airports can be towered or non-towered, depending on traffic demand. We anticipate that some satellite airports will experience higher traffic demand due to migration of aircraft with less sophisticated avionics to these smaller airports to avoid traffic congestion. These airports can serve an important role by handling the potential increase in use of personal aircraft for pleasure and business.

Timeline:

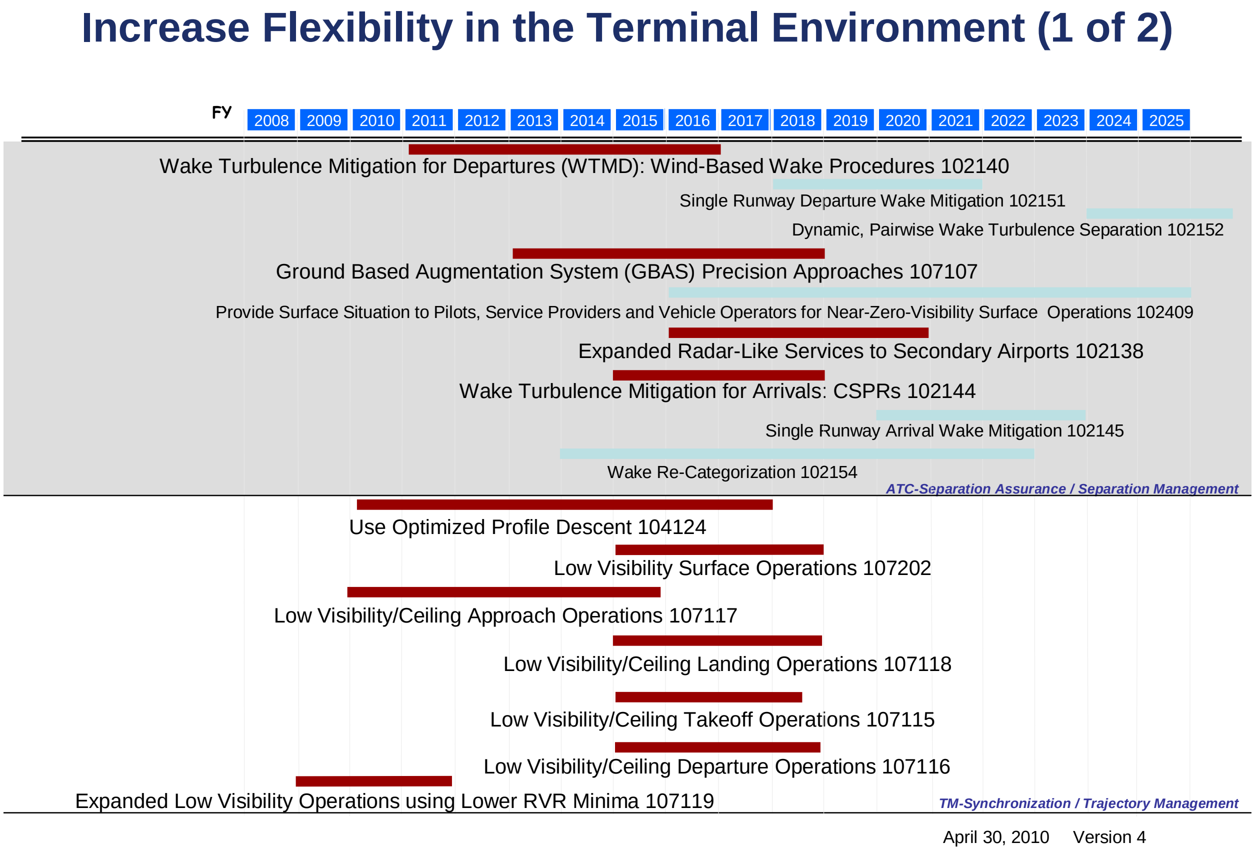


Figure 8 Increase Flexibility in the Terminal Environment (1)

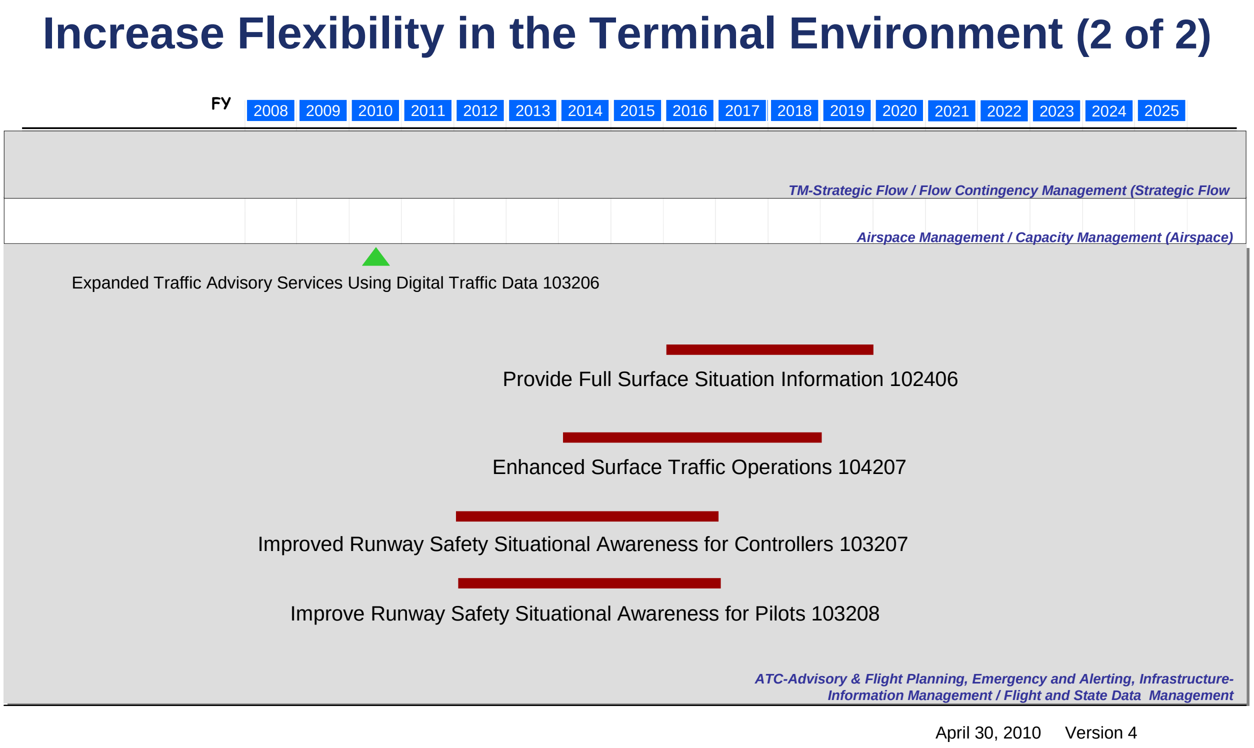


Figure 9 Increase Flexibility in the Terminal Environment (2)

Operational Improvements

This section describes the mid-term planned improvements associated with Increase Flexibility in the Terminal Environment. In Figure 8 the ATC Separation Assurance/Separation Management services area planned improvements are the following:

1. Wake Turbulence Mitigation for Departures (WTMD): Wake turbulence separation standards can be adjusted quickly to allow more departure operations on an airport's Closely Spaced Parallel Runways (CSPR), which would improve use of runway capacity, based on wind measurements. Investments that support this capability are a small laptop sized computer to process observed and forecasted airport wind information, and enhanced tower controller display areas to indicate which runways can be used for immediate departures after a Boeing 757 or heavier aircraft departs on an adjacent CSPR. The wake turbulence generated by a departing 757 or heavier aircraft presents a serious danger to aircraft that depart after them on an adjacent CSPR. Aircraft generated wakes are transported by crosswinds. The WTMD system measures and forecasts runway crosswinds to determine when there will be sufficient crosswind to prevent the wake from a departing aircraft from moving into the takeoff corridor of an aircraft departing on an adjacent runway. Using WTMD during periods of favorable crosswinds will allow controllers to maximize the departure capacity of an airport's CSPR.
2. Ground Based Augmentation System (GBAS) Precision Approaches rely on installing LAAS at an airport to support precision approaches to Category I and eventually Category II/III minimums for properly equipped runways. GBAS can support approach

minimums with fewer restrictions to surface movement and can support curved precision approaches and high-integrity surface movement requirements. Investments that support this capability include TFDM; enhanced terminal automation; National Weather Service Space Weather Center; and the GBAS equipment. This is an economical way to increase the number of runways with instrument approaches that allow operations in low-visibility conditions.

3. Expanded Radar-Like Services to Secondary Airports will be available in Instrument Meteorological Conditions (IMC) at secondary airports. Equipped aircraft will automatically receive airborne broadcast traffic information, and at select airports surface traffic information. Enhanced surveillance coverage will also be available in areas of mountainous terrain where radar coverage is limited.
4. Wake Turbulence Mitigation for Arrivals (WTMA) allows controllers to reduce the instrument flight rules wake mitigation dependent staggered separation for two aircraft landing on an airport’s adjacent CSPR. When crosswinds are stable and strong enough so that the wake of the lead aircraft landing on one runway can not be transported into the path of the following aircraft, controllers can reduce wake mitigation separations. To implement WTMA investments would include a small laptop sized computer to process observed and forecasted airport wind information and enhancements to terminal area controller displays to show the minimum diagonal separation between approaching aircraft.

The Traffic Management Synchronization/ Trajectory Management service area (shown in Figure 8) planned improvements are the following:

1. Use Optimized Profile Descent permits aircraft to minimize power settings during descent to an airport to save fuel. These descent profiles have been tested, and they save significant fuel. Investments that support this capability include: TBFM Work Package 3, the ERAM D-position upgrade and system enhancements, an enhanced terminal automation system, WARP, the NextGen Weather Processor, ITWS, the 4D Weather Cube and DataComm segment 1.
2. Low Visibility Surface Operations improves the safety and efficiency of aircraft and ground vehicle movements on the airport surface because tower controllers have improved location information. Investments that support this capability are: TFDM, Automatic Dependent Surveillance – Broadcast (ADS-B), ASDE 3 and ASDE-X, and Runway Status Lights (RWSL). During darkness or foggy conditions controllers, pilots and ground equipment operators need help in avoiding conflicts on the airport surface. The ground surveillance systems inform controllers of surface movements and the runway status lights alert pilots when it unsafe to enter or cross a runway.
3. Low Visibility/Ceiling Approach Operations improves the ability of aircraft to complete approaches in low visibility/ceiling conditions. It requires aircraft be equipped with augmented GPS, ILS or similar technologies. Investments that support this capability are a 4D Weather Cube and GBAS.
4. Low Visibility/Ceiling Landing Operations permit aircraft to land in low visibility/ceiling conditions when equipped with augmented GPS, ILS or combinations of cockpit

technologies and ground infrastructure. Investments that support this capability are GBAS, Precision Approach Path Indicator (PAPI) and Runway End Identification Lights (REIL).

5. Low Visibility/Ceiling Takeoff Operations allows aircraft to takeoff when visibility is very limited. The aircraft must have advanced vision capabilities such as a heads up display, synthetic vision system, or an enhanced flight vision system.
6. Low Visibility/Ceiling Departure Operations allows appropriately equipped aircraft to depart in low visibility conditions. Investments that support this capability include the 4D Weather Cube and GBAS.
7. Expanded Low Visibility Operations using Lower RVR Minima would allow aircraft to land when visibility is less than current minimums. This capability would depend on aircraft being equipped with sophisticated precision guidance equipment and some form of synthetic vision. The FAA would have to sustain precision guidance systems and the runway visual range equipment. The Runway Visibility Range (RVR) equipment measures visibility along the runway, and normally about one-quarter of a mile horizontal visibility is required before a pilot is allowed to land. With more precise landing guidance and a vision device to see through fog or other obscurations, pilots would be able to land in lower visibility conditions.

In Figure 9, the ATC Advisory and Flight Planning, Emergency and Alerting, Infrastructure Information Management/Flight and State Data Management service area's planned improvements are the following:

1. Provide Full Surface Situation Information by broadcasting aircraft and vehicle position to ground and aircraft displays would provide a comprehensive picture of the airport surface to controllers, equipped aircraft and flight operation centers to enhance safety and efficiency. This would also help prevent runway incursions. Investments that support this capability are TFDM segment 2; ADS-B, ASDE–3 and ASDE–X; and an Airport Wireless System.
2. Enhanced Surface Traffic Operations would use DataComm to exchange taxi clearances, amendments and requests between ATC and aircraft. This would decrease the time to provide clearances to aircraft and potentially decrease taxi and takeoff delays. Investments that support this capability are TFDM and ADS-B.
3. Improved Runway Safety Situational Awareness for Controllers will improve runway safety. Additional ground based capabilities will be developed including improved runway markings and initial controller taxi monitoring capabilities. All of these improvements will increase the controller's awareness of the location of surface traffic. Investments that support this capability are TFDM segment 1; ASDE-3 and ASDE-X; and RWSL.
4. Improved Runway Safety Situational Awareness for Pilots improves pilot awareness of their location on the airport surface. Equipped aircraft will have a surface moving map to display their position and in future enhancements it will show the location of other aircraft near them. Investments that support this capability are TFDM, ADS-B, ASDE-3 and ASDE-X, and RWSL.

3.4 Improve Collaborative Air Traffic Management (CATM)

Summary Description:

This solution set covers strategic and tactical air traffic flow management, including interactions with operators to guide choices when the FAA cannot accommodate the desired route of flight. CATM includes flow programs and collaboration on procedures that will shift flights to alternate routings, altitudes, or times when there is severe weather affecting operators' planned routes, or demand for certain routes exceeds capacity. CATM also includes development of systems to distribute and manage aeronautical information, manage airspace reservations, and manage flight information from preflight to post flight analysis.

Existing ATM tools for managing system demand and capacity imbalances are relatively coarse. Optimal solutions would minimize the extent to which flights are either over-constrained or under-constrained. Flight restrictions can unnecessarily interfere with optimizing operator efficiency and increase the cost of travel. Restrictions also inhibit operators from specifying a preferred alternative and constrain their involvement in resolving imbalance issues. The overall philosophy driving delivery of CATM services in NextGen is to accommodate flight operator preferences as much as possible. Restrictions should be imposed only when a real operational need exists. If restrictions are required, the goal is to maximize opportunity for aircraft operators to maintain operating efficiency based on their priorities while complying with the restrictions.

Timeline:

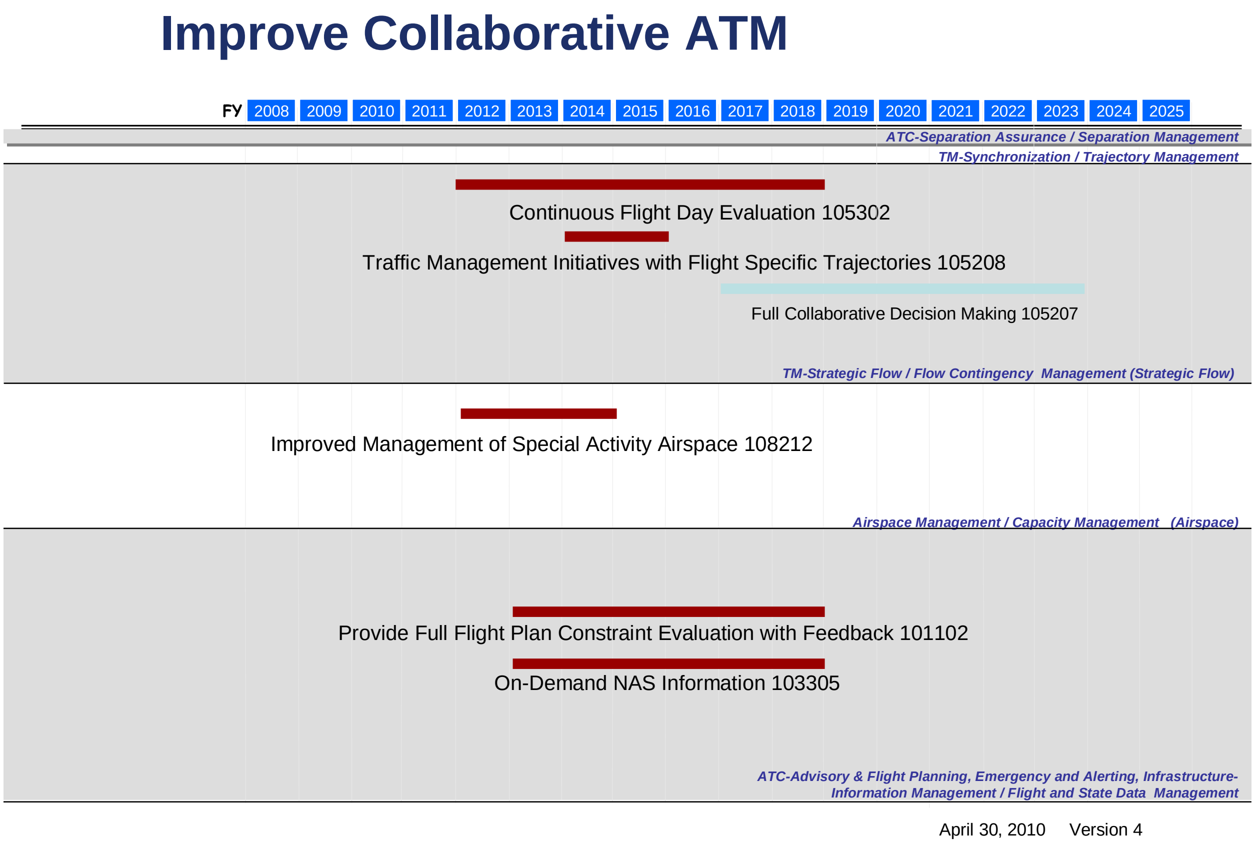


Figure 10 Improve Collaborative ATM

Operational Improvements

This section describes the mid-term planned improvements associated with Improve Collaborative Air Traffic Management.

In Figure 10, the Traffic Management Strategic Flow/Flow Contingency Management service area's planned improvements are the following:

1. Continuous Flight Day Evaluation involves both real-time NAS performance and post-event analysis of traffic management initiatives. Real-time constraints are transmitted to the ATC Command Center to help determine whether ground stops need to be implemented or other air traffic constraints are required. Real-time information minimizes the delays associated with flow restrictions and continuous evaluation of past performance improves future decisions about when they should be used. Investments that support this capability are: the Aeronautical Information Management (AIM)

segment 2, CATM work packages 2, 3 and 4, the ERAM D-position upgrade and system enhancements, an enhanced terminal automation system, and SWIM.

2. Traffic Management Initiatives with Flight Specific Trajectories will generate and send flight specific trajectory changes for aircraft to FAA facilities for approval when these initiatives are implemented. This capability will increase the agility within the NAS to adjust and respond to dynamically changing conditions such as severe weather, air traffic congestion, and system outages. Investments that support this capability are: the CATM work package 2, the ERAM Release 2, ERAM D-position upgrade and system enhancements; Terminal Data Link System (TDLS) Tech refresh, the 4D Weather Cube, the NextGen Weather Processor, DataComm Segment 1, and SWIM segments 1 and 2. Upgrading the information databases and the speed with which information can be shared is essential to this operational improvement.

In the Airspace Management/Capacity Management service area the planned improvement is the following:

> Improved Management of Special Use Airspace calls for upgrading the automated links used to transfer information concerning when airspace reserved for special purposes such as military operations is not being used. Status changes are transmitted to the flight deck via voice or DataComm. Trajectory planning is managed dynamically based on real-time information on special use airspace. The ability to use special use airspace can shorten route lengths and avoid the congestion caused by forcing aircraft into narrow paths between restricted areas. This improvement builds on existing systems with the important upgrade of almost instantaneous information transfer regarding when it is safe to use this airspace. Investments that support this capability are AIM segment 2; the CATM work package 3; the ERAM D-position upgrade and system enhancements and accelerated TDLS.

In the ATC - Advisory & Flight Planning, Emergency and Alerting, Infrastructure Information Management/Flight and State Data Management service area, the planned improvements are the following:

1. Provide Full Flight Plan Constraint Evaluation with Feedback both incorporates constraint information into FAA automation systems and makes this information available to users for pre-departure flight planning. The constraint information includes: equipment outages, air traffic congestion, status of special use airspace, and significant weather information. Providing this information will allow selection of the most efficient flight path and avoid adjustments while in flight that increase flight time and fuel burn. Investments that support this capability are; Flight Service Automation Modernization (FSAM); AIM segment 2; the ERAM D-position upgrade and system enhancements; the CATM work package 3; the 4D Weather Cube; the NextGen Weather Processor, the National Airspace Data Interchange Network (NADIN) Rehost; ADS-B; and SWIM segment 2.

2. On-Demand NAS Information makes NAS status and aeronautical information available to users on demand. It will be available to authorized users and equipped aircraft. This will allow pilots to make informed decisions on routes to fly and conditions at departure

and destination airports. Investments that support this capability include weather observing information display systems; FSAM; AIM segment 2; CATM work packages 2 and 3; En Route Information Display System (ERIDS); the ERAM D-position upgrade and system enhancements; the 4D Weather Single Authoritative Source (SAS), and SWIM segment 2.

3.5 Reduce Weather Impact:

Summary Description:

Current NAS weather data is not well integrated into either manual procedures or automated decision-support systems. Moreover, data is not readily available to the full spectrum of decision makers, and forecast weather is not sufficiently accurate. To support the predicted volume of future air traffic operations, improvements are needed. Unpredicted changes in weather are of prime concern because of the significant impact and disruption they create throughout the entire NAS. The current system does not respond well to unpredicted weather situations or to weather systems that evolve differently than expected. This solution set will improve weather predictions to support proactively planning operations rather than hurriedly adjusting for impacts after the weather has changed.

Improvements include providing accurate, consistent, and integrated weather information to Air Traffic Management Specialists, other air traffic control facilities, airline flight operations centers (FOC), and the flight deck to support both tactical and strategic operational decision-making tools. Other refinements will be developed that improve weather observations, upgrade forecasts, and disseminate weather information to mitigate the severity of weather impacts on NAS operations. Improved forecasts will incorporate a better characterization of uncertainty and assist operators in safely planning and conducting four dimensional, gate-to-gate, trajectory-based operations to not only avoid storm hazards and provide comfortable flight conditions, but also to increase overall efficiency by improving routing/rerouting decision making. Decision support systems will directly incorporate weather data to aid decision makers in determining the impact of weather on NAS operations and the best response to potential weather-related operational effects, thus minimizing the level of traffic restrictions required in planning horizons that extend from 0–8 hours.

We will upgrade four functional areas. We will expand weather sensing capability to provide better observations to support better forecasting; make weather processing more sophisticated and better tailor forecasts for users; and integrate weather information into decision-support tools; and ensure users have access to all information. NextGen Network Enabled Weather (NNEW) will be the core of the NextGen weather support services. It will enable widespread distribution of weather products to enhance collaborative and dynamic NAS decision making. It will provide network access to weather information from many different sources.

Timeline:

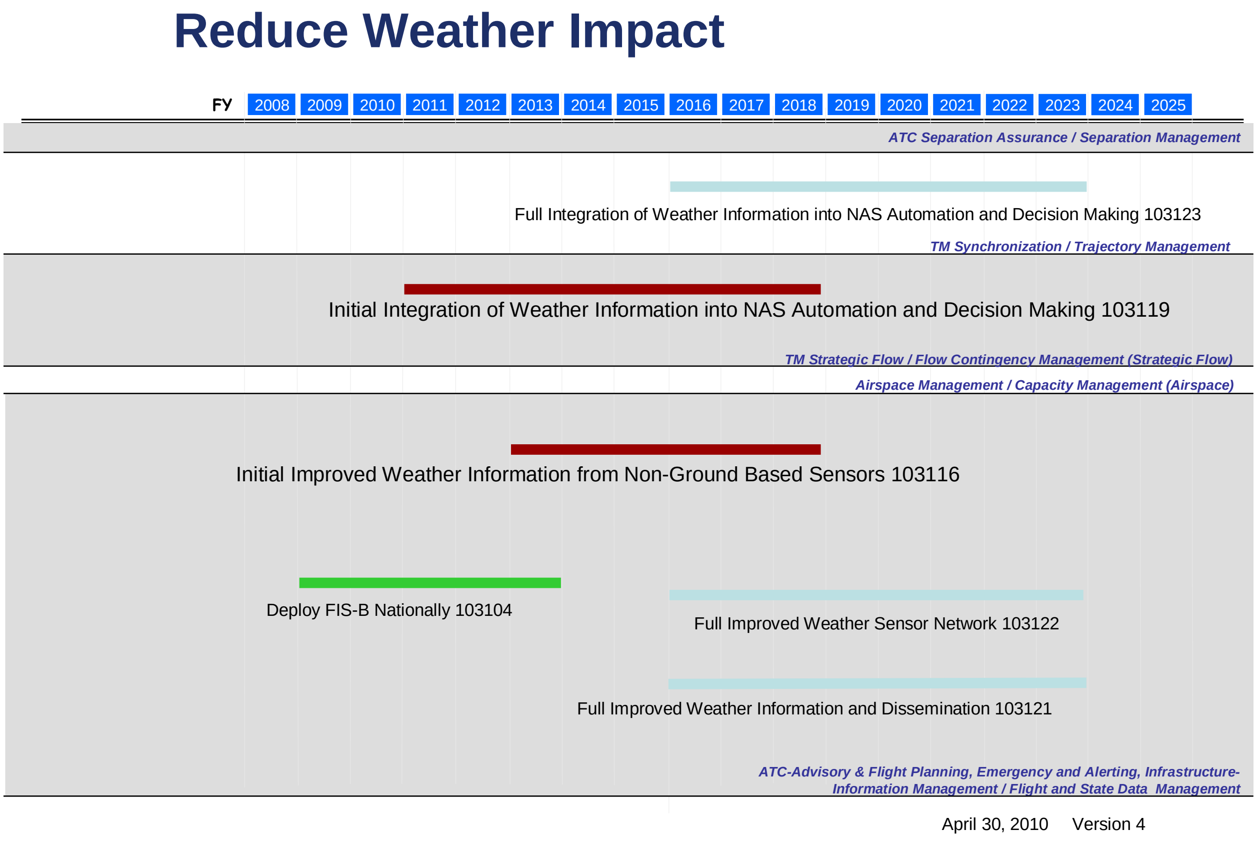


Figure 11 Reduce Weather Impact

Operational Improvements

This section describes the mid-term planned improvements associated with the Reduce Weather Impact solution set.

In Figure 11, the Traffic Management Synchronization/Trajectory management service area's planned improvement is the following:

> Initial Integration of Weather Information into NAS Automation and Decision Making would disseminate timely, more accurate weather information to the FAA and airline dispatch decision support tools. It would also provide more users easier access to weather information. Having improved weather forecasts, and easier access to them, as well as integrating this information into decision support tools will improve efficiency of operations by avoiding unnecessary deviations from planned flight paths and save time and fuel. Investments that support this capability are: upgrades to Flight service stations, AIM segment 2, the CATM work package 2, the Dynamic Ocean Tracking System (DOTS), the ERAM Midterm work package, upgrades to terminal automation system,

> TFDM, the Automated Surface Weather Observation Network, the 4D Weather Cube, and SWIM segments 1, 2 and 3.

The ATC Advisory & Flight Planning, Emergency and Alerting, Infrastructure Information Management/Flight and State Data Management service area's planned improvement is the following:

> Initial Improved Weather Information from Non-Ground Based Sensors would collect weather information from aircraft in flight and satellites to supplement the existing network of ground sensors to improve safety of flight. It would increase the reliability of forecasts of turbulence, convective weather, and in-flight icing. The advantage is that the improved accuracy of these weather forecasts will be route and altitude specific, which improves both safety and efficiency. Investment that support this capability are: upgrades to Flight Service stations, AIM segment 2, the CATM work package 2, DOTS, the ERAM Midterm work package, the ERAM D-position upgrade and system enhancements, upgraded terminal automation, TFDM, the 4-D Weather Cube, data link from aircraft to ground, and SWIM segment 2.

3.6 Increase Safety, Security, and Environmental Performance

Safety:

Summary Description:

Safety is FAA's highest priority. NextGen will interweave safety analysis with every initiative that is part of the NextGen effort. As NextGen technologies are introduced in the NAS, cross-cutting teams of safety experts from FAA lines of businesses (LOB's) will ensure that potential risks due to system changes are identified and adequately mitigated. Integrated safety assessments of NextGen conceptual initiatives will identify hazards and potential contributory factors (e.g., high workload, training, fatigue, and situational awareness) to help validate requirements for system design and implementation.

An integrated Safety Risk Management (SRM) capability for NextGen portfolios will enable safety stakeholders to take a system-of-systems approach to ensure safe design and implementation of NextGen mid-term capabilities. Risk-based models for NextGen concepts/solution sets will be developed at the NextGen Integration and Evaluation Capability (NIEC) lab in coordination with the aviation research stakeholders on human factors during NextGen development.

The ATO Safety Management Services will integrate and fuse ATC safety data sources, current and future, to support the safety data analysis for prognostic safety risk management of NextGen initiatives.

Safety Timeline:

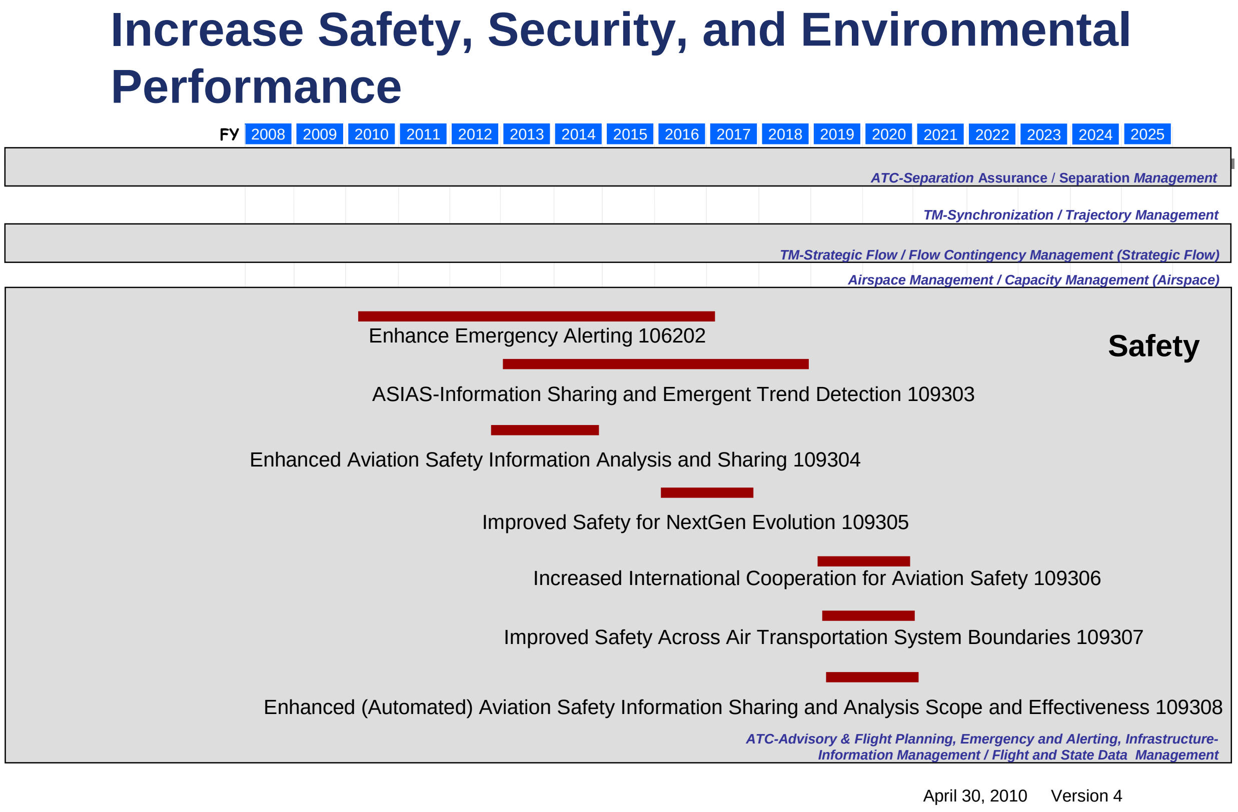


Figure 12 Increase Safety

Operational Improvements

This section describes the mid-term planned improvements associated with the Increase Safety timeline.

In Figure 12, the ATC-Advisory & Flight Planning, Emergency and Alerting, Infrastructure Information Management/Flight and State Data Management service area’s operational improvements are the following:

1. Enhance Emergency Alerting improves a controllers’ ability to assist in locating a downed aircraft and in identifying and tracking visual flight rules flights. The combination of GPS and ADS-B can provide a downed aircraft’s location and its identification number. This capability has proven successful in Alaska and has saved lives because it reduces the search time for downed aircraft. Aircraft using ADS-B report their position frequently, and the coverage can be more comprehensive than radar. Investments that support this capability are FSAM; upgraded terminal automation systems; the Oceanic Automation System; the ERAM D-position upgrade and system enhancements; the 4D weather Cube; the FANS/1A oceanic communications system; and ADS-B.

2. ASIAS – Information Sharing and Emergent Trend Detection. The Aviation Safety and Information Analysis (ASIAS) will integrate and share high-quality, relevant, and timely safety information that is critical to the success of the Safety Management System. ASIAS directly supports safety promotion and safety assurance initiatives with analytical results such as baseline information and trends, and it supports safety risk management through identifying issues and providing tools for analysis of hazards. Investments that support this capability are: AIM segment 2, the ERAM D-position upgrade and system enhancements, the Remote Maintenance Logging System (RMLS)/Swim interface, DataComm segments 1 and 2, the NAS Voice System (NVS), and air-to-ground radios.
3. Enhanced Aviation Safety Information and Analysis and Sharing will improve system-wide risk identification, integrated risk analysis and modeling, and implementation of risk management. Investments that support this capability are the same as those listed in item 2 above.
4. Improved Safety for NextGen Evolution mitigates the safety risk associated with changes to the air transportation system. This improvement provides advanced capabilities for an integrated and predictive safety assessment of new equipment and procedures; an improved validation and verification process for certification of new equipment; an enhanced focus on developing safe operational procedures; and enhanced training concepts for promoting safe system operation. Investments that support this capability are: DataComm segment 1, the NAS Voice System, and ASIAS.
5. Increased International Cooperation for Aviation Safety will reduce safety risk associated with international operations by harmonizing standards, regulations and procedures. A special focus will be on the handling of dangerous goods
6. Improved Safety Across Air Transportation Boundaries will address similar issues to item 5 above.
7. Enhanced (Automated) Aviation Safety Information Sharing and Analysis Scope and Effectiveness will automate risk identification and notification processes. The ASIAS will be expanded to include additional data sources and enhanced by actions that improve data security, quality and scope.

Security:

Summary Description:

Security is necessary for all aspects of NAS operations. The FAA has planned investments for both airspace and information security. Airspace security deals with protecting air traffic control, communication, and navigation facilities. Information security is already integral to the baseline of each NAS program, and we have designed information security processes and protocols into new equipment to protect FAA systems. The FAA will provide continuous upgrades as information security technology and best practices improve. The agency also must be part of the national preparation, response and recovery from such events, as natural disasters (e.g., hurricanes) and biological emergencies (e.g., pandemic influenza).

Security Timeline:

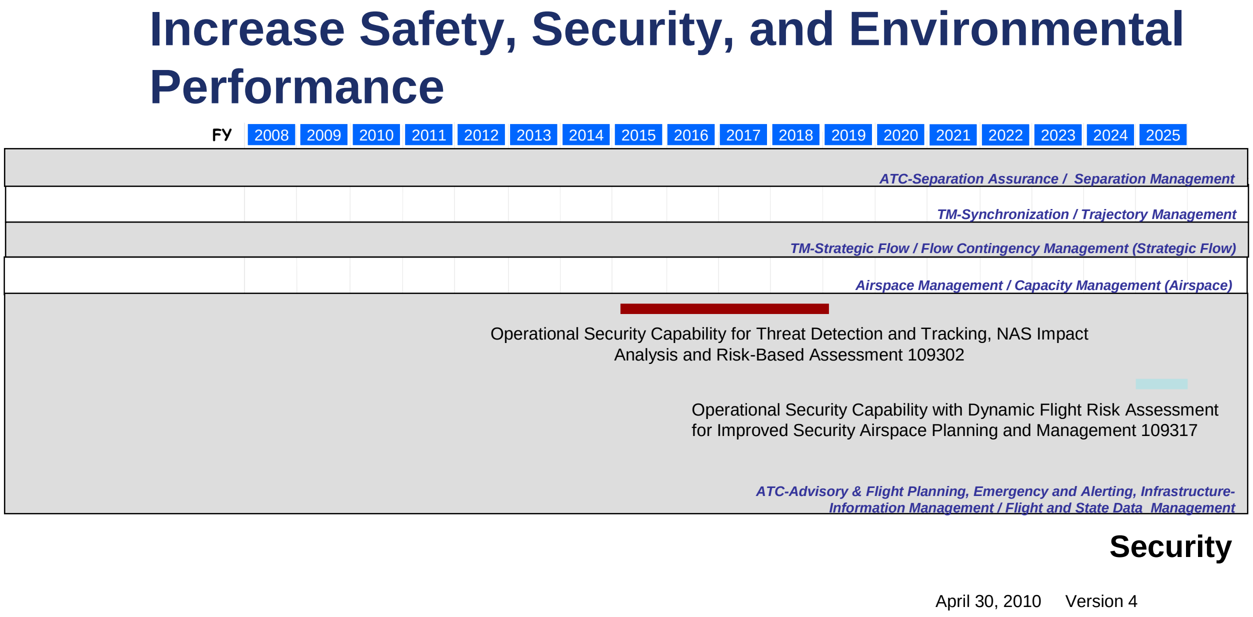


Figure 13 Improve Security

Operational Improvements

This section describes the mid-term planned improvements associated with the Improve Security timeline.

In Figure 13 the ATC-Advisory & Flight Planning, Emergency and Alerting, Infrastructure Information Management/Flight and State Data Management service area's operational improvement is the following:

> Operational Security Capability for Threat Detection and Tracking, NAS Impact Analysis and Risk Based Assessment address NAS security threats with more effective and efficient prevention, protection, response and recovery based on a net-enabled shared situational awareness and a risk-informed decision-making capability. Investments that support this capability are: Alaska and CONUS Flight Service Modernization, AIM segment 2, the oceanic automation system, the CATM work package 3, the En route Mid-term work package, terminal automation upgrades, TFDM, the 4D Weather Cube, and the Security Integrated Toolset. This toolset will allow controllers to determine whether aircraft under their control are registered aircraft with a legitimate flight plan.

Environment:

Summary Description:

Increased attention is being directed at aviation's impact on the environment — not only regarding longstanding noise and air quality impacts, but also in the important new areas of global climate change and energy consumption. Although aviation has been a relatively small source of emissions and has made significant strides in lessening its environmental "footprint," the anticipated growth in air transportation demand will increase pressure on aviation to reduce emissions and fuel consumption. NextGen investment planning must factor in changes (both positive and negative) in fuel use, emissions, and noise caused by operational improvements. Fuel consumption is also a concern because of the long-term outlook for fuel prices. The FAA must better understand the environmental consequences of its actions and strive for further improvements as it implements NextGen.

Environmental Timeline:

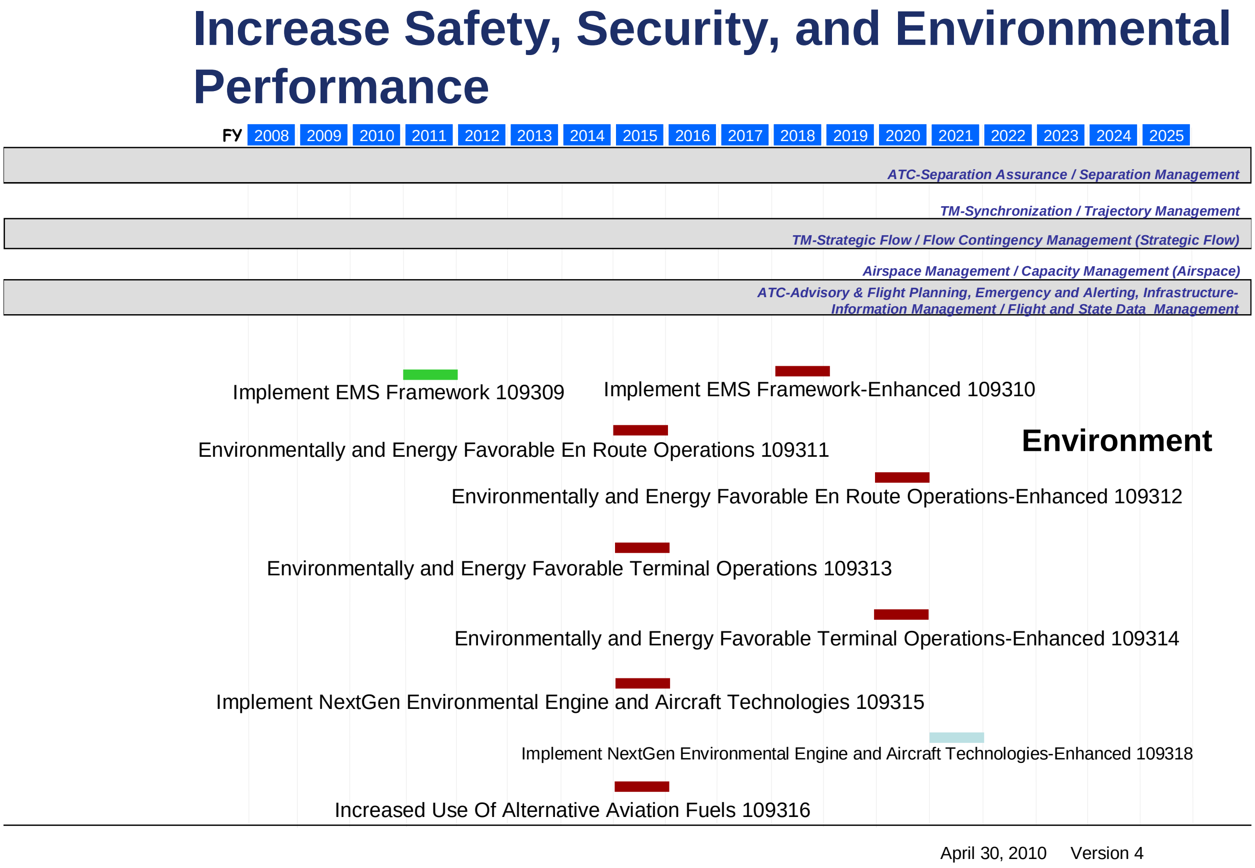


Figure 14 Improve Environmental Performance

Operational Improvements

This section describes the mid-term planned improvements associated with the Improve Environmental Performance timeline. Many of the Operational Improvements shown below are supported by the NextGen project – Environment & Energy – Environmental Mgmt System & Noise/Emission Reduction, which provides the funds to model and demonstrate the initiatives aimed at achieving these improvements. Capital investment will be needed to implement the operational improvements

In the Environment service area, the operational improvements include the following:

1. Implement EMS Framework – Enhanced will further enable the use of the Environmental Management System (EMS) framework for subsequent applications including refined environmental goals and decision support tools to address, plan and mitigate environmental issues through implementation of ongoing EMS improvements and availability of enhanced environmental information.
2. Environmentally and Energy Favorable En Route Operations will optimize en route operations to reduce emissions, fuel burn and noise. It will take advantage of new operational capabilities such as advanced aircraft technologies including Flight Management Systems and avionics to achieve more efficient en route operations for individual aircraft and system wide (which would include environmentally sensitive areas).
3. Environmentally and Energy Favorable En Route Operations – Enhanced will further optimize en route operations to reduce emissions, fuel burn and noise. It will use the EMS for real time route planning to reduce environmental impact and improve operations system wide.
4. Environmentally and Energy Favorable Terminal Operations will optimize aircraft arrival, departure, and surface operations to reduce emissions, fuel burn and noise using environmentally favorable procedures. It will develop enhanced surface operation procedures to maximize airport through put.
5. Environmentally and Energy Favorable Terminal Operations – Enhanced will further optimize aircraft arrival, departure, and surface operations to reduce emissions, fuel burn, and noise.
6. Implement NextGen Environmental Engine and Aircraft Technologies will reduce aircraft noise, emissions, and fuel burn through improvements in engines and airframe technologies based on the Continuous Low Emissions, Energy, and Noise (CLEEN) program.
7. Increased Use of Alternative Aviation Fuels will determine the feasibility and market viability of alternative aviation fuels for civil aviation use. It will obtain certification of Hydrotreated Renewable Jet (HRJ) fuels from fossil and renewable resources that are compatible with the existing infrastructure and aircraft fleet and will meet the requirements for a “drop in” fuel.

3.7 Transform Facilities

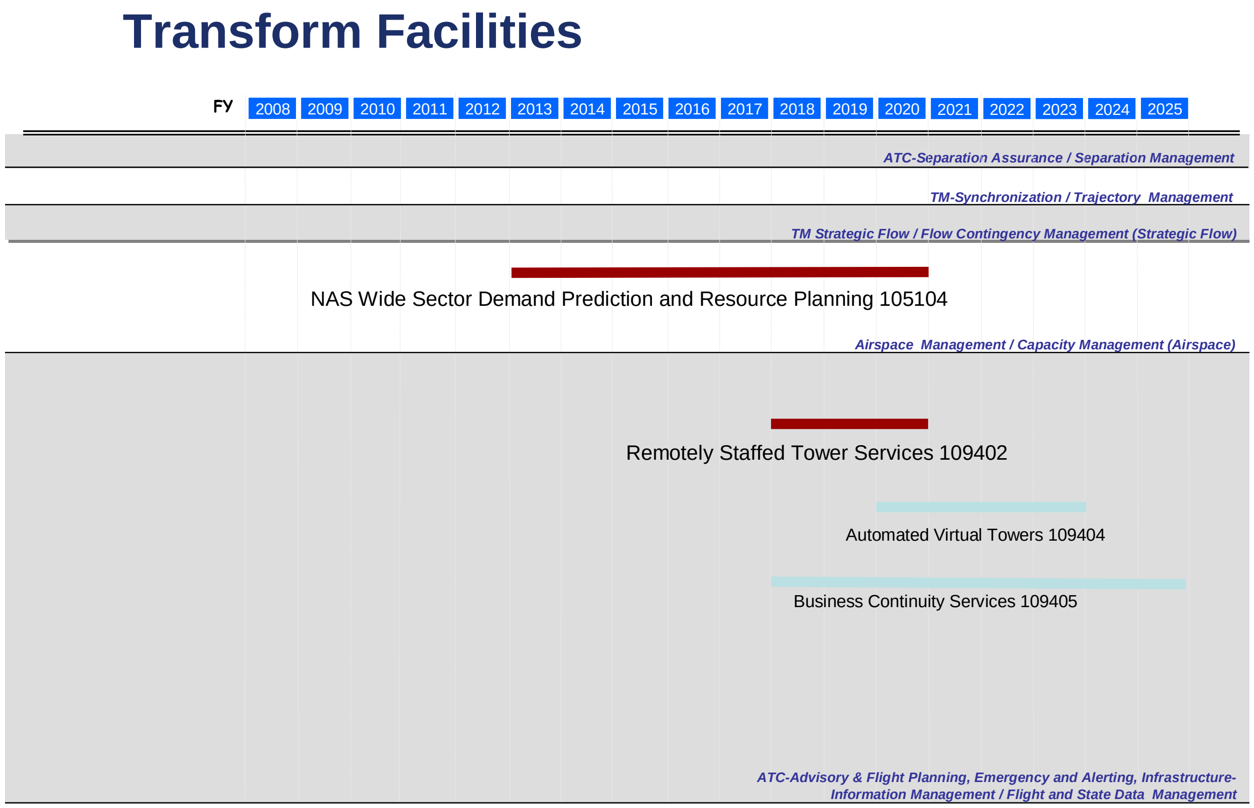
Summary Description:

NextGen redesigns air traffic control systems to make them flexible, scalable, and maintainable. It will break down the geographical boundaries that characterize air traffic control and lead to a more seamless view of traffic, organized not by geographically oriented sectors, but by aircraft trajectories. Infrastructure, automation, equipage, procedures, and regulations will be designed to support this seamless operational concept and must evolve from a geographical focus to a broader air traffic management concept. This includes facilities and the associated personnel.

To address this redesign, the Facilities component of NextGen focuses on optimizing air navigation service provider (ANSP) resources. This includes: establishing new facilities, changing the numbers and sizes of existing control facilities, and thinning/eliminating other facilities such as navigational aids. It also includes allocating staffing and facilities to provide expanded services; continuity of operations; best deployment, management, and training of the workforce; and use of more cost-effective and flexible systems for information sharing and back-up.

Due to the net-centric capabilities and the geo-independence that NextGen provides, facilities need not be near air traffic being managed. Facilities will be sited and occupied to provide for air traffic management optimization. This includes combining facilities (e.g., air route traffic control centers (ARTCCs), terminal radar approach control (TRACONs), and air traffic control towers (ATCTs)) when appropriate.

Timeline:



April 30, 2010 Version 4

Figure 15 Transform Facilities

Operational Improvements

This section describes the mid-term planned improvements associated with the Transform Facilities solution set.

In Figure 15, the Airspace Management/Capacity Management service area's operational improvement is:

> NAS Wide sector Demand Prediction and Resource Planning which uses an integrated model of capacity resource drivers and demand information from collaborative decision making (CDM) to determine the capacity impact of key resource constraints such as: (1) gate, airspace or runway blockages (for safety, security or weather); (2) fleet mix and performance characteristics; (3) flow structure which modifies the complexity of the operation; and (4) workload. It also models strategic resources (e.g., airspace, sectors, personnel, facilities, NAS systems) in parallel with systemic changes in demand due to increases in air traffic, seasonality, or city pair business case decisions. Future traffic loads are modeled against various solutions to mitigate adverse impacts to users.

In the ATC-Advisory & Flight Planning, Emergency and Alerting, Infrastructure Information Management/Flight and State Data Management service area, the operational improvement is:

> Remotely Staffed Tower Services to provide ATM services for operations into and out of selected airports without constructing, equipping and/or sustaining tower facilities at these airports. Investments that support this capability are: upgraded terminal automation systems, TFDM, DataComm segments 1 and 2, the NAS Voice System, ADS-B, ASDE 3 and ASDE – X, Runway Status Lights, and SWIM segments 2 and 3.

4 Enterprise Architecture Roadmaps

The detailed roadmaps appearing in the following subsections are an integral part of the NAS Enterprise Architecture to show progression from the present system to NextGen. The roadmaps show planned activities that extend beyond the 5-year financial horizon covered in the CIP, because the transition to NextGen capabilities will occur incrementally stretching beyond the five year timeframe of the CIP. The roadmaps are our plan for an achievable transition to the sophisticated capabilities that we need in order to meet expected future growth in an organized and timely manner. They also help to ensure that the interim steps we take to modernize the existing system are consistent with the future system we envision.

Transition to NextGen requires detailed engineering design and testing of both new equipment and operational changes. Many changes will also require aviation users to add equipment to their aircraft and adopt new procedures so the roadmaps serve to inform them of the schedule they should expect for changes to their equipment and crew training. We update these roadmaps annually to reflect results of studies, demonstration projects, and economic analysis related to projects; however, the roadmaps are and should be reasonably stable from year-to-year.

The funding tables at the end of each roadmap section contain both projects that are shown in the roadmap and those that are included in an overall FAA Enterprise Architecture. Some projects that support safety are not directly related to air traffic control equipment, so they are in the funding tables but not in the roadmaps. All projects with estimated funding anytime within the next 5 years except the internal labor related project are described in appendix B. For more detailed information on the roadmaps, view the Enterprise Architecture and Roadmaps at: https://nasea.faa.gov

Figure 16 shows and defines the symbols used in the roadmaps. The dashed lines indicate that a system may be drawn down after economic and operational analysis determines that it is no longer necessary. The solid lines indicate either the continued operation of an existing system or the progression from a current system to a more capable or modernized system. The boxes with names identify systems, which are either described in the text or, when they are not described, their acronyms are defined in appendix E.

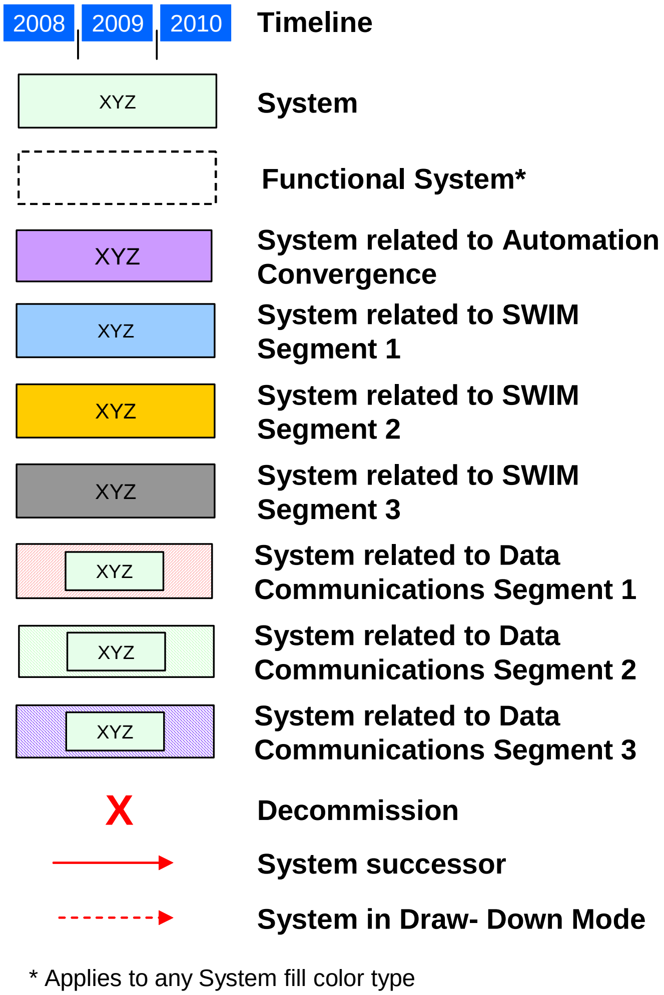


Figure 16 Roadmap Legend

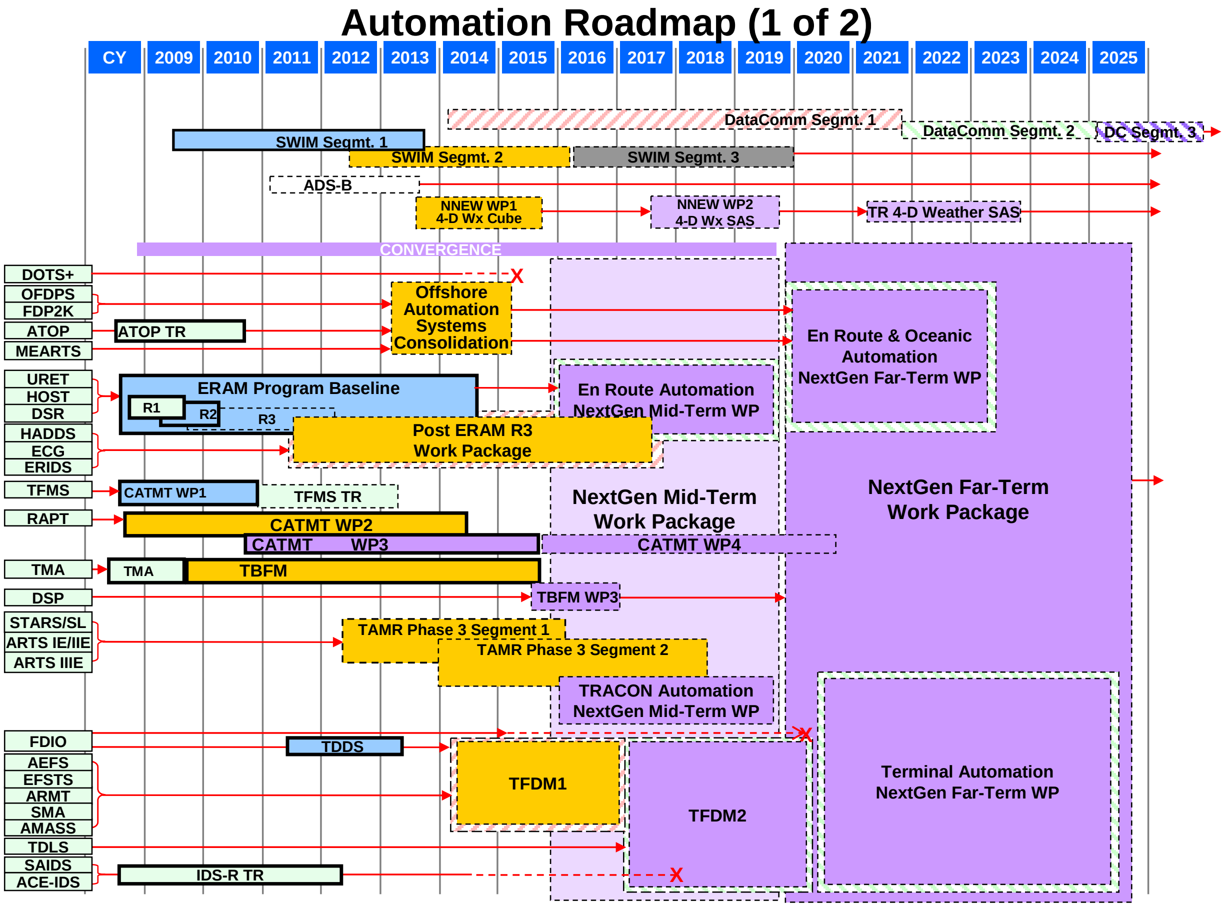
4.1 Automation Roadmap

Automation is a core element of the air traffic control system. Controllers require a real-time display of aircraft location as well as information about the operating characteristics of aircraft they are tracking — such as speed and altitude — to keep the approximately 50,000 flights safely separated every day. Automation gives controllers continuously updated displays of aircraft position, identification, speed, and altitude as well as whether the aircraft is level, climbing, or descending. Automation systems can also continue to show an aircraft's track when there is a temporary loss of surveillance information. It does this by calculating an aircraft's ground speed and then uses it to project an aircraft's future position.

Other important features of automation include the following:

- It maintains flight information and controller-in-charge data from pre-flight to post-flight analysis, which supports coordination between air traffic controllers as they hand off responsibility of the flight from the tower to the terminal to the en route sector and then back to terminal and tower as the aircraft approaches its destination.
- It generates symbols displaying information on routes, restricted areas, and several other fixed features of the controller's sector.
- It uses software that further enhances safety by providing automated alerts to controllers regarding potential aircraft conflicts and warnings that an aircraft may be approaching a terrain hazard.
- It supports many functions that are essential to controlling air traffic, such as showing the data from weather sensors, giving the status of runway lights and navigational aids, and providing flight plan information on monitored aircraft.

The automation roadmaps in figures 17 and 18 depict the planned architecture from 2009 to 2025. The FAA will upgrade and ultimately replace current systems with more capable systems that can manage the levels of air traffic we predict for the future. These newer systems and the enhanced software will allow controllers to use airspace more efficiently and offer more sophisticated services, such as early approval of direct routes. They will also allow better allocation of workload among facilities.



Infrastructure Roadmap, Version 5.0—January 11, 2011

Figure 17 Automation Roadmap (1 of 2)

Enabling technologies for NextGen appear at the top of the automation roadmaps: Data Communications (DataComm) Segments 1, 2 & 3, System-Wide Information Management (SWIM) Segments 1, 2, & 3, Automatic Dependent Surveillance-Broadcast (ADS-B), and the Next Generation Network Enabled Weather (NNEW) System which will use data from the 4-D Weather (Wx) Cube (which will support the 4-D Weather Single Authoritative Source (4-D Wx SAS). These systems are central to the concept of NextGen which relies on collecting and sharing information to improve operational efficiency. They transmit and receive critical information to support air traffic control in both the en route and terminal environments. DataComm and SWIM will allow improved data sharing that will minimize adjustments to planned trajectories and make more efficient use of airspace capacity. The 4-D Wx SAS for weather data will ensure that the same data is available to both the FAA and users to assist in making decisions. ADS-B, which relies on position reporting from the aircraft to a ground station, will improve both the accuracy and update rate of surveillance systems. Collecting and sharing data provides common ground for all parties making operational decisions.

The first grouping on the left side comprises the oceanic control projects. The DOTS+ system uses weather information to determine the most fuel-efficient routes based on wind velocity and direction. The oceanic automation systems (OFDPS, FDP2K, ATOP, and MEARTS) process data regarding the position of aircraft on oceanic flights to aid controllers in separating flights in FAA controlled oceanic airspace. The FAA plans to establish a program for consolidating these automation systems in 2013 and upgrading the consolidated system in the 2020 timeframe.

The next six blocks on the left side are components of the en route control system, which the FAA is replacing with the En Route Automation Modernization (ERAM) program. The ERAM program replaces all these component pieces except ECG (which is a separate program) with new hardware and revised ATC software. Although originally planned to be deployed by December 2010 at all 20 sites, the ERAM program experienced several difficulties in its testing and deployment phase and is now being tested at operational sites. FAA plans to have it operational at the first site during FY 2011. ERAM is needed to replacing the aging legacy automation infrastructure that is not supportable over the long term, as well as provide a foundation for the agency's transition to NextGen. This new system will have the capacity and expansion potential to support the introduction of Next Gen operational improvements. The improvements are being added with a series of releases to introduce improvements as quickly as possible. The ERAM D-position upgrade and system enhancements will build in new software to fully support Trajectory Based Operations. As the roadmap shows, the FAA plans to transform ERAM over time into a NextGen Automation System that will address both en route and terminal automation requirements.

The third group on the left side of the roadmap contains the systems used for traffic management, such as the Traffic Flow Management System (TFMS), Route Availability Planning Tool (RAPT), Traffic Management Advisor (TMA) and Departure Spacing Program (DSP). These systems are installed at the Air Traffic Control System Command Center (ATCSCC), en route centers, and busy terminal control facilities. They are used to analyze future demand for en route and terminal services and to strategically plan for how to best accommodate that demand. These systems use real-time displays both of aircraft in flight and of weather affecting aviation to assess which routes are best and to prevent severe congestion at airports. The FAA will continue to improve these functions as described in the Collaborative Air Traffic Management (CATM) NextGen solution set, by expanding collaboration to individual pilots and by improving information exchanged between the FAA and airline dispatch offices.

The next three systems (STARS/S L, ARTS 1E/IIE, and ARTS IIIE) are different terminal automation models that the FAA will maintain as separate systems, until the Terminal Automation Modernization and Replacement Phase 3 (TAMR P3) upgrades or replaces them. TAMR Phase 3 will initially update 11 larger ARTS systems and a decision is pending on whether it will replace all the current ARTS systems and upgrade the existing Standard Terminal Automation Replacement System (STARS) so they can process position information from the ADS-B system along with information from terminal radars.

The Tower Flight Data Management (TFDM) system supports a phased implementation of a new terminal local area network (LAN)-based infrastructure to reduce redundant displays and integrate flight data functions. TFDM will provide System Wide Information Management (SWIM)-enabled flight data exchanges with other National Airspace System (NAS) subsystems. TFDM Phase 1 is the initial capability that will integrate Flight Data Input/Output (FDIO), Advanced Electronic Flight Strip (AEFS), Electronic Flight Strip Transfer System (EFSTS), Airport Resource Management Tool (ARMT), Surface Movement Advisor (SMA), Airport Movement Area Safety System (AMASS), and the Tower Data Link Services (TDLS) function. Trade studies will identify whether information from additional systems such as the Automated Surface Observing System (ASOS) Controller Equipment-Information Display System (ACE-IDS), and System Atlanta Information Display System (SAIDS can be integrated in TFDM phase 2).

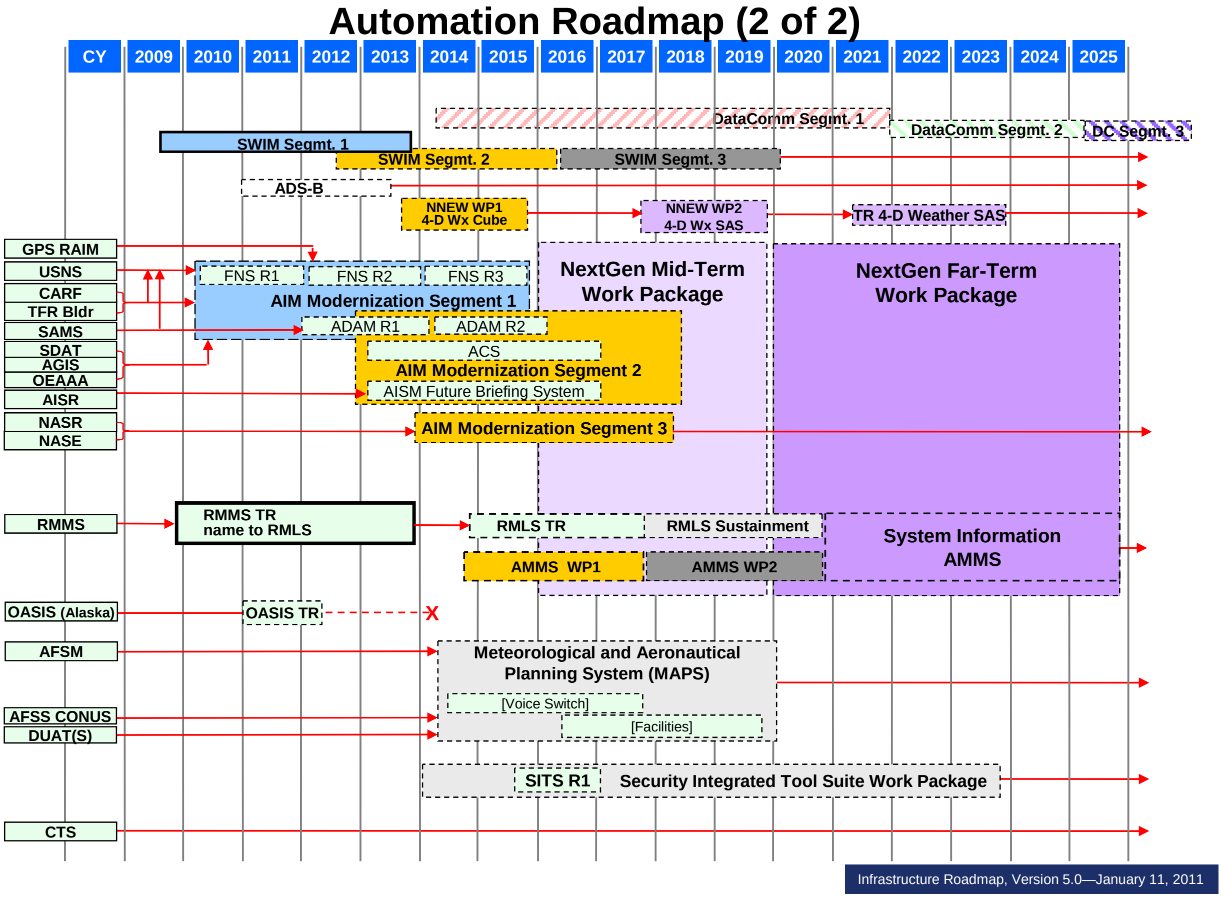


Figure 18 Automation Roadmap (2 of 2)

The GPS Reliability and Integrity Monitor (RAIM) determines whether there are enough Global Positioning System (GPS) satellites in view during a planned flight for an aircraft navigation receiver to determine if any of the satellites are producing inaccurate or inconsistent navigation data. Aircraft can only use GPS for primary navigation if they can receive signals from a sufficient number of satellites so that their navigation receiver can detect and reject information from a malfunctioning satellite. The FAA plans to transition the current FAA operated RAIM system into the Aeronautical Information Management (AIM) system.

The next 10 systems (see following bullets) mainly provide status information on airports, airspace, and navigation facilities, but the FAA uses some of them to evaluate airspace. We will replace these individual systems with a modernized and consolidated AIM system.

- USNS — United States NOTAM (Notice to Airmen) System,
- CARF — Central Altitude Reservation Function,
- TFR Bldr – Temporary Flight Restriction Builder,
- SAMS — Special Airspace Management System,
- SDAT — Sector Design and Analysis Tool,
- AGIS – Airport Geographic Information System
- OEAAA — Obstruction Evaluation/Airport Airspace Analysis,
- AISR – Aeronautical Information System Replacement,
- NASR — National Airspace System Resources,
- NASE — NAS Adaptation Services Environment.

NOTAMs are notices of temporary changes, such as temporary flight restrictions and runway closures for construction. SAMS and CARF inform controllers when airspace ordinarily reserved for military use is available for civilian use. The other systems contain more detailed information about FAA air traffic control equipment or less frequently changed information such as charts and airspace regulations. The AIM program will establish a standard format and a user-friendly interface for finding the information related to a specific route of flight.

The Remote Maintenance Monitoring System (RMMS) serves two functions. It allows the maintenance staff to monitor equipment performance electronically from a central location, and it provides software for management of workforce hours and maintenance actions. The existing system is undergoing a technical refresh and will be upgraded and renamed the Remote Monitoring and Logging System (RMLS) in 2014.

OASIS (Alaska), AFSM, AFSS CONUS and DUATS support flight services. Flight services are mostly used by general aviation pilots and include weather briefings and flight plan filings. The Direct User Access Terminals (DUATS) currently allow pilots to file flight plans and obtain weather information for their planned routes from flight service station automation systems. The FAA has contracted for flight services in the lower 48 States, and flight service specialists use Automated Flight Service Systems (AFSS CONUS) to record flight plans and provide weather briefings to pilots. The Alaska Flight Service Modernization (AFSM) sustainment project will modernize or replace the Flight Service facilities in Alaska.

Flight Service Automation Modernization (FSAM), formerly known as Meteorological and Aeronautical Planning System (MAPS), program is developing alternatives and acquisition strategy for the automation platform for all FSS facilities. Options include integrating graphical and text-based weather products and other aeronautical information for use in pilot briefings; integrating aeronautical data updates with NOTAM and flight plan data into FSAM; and the development of a web portal that will provide both FAA users and aviation community users with access to the same data, improving access to consistent and accurate flight service information. In addition, there will be consideration of an automatic capability to provide pilots with critical updates that occur after having received preflight briefings, and to monitor VFR aircraft in order to be more proactive in search and rescue efforts.

The Security Integrated Tool Set (SITS) is a security system that validates the identity and legitimacy of aircraft within or entering the NAS; it will be incorporated into the NAS in 2014.

The Coded Time Source (CTS) project seeks to standardize the official source of time that synchronizes the information flows in the air traffic control equipment. It will also determine an appropriate backup to the primary source that can be used in case the primary source fails.

The Aviation System Performance Metrics (ASPM) system provides information on individual flight performance and airport efficiency. Arrival /departure rates and runway configuration data are stored in this system

Figure 19 shows projected CIP expenditures on automation roadmap projects. Expenditures are in Millions of Dollars.

BLI Number	Program Name	FY 2012 Manda-tory	FY 2012 Discre-tionary	FY 2012 Budget Total	FY 2013	FY 2014	FY 2015	FY 2016
	Automation Functional Area	**$174.4**	**$711.3**	**$885.7**	**$673.1**	**$649.0**	**$776.8**	**$826.7**
1A07	Next Generation Air Transportation System (NextGen) - Demonstrations and Infrastructure Development*	$8.1	$16.9	$25.0	$24.6	$24.6	$24.6	$24.6
1A08	Next Generation Air Transportation System (NextGen) - System Development*	$19.0	$90.0	$109.0	$76.5	$76.5	$80.5	$80.5
1A09	Next Generation Air Transportation System (NextGen) - Trajectory Based Operations (TBO)*	$13.7	$9.3	$23.0	$18.0	$18.0	$18.0	$33.0
1A11	Next Generation Air Transportation System (NextGen) - Arrivals/Departures at High Density Airports*	$13.7	$14.3	$28.0	$11.0	$8.0	$27.4	$42.4
1A12	Next Generation Air Transportation System (NextGen) - Collaborative Air Traffic Management (CATM)*	$25.0	$28.0	$53.0	$27.5	$31.0	$37.0	$33.0
1A13	Next Generation Air Transportation System (NextGen) - Flexible Terminal Environment*	$21.8	$36.3	$58.1	$69.1	$70.5	$67.5	$98.8
2A01	En Route Automation Modernization (ERAM)	$0.0	$120.0	$120.0	$90.0	$70.0	$0.0	$0.0
2A02	En Route Automation Modernization (ERAM) - D-Position Upgrade and System Enhancements*	$64.5	$0.0	$64.5	$57.0	$70.0	$204.0	$165.0
2A03	En Route Communications Gateway (ECG)*	$4.0	$2.0	$6.0	$3.1	$4.9	$4.7	$0.9
2A07	Air Traffic Management (ATM)	$0.0	$7.5	$7.5	$23.7	$8.3	$0.9	$1.2
2A11	Oceanic Automation System*	$2.0	$6.0	$8.0	$4.0	$2.8	$0.0	$0.0
2A13	System-Wide Information Management (SWIM)	$0.0	$66.4	$66.4	$33.0	$28.0	$59.1	$61.7
2A17	Collaborative Air Traffic Management Technologies (CATMT)	$0.0	$41.5	$41.5	$34.4	$29.3	$3.3	$15.6
2A20	Tactical Flow Time Based Flow Management (TBFM)	$0.0	$38.7	$38.7	$12.9	$10.5	$0.5	$3.6
2B03	Standard Terminal Automation Replacement System (STARS) (TAMR Phase 1)	$0.0	$25.0	$25.0	$42.0	$39.5	$54.0	$76.8
2B04	Terminal Automation Modernization/ Replacement Program (TAMR Phase 3)	$0.0	$98.8	$98.8	$67.4	$91.9	$141.2	$126.9
2B05	Terminal Automation Program	$0.0	$2.5	$2.5	$2.5	$2.6	$2.6	$2.7
2B14	Integrated Display System (IDS)	$0.0	$8.8	$8.8	$8.2	$8.2	$2.9	$2.3
2B19X	Terminal Automation Modernization/ Replacement Program (TAMR Phase 2)**	$0.0	$0.0	$0.0	$0.0	$3.0	$2.7	$5.4
2D08	Instrument Flight Procedures Automation (IFPA)	$0.0	$2.2	$2.2	$7.1	$4.5	$2.4	$3.0
3A02	Aviation Safety Analysis System (ASAS) - Regulation & Certification for Infrastructure System Safety (RCISS)	$0.0	$30.1	$30.1	$15.8	$12.7	$11.9	$20.2
3A07	System Approach for Safety Oversight (SASO)	$0.0	$23.6	$23.6	$26.0	$11.5	$10.5	$9.5
3A08	Aviation Safety Knowledge Management Environment (ASKME)	$0.0	$17.2	$17.2	$6.8	$16.0	$6.1	$4.6
4A09	Aeronautical Information Management Program*	$2.6	$26.3	$28.9	$12.5	$6.7	$15.0	$15.0

Figure 19 Expenditures in the Automation Functional Area[2]

Figure 8 lists funding for systems appearing in the roadmaps as well as the following systems that are part of the overall FAA Enterprise Architecture and support the FAA safety functions:

- Aviation Safety Analysis System – Regulation and Certification Infrastructure System Safety (ASAS-RCISS)
- System Approach for Safety Oversight (SASO)
- Aviation Safety Knowledge Management Environment (ASKME)

---

[2] *BLI's that support the mandatory General Fund appropriation request and include a breakout of the funding amount for Mandatory, Discretionary and Total request. ** BLI numbers with X represent outyear programs not requested in the FY 2012 President's Budget. FY 2013 – 2016 Out-year funding amounts are estimates.

These three systems support databases of safety information to assist safety inspectors in reviewing performance of flight crews and companies that provide aviation services.

4.2 Communications Roadmaps

Communication between pilots and controllers is an essential element of air traffic control. Pilots and controllers normally use radios for communication, and because en route control sectors cover areas that extend beyond direct radio range, remotely located radio sites are used to provide extended coverage. The controller activates radios at these sites and ground telecommunication lines carry the information exchange to and from air traffic control facilities. If ground links are not available, communication satellite links can be used to connect pilots with controllers. Backup systems are always available to provide continued ability to maintain communications when the primary systems fail.

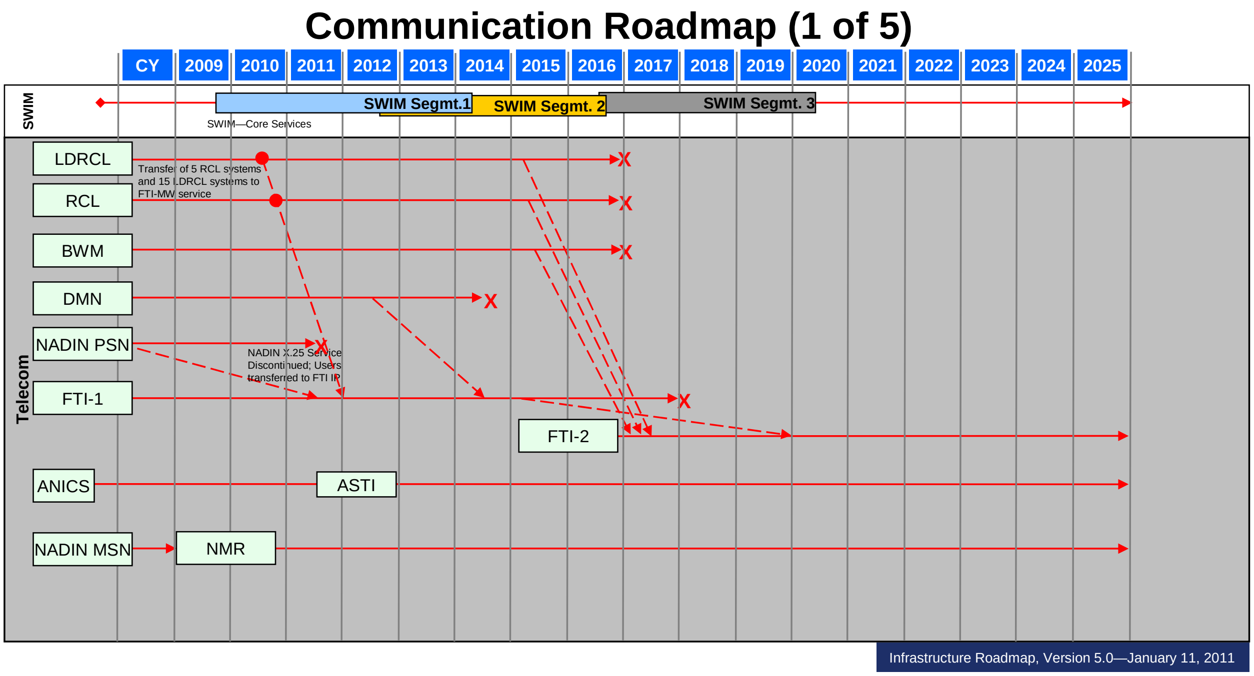


Figure 20 Communications Roadmap (1 of 5)

At the top of figure 20 are the System-Wide Information Management (SWIM) program segments that will establish information management and data-sharing capabilities to support NextGen. SWIM will develop policies and standards to support data management, along with the core services to enter data into NAS systems, retrieve it, secure its integrity, and control its access and use. The FAA is developing SWIM incrementally. Segment 1, the initial phase, includes capabilities that were selected based on the needs of various users (both government and private sector), maturity of design standards for concepts of use, and the ability of existing programs to integrate these SWIM capabilities into their program plans. Future segments will build on the initial steps to support the data sharing that NextGen programs require.

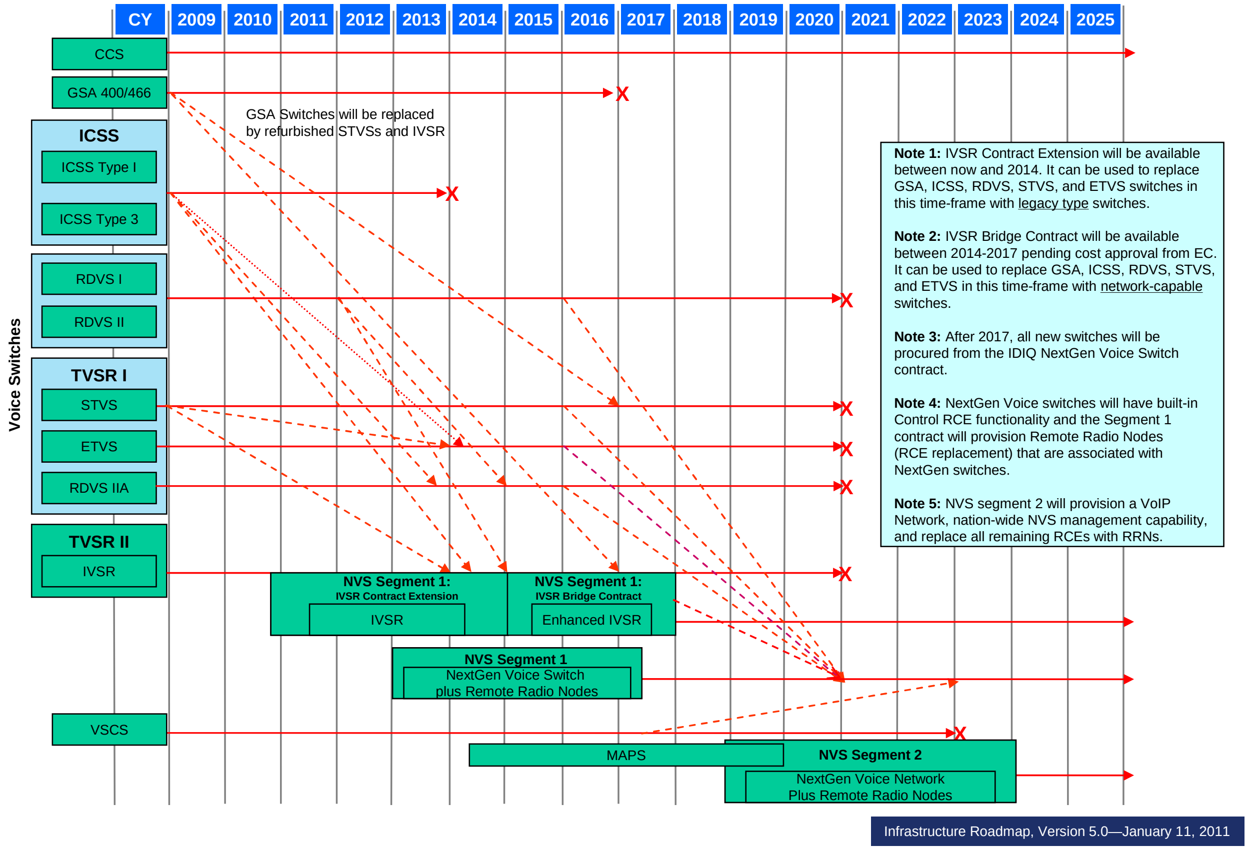
SWIM will reduce the number and types of interfaces between NAS systems, reduce unnecessary redundancy of information systems, improve predictability and operational decision-making, and reduce cost of service. The improved coordination that SWIM will provide will enable the FAA to transition from tactical conflict management of air traffic to strategic trajectory-based operations.

Below SWIM is a list of several FAA communication systems used mainly for transmitting data. The LDRCL (Low Density Radio Communication Link) and the RCL (Radio Communication Link) are microwave systems that transmit radar data from remote radar sites to FAA air traffic control facilities, and these systems have been linked in a national network to transmit operational and administrative information to and from air traffic control facilities. Some of the LDRCL and RCL systems have already transitioned to the FAA Telecommunications Infrastructure (FTI) to carry this data. In 2013, a decision will be made concerning the transitioning of the remaining systems (majority of the systems) to the FTI - Phase 2 (FTI-2) contract. The Band Width Manager (BWM) improves efficiency of information flow on the microwave network. It will not be needed when the FAA shuts down RCL and LDRCL. The NADIN PSN (National Airspace Data Interchange Network – Package Switching Network) and DMN (Data Multiplexing Network) transmit flight plans and other important aeronautical information to air traffic facilities. The DMN improves efficiency of message transmission by dividing messages into packages and sending multiple packages simultaneously to make fuller use of communication links. The packages are coded, and each complete message is reassembled at the receiving end. The FAA will transition some functions of NADIN PSN and DMN to the FTI network and its follow on contract. We will sustain the NADIN MSN (Message Switching Network) to comply with international standards for transmitting flight plans.

The Alaska National Airspace System Interfacility Communications System (ANICS) consists of ground stations that send and receive data from communications satellites to connect the operational facilities in Alaska. The ASTI (Alaska Satellite Telecommunications Infrastructure) program is a follow-on effort to ANICS, and it provides the same services while modernizing the infrastructure. Because there are far fewer ground telecommunications connections in Alaska, we use a satellite system to ensure that important air traffic information is reliably transmitted between smaller and larger facilities.

Figure 21 shows the Roadmap for NAS Voice switches. Voice switches in air traffic facilities enable controllers to select among the different channels they need to communicate with one another, with traffic management and weather specialists, with emergency services, and with pilots.

Communication Roadmap (2 of 5)



Note 1: IVSR Contract Extension will be available between now and 2014. It can be used to replace GSA, ICSS, RDVS, STVS, and ETVS switches in this time-frame with legacy type switches.

Note 2: IVSR Bridge Contract will be available between 2014-2017 pending cost approval from EC. It can be used to replace GSA, ICSS, RDVS, STVS, and ETVS in this time-frame with network-capable switches.

Note 3: After 2017, all new switches will be procured from the IDIQ NextGen Voice Switch contract.

Note 4: NextGen Voice switches will have built-in Control RCE functionality and the Segment 1 contract will provision Remote Radio Nodes (RCE replacement) that are associated with NextGen switches.

Note 5: NVS segment 2 will provision a VoIP Network, nation-wide NVS management capability, and replace all remaining RCEs with RRNs.

Infrastructure Roadmap, Version 5.0—January 11, 2011

Figure 21 Communications Roadmap (2 of 5)

The Command Center Conference Control Switch (CCS) installed at the facility in Herndon, Virginia at the top of the diagram will remain in operation until 2011, when the new CCS installed at the facility in Warrenton, Virginia will become operational to support the Command Center relocation. It allows the specialists at the Air Traffic Control System Command Center (ATCSCC) to stay in contact with air traffic control facilities and external users of the NAS.

The nine switches shown below the CCS are different models of the switches used in terminal facilities. They are:

- GSA 400/466 – A voice switch developed by Litton/Amecom purchased through a national program/contract
- ICSS Type 1 and 3 – Integrated Communication Switching System
- RDVS I and II & IIA – Rapid Deployment Voice Switch

- TVSR I & II – Terminal Voice Switch Replacement program, which is the umbrella replacement program for all voice switches
- STVS – Small Tower Voice Switch
- ETVS – Enhanced Terminal Voice Switch

The ETVS program is replacing terminal voice switches at the rate of about 10 per year, as well as installing new voice switches when new airport traffic control towers are built.

The Voice Switching and Communications System (VSCS) is the voice switch used in ARTCCs. The FAA is upgrading the VSCS with a technical refresh to replace components that have a high failure rate.

The FAA has begun developing requirements for the NAS Voice System (NVS). The NVS program will include voice switches, air/ground (A/G) radio control equipment, and the associated transmission services. The NVS will provide flexible networking for voice switch-to-voice switch connectivity as well as for voice switch to A/G radio connectivity. This architecture will facilitate meeting NextGen requirements for ATC workload sharing, unmanned aircraft system (UAS) operations, virtual tower operations, and business continuity. NVS will replace ARTCC and TRACON voice switches. Depending on the results of further analysis, NVS may replace some or all of the ATCT switches.

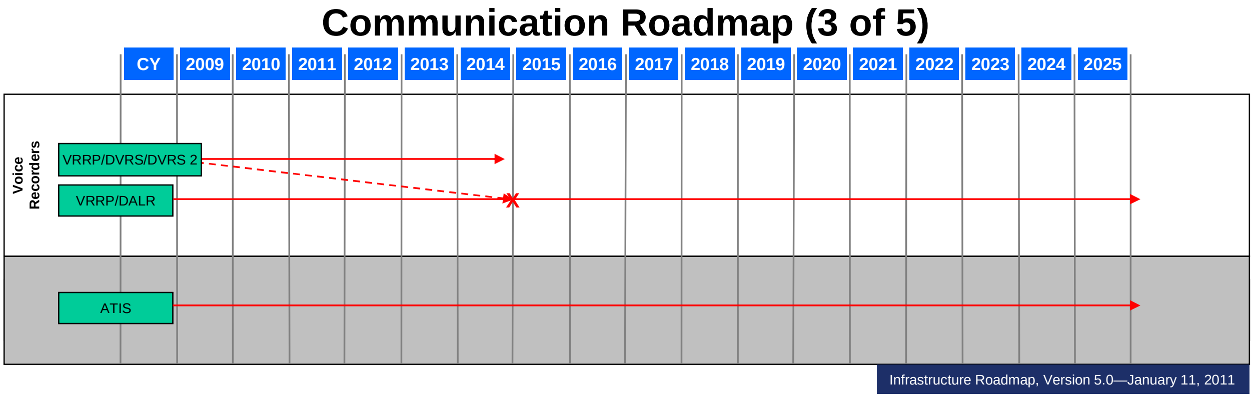
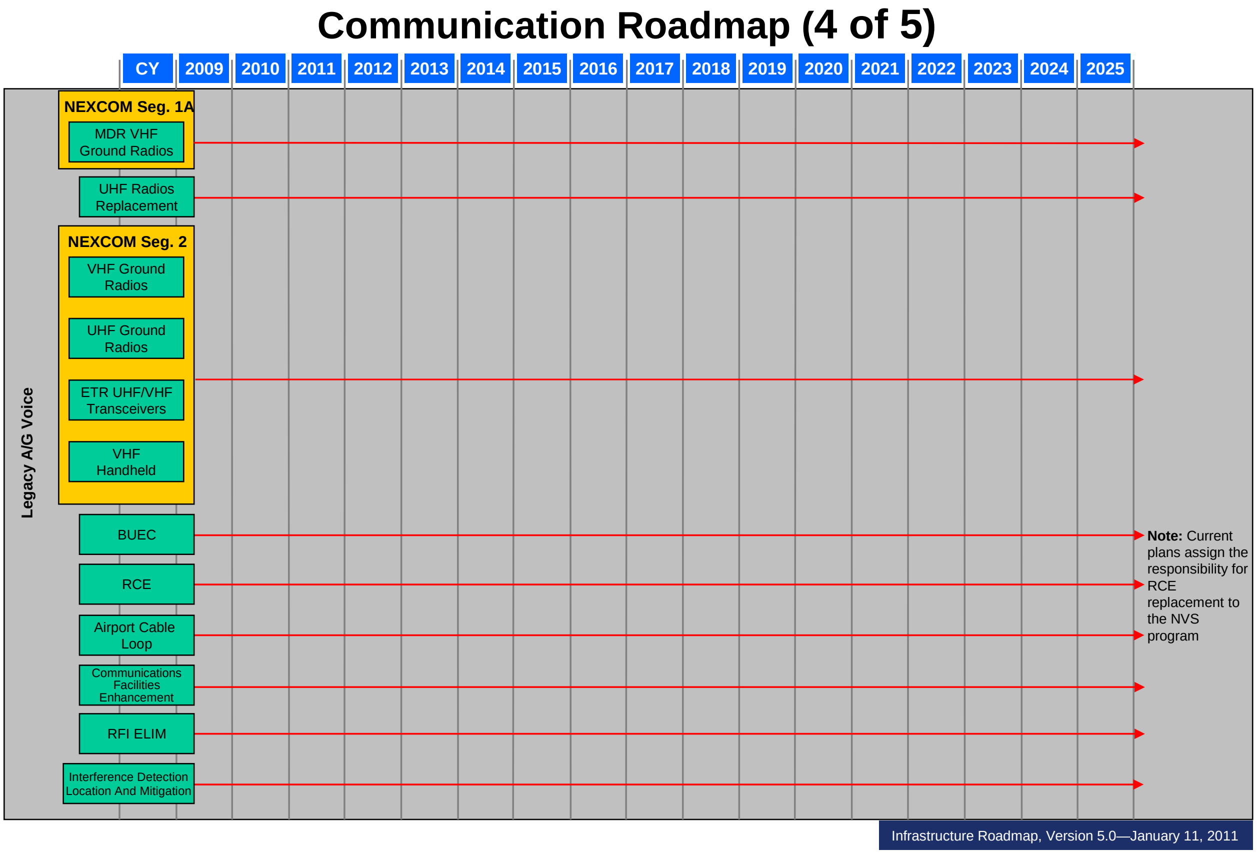


Figure 22 Communications Roadmap (3 of 5)

The Digital Voice Recorder System Replacement (DVSR) program is upgrading the digital recorders that keep a record of controller voice messages that can be used for safety analysis and when approved the Digital Audio Legal Recorder (DALR) program will replace these recorders. The Automated Terminal Information System (ATIS) broadcasts weather and other pertinent information to pilots as they approach an airport. We will maintain the ATIS functions during the entire timeframe of the roadmap.


Communication Roadmap (4 of 5)

Note: Current plans assign the responsibility for RCE replacement to the NVS program

Infrastructure Roadmap, Version 5.0—January 11, 2011

Figure 23 Communications Roadmap (4 of 5)

The fourth communications roadmap (figure 23) shows the programs that improve the radios used for air-ground communications and some of the supporting services to sustain NAS operations. The Next Generation Air/Ground Communications (NEXCOM) program is upgrading Very High Frequency (VHF) radios used by civil users and Ultra High Frequency (UHF) radios used by military aircraft. NEXCOM Segment 1A will replace the radios used for high and ultrahigh en route sectors. Segment 2 will replace the radios that terminal facilities use and will be a combined contract for both VHF and UHF radios. It will also upgrade emergency backup radios used if the primary radios are not working.

The Back Up Emergency Communication (BUEC) program replaced the radios installed at remote sites that back up the primary radios that controllers use. The Radio Control Equipment (RCE) program is ongoing, and it modernizes the electronic equipment that allows controllers to control the radios they use at remote sites. The Airport Cable Loop program replaces the communications cables that report the condition of equipment necessary for airport operations such as the Airport Surveillance Radar. We are replacing copper wires with fiber optics and adding dual path operations so that a break in the cable does not stop the flow of information. Communication Facilities Enhancement (CFE) funds the replacement, relocation, or establishment of remote receiver transmitter stations to sustain radio contact with pilots when existing sites are damaged, air travel routes are relocated, or new air service requires additional sites.

The last two items on the roadmap are supporting services that we must continually do to ensure reliable radio communications. The Radio Frequency Interference (RFI) and Interference Detection, Location and Mitigation (IDLM) programs investigate occurrences of other transmitters interfering with FAA radios and navigation systems, locate the source, and either shut it down or adjust its operations so it no longer interferes with FAA controlled frequencies.

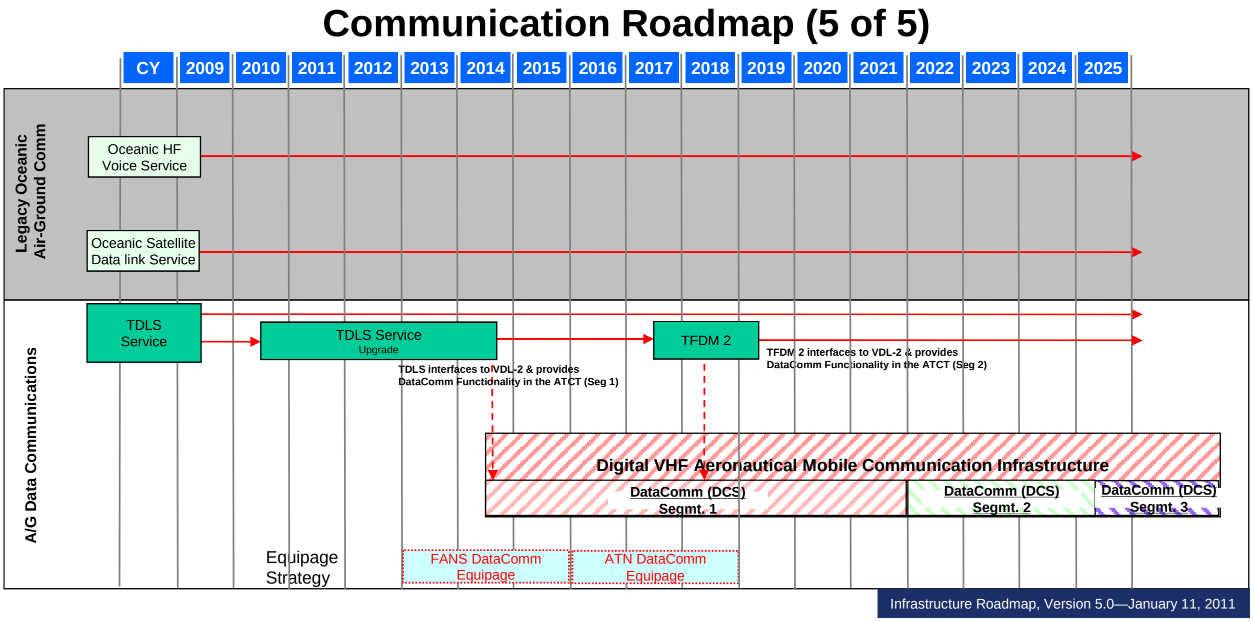


Figure 24 Communications Roadmap (5 of 5)

The fifth communications roadmap (figure 24) shows an Airport Wireless Communications System named AeroMACS based on existing (Institute of Electrical and Electronic Engineers) IEEE 802.16e standards. We are considering using this system to provide communications for both fixed and mobile units on the airport surface. This technology could be a low cost alternative for supporting existing and future applications associated with ASDE-X, ADS-B, and SWIM in the airport environment.

One of the communications systems used for oceanic air traffic control is the HF (high frequency) radio. Operated by a company named ARINC, HF radio allows the FAA to stay in touch with aircraft that are several thousand miles from shore. HF radio is supplemented by Oceanic Satellite Data Link Services used by newer better equipped aircraft, and this system relies on communications satellites to transfer messages over long distances.

The Terminal Data Link System (TDLS) is currently used to transmit clearances and other information to aircraft preparing to depart the airport. It is being upgraded and modernized for use until Tower Flight Data Management (TFDM) or Data Comm can take over its functions.

The FAA is developing digital communications with data link capability (DataComm) for pilot controller communications. Initially, DataComm will be used for such routine messages as air traffic clearances, advisories, flight crew requests, and reports. As the technology matures, the FAA may be able to upload an entire route of flight directly to an aircraft's flight management system.

Figure 14 shows the projected CIP spending for replacing communications systems and improving and modernizing communications channels. Expenditures are in Millions of Dollars.

BLI Number	Program Name	FY 2012 Manda-tory	FY 2012 Discre-tionary	FY 2012 Budget Total	FY 2013	FY 2014	FY 2015	FY 2016
	Communication Functional Area	**$10.2**	**$252.8**	**$263.0**	**$206.1**	**$221.7**	**$245.8**	**$204.4**
1A06	Data Communication in support of Next Generation Air Transportation System (NextGen)*	$7.2	$143.0	$150.2	$113.3	$119.1	$129.8	$104.8
2A08	Air/Ground Communications Infrastructure	$0.0	$4.8	$4.8	$2.6	$2.6	$2.6	$2.6
2A10	Voice Switching Control System (VSCS)	$0.0	$1.0	$1.0	$15.0	$20.0	$20.0	$15.0
2A12	Next Generation Very High Frequency Air/Ground Communications System (NEXCOM)	$0.0	$45.2	$45.2	$33.4	$22.0	$40.0	$40.0
2A19	Automated Terminal Information Services (ATIS)	$0.0	$1.0	$1.0	$0.0	$0.0	$0.0	$0.0
2B08	Terminal Voice Switch Replacement (TVSR)	$0.0	$10.0	$10.0	$8.0	$5.0	$0.0	$0.0
2B13	National Airspace System Voice System (NVS)	$0.0	$19.8	$19.8	$10.0	$30.0	$30.0	$30.0
2E05	Alaskan Satellite Telecommunication Infrastructure (ASTI)*	$3.0	$16.0	$19.0	$11.8	$11.0	$11.4	$0.0
3A04	National Airspace System (NAS) Recovery Communications (RCOM)	$0.0	$12.0	$12.0	$12.0	$12.0	$12.0	$12.0

Figure 25 Expenditures in the Communications Functional Area[3]

4.3 Surveillance

To provide separation services to aircraft, air traffic controllers must have an accurate display of all aircraft under their control. Controller displays use a variety of inputs, including radar and transponder information, to show the location of aircraft. Automation systems process radar data and other inputs and send it to the displays. En route facilities use the Air Route Surveillance Radar (ARSR), and terminal facilities use several models of the Airport Surveillance Radar (ASR) as primary radars. The ARSR and ASR radars are primary because they do not require a cooperative transmission from an aircraft to detect and track its location. En route and terminal facilities normally use secondary radars called the Air Traffic Control Beacon Interrogators (ATCBI) and Mode Select (Mode S) for traffic separation. Secondary radar sends a signal to aircraft equipped with a transponder. The transponder sends a reply, which can be processed to determine the aircraft call sign, altitude, speed, and its position. Using ATCBI or Mode S enhances the controller's ability to separate traffic because flight and altitude information can supplement the position display for each aircraft.

The FAA uses two systems for tracking aircraft on or near the airport surface. The ASDE-3 is a primary radar system that provides a display of aircraft and ground vehicles in the airport operating areas (runways and taxiways). This helps controllers manage aircraft on the ground and warn them of potential runway collisions. The ASDE-X uses several technologies to

---

[3] *BLI's that support the mandatory General Fund appropriation request and include a breakout of the funding amount for Mandatory, Discretionary and Total request. ** BLI numbers with X represent outyear programs not requested in the FY 2012 President's Budget. FY 2013 – 2016 Out-year funding amounts are estimates.

improve detection of aircraft and provides a clear display of the positions of aircraft and vehicles on or near taxiways and runways.

Figure 26 is one of the two roadmaps for surveillance systems.

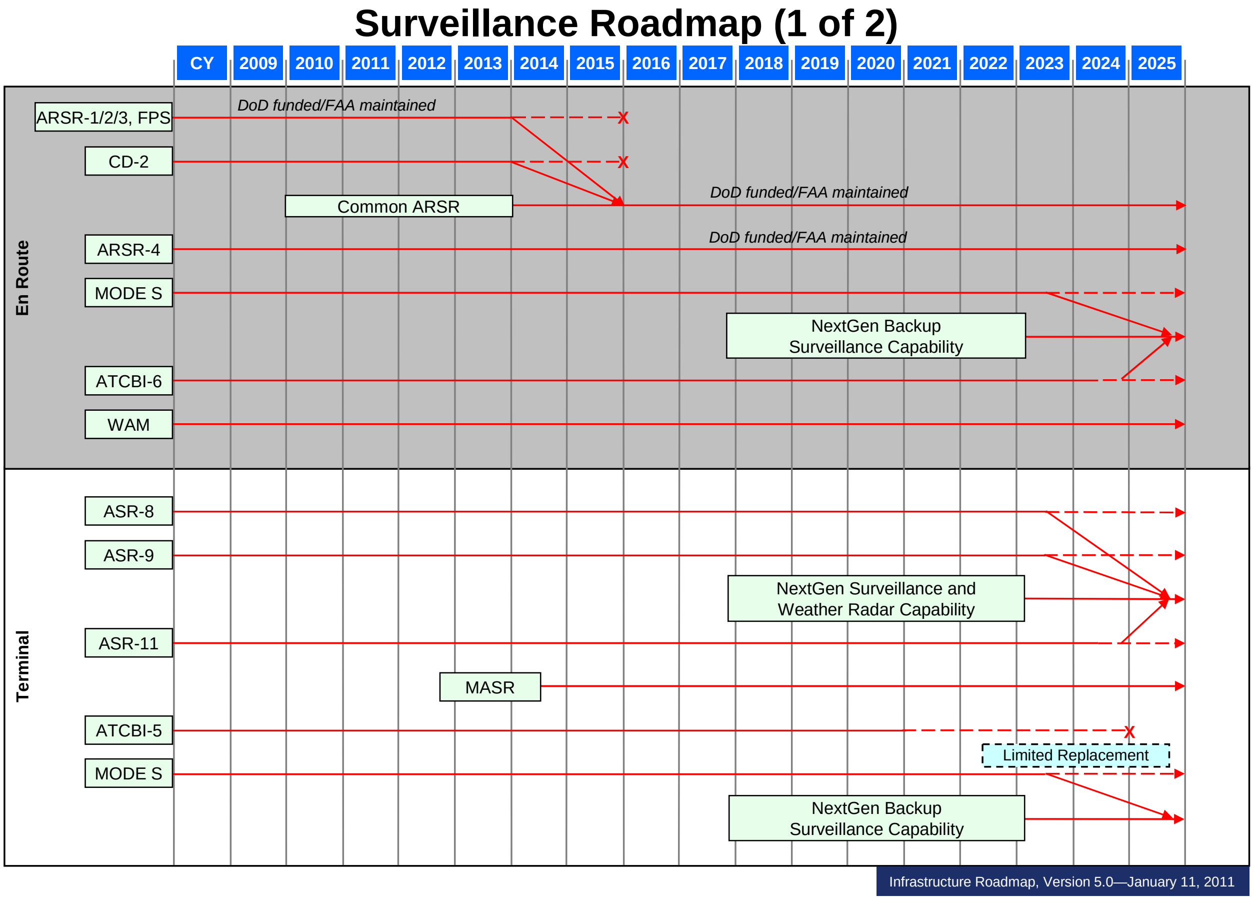


Figure 26 Surveillance Roadmap (1 of 2)

The major systems shown in the en route block are the various ARSR models and Common Digitizer (CD-2); the Air Traffic Control Beacon Interrogator (ATCBI); and the Mode S. The ARSR has a range exceeding 200 miles, and it provides aircraft location information to the en route centers. It is a “skin-paint” radar (does not require cooperation from the detected aircraft) that transmits radio frequency pulses and processes the reflected energy to determine aircraft range based on the total time for the signal to reach and return from the target, and the direction from the radar based on the antenna position. The ATCBI and the more advanced Mode S transmit an electronic signal to aircraft, which triggers a transponder. An ATCBI triggers all transponders within its beam, while the Mode S is able to address each aircraft within its beam separately. The Colorado Wide Area Multilateration (WAM) system uses several technologies to detect aircraft position in areas where the radar signal may be blocked by mountainous terrain.

The FAA, the Department of Homeland Security, and the Department of Defense will jointly maintain the ARSR through 2025 due to aviation security concerns. We will begin evaluating a next-generation backup surveillance capability in 2013 and decide whether to begin a replacement program in 2017.

There are four models of terminal radars currently in use. The Airport Surveillance Radar Model 11 (ASR-11) is the newest and has replaced some of the older radars that the ASR-9 program did not replace. The ASR-8 and the ASR-9 will have Service Life Extension Programs (SLEP) to update and modernize their components, and the FAA will decide in 2017 whether to replace these systems with new systems providing NextGen surveillance and weather capability. Current planning calls for keeping some terminal primary radar systems as a backup for ADS-B to address safety, security, and weather detection requirements.

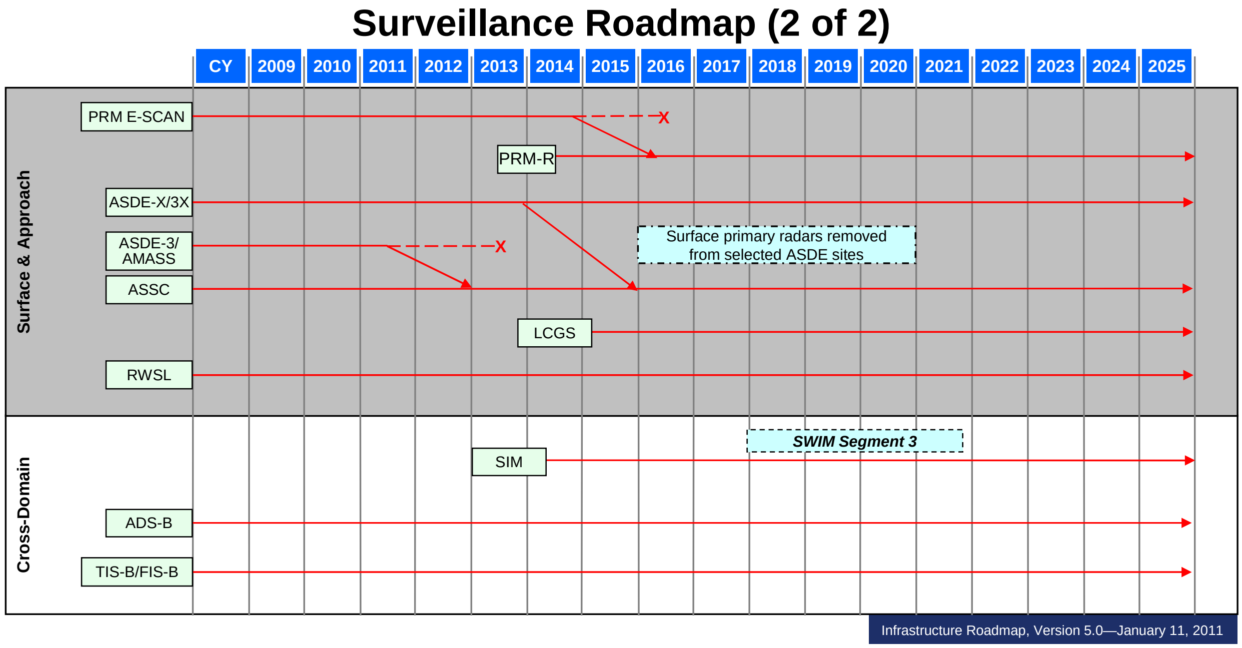


Figure 27 Surveillance Roadmap (2 of 2)

The second Surveillance roadmap (figure 27) shows the systems used on the surface and ADS-B with the application it supports. The Precision Runway Monitor (PRM) is installed at six airports, and it can be used to allow simultaneous approaches to closely spaced parallel runways. It is a rapid-update radar that provides the precision that controllers need to ensure that two aircraft flying side-by-side maintain safe clearance between them while approaching closely spaced runways. The electronic scan (E-SCAN) version achieves the rapid update by moving the beam electronically rather than relying on a back-to-back turning antenna.

Controllers use two systems to maintain aircraft separation on the airport surface. Some airports have ASDE-3, which uses radar and a display in the tower to depict the location of aircraft on or approaching the taxiways and runways. These displays help controllers determine aircraft location when weather or darkness makes it difficult to see the airport surface. The ASDE-X uses several technologies to perform the same function, and 25 of the 35 planned ASDE-X sites were formerly ASDE-3/AMASS sites. The FAA will upgrade 18 ASDE-3 systems to ASDE-X and replace 7 existing ASDE-3 radars. Once all aircraft are equipped with ADS-B, we will maintain 9 ASDE-3 systems and 35 ASDE-X systems.

A third system that warns pilots about potential runway incursions is the Runway Status Lights (RWSL). These systems use lights embedded in the runway to inform a pilot when it is unsafe to cross a runway; and they are turned off when it is safe to proceed. We have tested these lights at Dallas/Fort-Worth International Airport, and there is an operational system at Los Angeles International Airport. The FAA plans to have 23 systems operational and 3 support sites within the 5-year timeframe of the CIP.

Over the next 2 years, the FAA will be evaluating whether to install Surveillance Interface Modernization (SIM) systems in terminal and en route radar systems. Use of SIM would precede a transition to SWIM for collection and storage of radar data.

The ADS-B line will support a planned shift toward that technology for providing surveillance data to controllers. Nationwide implementation of ADS-B will enable a more frequent transmission of location and other flight information from the aircraft to air traffic control facilities. It may replace or supplement the data from a transponder response or passive reflected energy from radars. ADS-B has a faster update rate (1 second versus 5 seconds for a radar), and unlike radar technology, the accuracy remains constant regardless of the distance from the aircraft to the receiving site. The Traffic Information System (TIS-B) broadcasts information on the location of nearby aircraft to aircraft that are equipped with the capability to receive it.

Figure 28 shows the CIP costs associated with upgrading the surveillance units. Expenditures are in Millions of Dollars.

BLI Number	Program Name	FY 2012 Manda-tory	FY 2012 Discre-tionary	FY 2012 Budget Total	FY 2013	FY 2014	FY 2015	FY 2016
	Surveillance Functional Area	**$8.0**	**$343.3**	**$351.3**	**$338.8**	**$336.4**	**$156.1**	**$126.2**
2A09	Air Traffic Control En Route Radar Facilities Improvements	$0.0	$5.8	$5.8	$5.9	$0.0	$0.0	$0.0
2A14	Automatic Dependant Surveillance - Broadcast (ADS-B) NAS Wide	$0.0	$285.1	$285.1	$270.7	$271.9	$107.3	$112.5
2A18	Colorado ADS-B Wide Area Multilateration (WAM) Cost Share*	$2.0	$3.8	$5.8	$1.4	$1.4	$1.4	$1.4
2B01	Airport Surface Detection Equipment - Model X (ASDE-X)	$0.0	$2.2	$2.2	$10.0	$11.1	$13.4	$7.9
2B10	Airport Surveillance Radar (ASR-9) Service Life Extension Program (SLEP)*	$2.0	$6.0	$8.0	$4.0	$5.0	$5.0	$0.0
2B11	Terminal Digital Radar (ASR-11) Technology Refresh	$0.0	$3.9	$3.9	$8.4	$9.4	$6.3	$4.4
2B12	Runway Status Lights (RWSL)	$0.0	$29.8	$29.8	$36.4	$32.6	$22.7	$0.0
2B16	Mode S Service Life Extension Program (SLEP)*	$4.0	$4.0	$8.0	$2.0	$5.0	$0.0	$0.0
2B17	ASR-8 Relocation	$0.0	$2.7	$2.7	$0.0	$0.0	$0.0	$0.0

Figure 28 Expenditures in the Surveillance Functional Area[4]

4.4 Navigation Roadmaps

There are two major types of navigational aids: those used for en route navigation, and those used for precision approach and landing guidance. The en route aids have traditionally been radio transmitters that provide pilots direction and/or distance from their location. The ground-based system commonly used for en route navigation is the Very High Frequency

---

[4] *BLI's that support the mandatory General Fund appropriation request and include a breakout of the funding amount for Mandatory, Discretionary and Total request. ** BLI numbers with X represent outyear programs not requested in the FY 2012 President's Budget. FY 2013 – 2016 Out-year funding amounts are estimates.

Omnidirectional Range with Distance Measuring Equipment (VOR with DME). There are more than 1,000 VORs spread across the United States. They enable pilots to determine an accurate position and also define the Victor and Jet airways, which are published routes based on straight lines from VOR to VOR. Airways simplify route planning and provide predictability for air traffic controllers who often must project an aircraft's future position to avoid conflicts. Pilots use VOR/DME to follow their planned routes accurately under all visibility conditions.

As we implement NextGen and more aircraft equip, the Global Positioning System (GPS) satellite navigation system will be more widely used for en route navigation. Using GPS will support more direct routing because pilots will be able to program and fly routes defined by geographic coordinates rather than flying from VOR to VOR. GPS receivers in the aircraft will also be used to report an aircraft's position when we implement ADS-B.

Precision landing guidance systems and associated equipment support low-visibility operations by providing radio signals and approach lights to help pilots land safely in limited visibility. The current most widely-used precision landing aids are Instrument Landing Systems (ILS) that guide pilots to runway ends using a pair of radio beams – one for lateral guidance and the other for vertical guidance - to define the approach glidepath, so that pilots can follow it to the runway using cockpit instrumentation. There are more than 1,200 ILSs installed in the United States. They are essential to airlines for maintaining schedule reliability during adverse weather conditions. Augmented GPS satellite signals also provide precision landing guidance. There are two augmentation systems that will be used for this purpose. The Space Based Augmentation System (SBAS) is the FAA's Wide Area Augmentation System (WAAS) that uses a network of 38 ground monitors to calculate corrections to the GPS signals and broadcast those corrections from telecommunications satellites. WAAS-equipped aircraft can use the information to fly a precision approach to a runway in low-visibility conditions. There are currently more than 1,300 WAAS precision approach procedures referred to as Localizer Performance with Vertical Guidance (LPV) that use GPS augmented by WAAS for both horizontal and vertical guidance. The Ground Based Augmentation System (GBAS) is the FAA's Local Area Augmentation System (LAAS), which is located on an airport's surface and calculates corrections that are used to support precision approach services to all runways at an airport in weather conditions approaching zero visibility.

Figures 29 and 30 show the roadmaps for navigation aids.

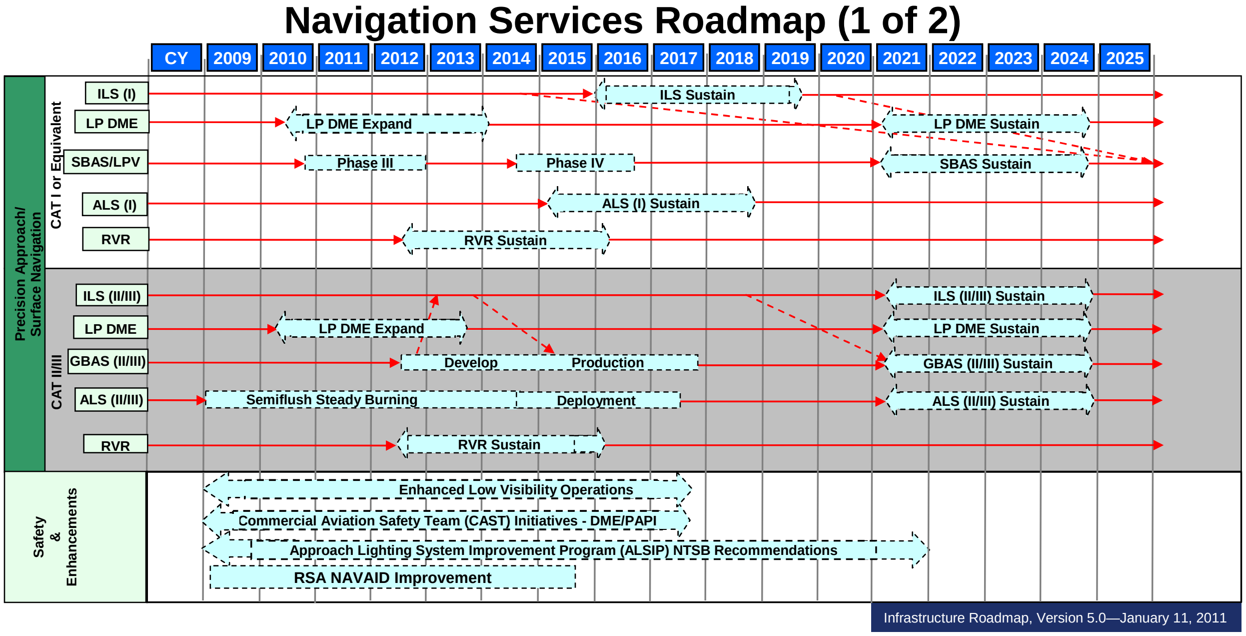


Figure 29 Navigation Roadmap (1 of 2)

There are three categories of precision approach. Category I is the most common. It guides the pilot to the runway end, but it requires that the pilot be able to see the runway when the aircraft is no less than 200 feet above the field elevation, and the horizontal visibility is one-half mile or more. The Category II and III approaches allow aircraft to descend to lower minimums (i.e., less vertical and horizontal visibility is required). Currently, ILS is the primary system used for precision approaches. Category II and III ILS have redundancy and reliability levels that reduce the risk of equipment failures and allow lower minimums. Alternatives for precision approach guidance are the SBAS/WAAS LPV and GBAS. As these alternatives come into broader use, the FAA can consider decommissioning ILS, but a number will remain in service to provide a back-up capability at the core and other airports as required. The FAA plans to make an initial decision in 2014 whether to begin a drawdown of Category I ILS, and a decision in 2020 whether to decommission all remaining Category I ILSs.

In both Category I and Category II/III sections of the roadmap the Approach Light System (ALS) and the Runway Visual Range (RVR) systems are shown. The ALS helps the pilot see the runway and transition from instrument to visual flight for landing before reaching runway minimums. The RVR informs the tower of the measured visibility so that controllers can inform the pilot whether the runway visibility is above or below minimums. The FAA is testing use of light-emitting diodes (LED) to replace the incandescent lamps currently in use in ALS to reduce both maintenance and operating costs. The approach lights and visibility sensors will need to be sustained and remain in operation for precision approach guidance regardless of any decision on decommissioning ILSs.

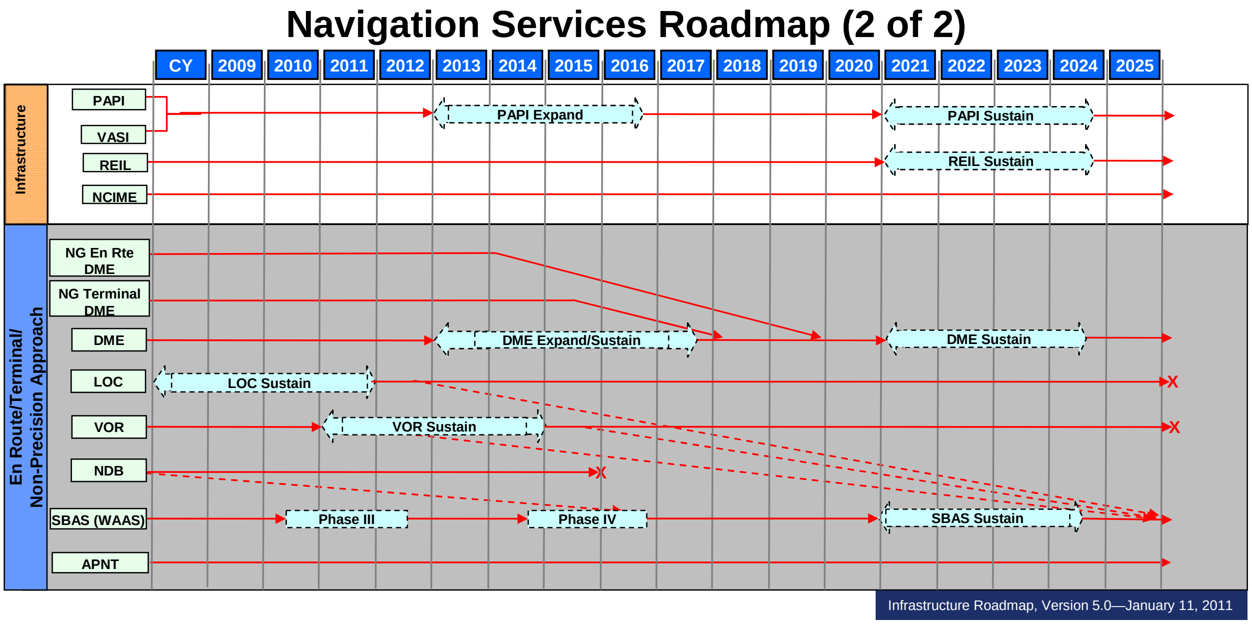


Figure 30 Navigation Roadmap (2 of 2)

As shown in Figure 30, Runway End Identification Lights (REIL) and the Precision Approach Path Indicator (PAPI) are also aids to landing an aircraft. The PAPI is replacing the Vertical Approach Slope Indicator (VASI), which uses an older technology to help pilots ensure they are on the proper glideslope for landing. The REIL and PAPI help pilots to visually align with the runway for both precision and non-precision approaches. Both will continue operating throughout the roadmap timeframe. The Navaid Control Interlock and Monitoring System (NCIME) will be installed to assist controllers to rapidly activate and deactivate the navigational aids in use at an airport

The low power Distance Measuring Equipment (LPDME) will replace outer markers that provide pilots with an indication of their distance from an airport as they fly the final approach. NextGen en route and terminal DME will be installed beginning in the 2014 timeframe to support Area Navigation/Required Navigation Performance (RNAV/RNP) operations.

The Localizer (LOC) is an ILS component that provides horizontal guidance to a runway end. When used as a stand-alone system without a Glideslope component, LOC supports non-precision approach operations. In 2012, FAA will decide whether to drawdown the systems at airports where only localizers are installed.

The en route and terminal domains have traditionally relied on the system of VORs to define airways within the NAS. We will decide in 2015 whether to continue operating VORs as a backup for GPS or remove all VORs by 2025. If we retain VORs, they will need a service life extension program (SLEP).

The FAA is phasing out and plans to decommission Non-Directional Beacons (NDB) by 2016, because NDB only provide limited directional information. NDBs allow a pilot to determine direction from an NDB transmitter, but do not provide distance information; modern navigational equipment has more advanced capabilities.

The Department of Defense operates GPS. There are typically 24 to 30 active satellites in orbit, and a navigation receiver can determine an aircraft's position by interpreting the data transmitted by the satellites in view of its antenna. We expect two GPS upgrades in future years. The next generation of satellites, Block IIF, will have a second frequency (L5) for civilian safety-of-life use. An aircraft receiver that receives both the existing L1 signal and the new L5 signal can internally calculate corrections that enhance the accuracy of the position calculation and eliminate the errors caused by ionospheric distortion. The GPS III family of satellites will be upgraded with an additional civil signal (L1C) and increased transmitting power.

The Wide Area Augmentation System (WAAS) improves the precision of GPS by providing corrections and satellite reliability information to aeronautical GPS receivers. Aircraft receivers use WAAS corrections to calculate a precise geographic position. Introduction of the L5 signal will significantly improve availability of LPV approaches.

Non-precision approaches provide guidance to pilots preparing to land on a runway when there is limited visibility; however they only provide lateral, not vertical guidance. These approaches do not allow descent to the same minimum altitudes possible with a precision approach. VORs support many of the non-precision approaches, and GPS and WAAS also support non-precision approach operations. If the FAA decides to decommission VORs, GPS and WAAS will become the primary means for providing this service. The FAA has more than 4,000 GPS-WAAS non-precision approach procedures in place.

Figure 31 shows the future capital investments for navigation systems included in the CIP. Expenditures are in Millions of Dollars.

BLI Number	Program Name	FY 2012 Manda-tory	FY 2012 Discre-tionary	FY 2012 Budget Total	FY 2013	FY 2014	FY 2015	FY 2016
	Navigation Functional Area	**$1.0**	**$268.4**	**$269.4**	**$251.8**	**$196.2**	**$192.6**	**$156.9**
1A18	Next Generation Air Transportation System (NextGen) - Performance Based Navigation (PBN) - Metroplex Area Navigation (RNAV)/Required Navigation Performance (RNP)	$0.0	$26.2	$26.2	$26.2	$21.2	$16.7	$16.7
2D01	VHF Omnidirectional Radio Range (VOR) with Distance Measuring Equipment (DME)	$0.0	$5.0	$5.0	$2.5	$2.5	$2.5	$2.5
2D02	Instrument Landing Systems (ILS) - Establish	$0.0	$5.0	$5.0	$7.0	$7.0	$7.0	$7.0
2D03	Wide Area Augmentation System (WAAS) for GPS	$0.0	$125.5	$125.5	$111.1	$115.5	$121.4	$95.7
2D04	Runway Visual Range (RVR)	$0.0	$5.0	$5.0	$4.0	$4.0	$4.0	$4.0
2D05	Approach Lighting System Improvement Program (ALSIP)	$0.0	$5.0	$5.0	$3.0	$3.0	$3.0	$3.0
2D06	Distance Measuring Equipment (DME)	$0.0	$5.0	$5.0	$5.0	$0.0	$0.0	$0.0
2D07	Visual Navaids - Establish/Expand	$0.0	$3.4	$3.4	$5.0	$0.0	$0.0	$0.0
2D09	Navigation and Landing Aids - Service Life Extension Program (SLEP)	$0.0	$6.0	$6.0	$8.0	$3.0	$3.0	$3.0
2D10	VASI Replacement - Replace with Precision Approach Path Indicator	$0.0	$7.0	$7.0	$5.0	$5.0	$5.0	$5.0
2D11	Global Positioning System (GPS) Civil Requirements	$0.0	$50.3	$50.3	$55.0	$0.0	$0.0	$0.0
2D12	Runway Safety Areas - Navigation Mitigation	$0.0	$25.0	$25.0	$20.0	$35.0	$30.0	$20.0
2D13	Navaid Control, Interlock and Monitoring Equipment (NCIME)*	$1.0	$0.0	$1.0	$0.0	$0.0	$0.0	$0.0

Figure 31 Expenditures in the Navigation Functional Area[5]

---

[5] *BLI's that support the mandatory General Fund appropriation request and include a breakout of the funding amount for Mandatory, Discretionary and Total request. ** BLI numbers with X represent outyear programs not requested in the FY 2012 President's Budget. FY 2013 – 2016 Out-year funding amounts are estimates.

4.5 Weather Systems

Timely and accurate weather observations and forecasts are essential to aviation safety and for making the best use of aviation capacity. Pilots need to know the direction and speed of winds aloft so that they can take advantage of tailwinds and minimize the effect of headwinds. They also need to know if there will be obstructions to visibility that restrict landings at their destination airport, and whether the runway is wet or dry and how that will affect braking action. Traffic flow managers and pilots use weather observations and forecasts to determine when they need to plan alternative routes to avoid severe weather. Pilots must avoid thunderstorms with hail and heavy rain, turbulence, and icing because they can damage the aircraft and potentially injure passengers. The FAA has a lead role in collecting and distributing aviation weather data – particularly hazardous weather. The agency distributes weather hazard information from its own systems and uses both the FAA and National Weather Service (NWS) computer forecast models based on data available from FAA and NWS sensors to develop forecasts for use by air traffic control facilities, pilots, airline operations centers, and other aviation-related facilities.

The FAA employs two categories of weather systems: weather sensors and weather processing/dissemination/display systems. Weather sensors include weather radars and surface observation systems that measure atmospheric parameters, such as surface temperature, prevailing wind speed and direction, relative humidity, and cloud bases and tops, as well as wind shear and microbursts. These weather sensors provide real-time information to air traffic facilities and to centralized weather-forecasting models. Weather processing/dissemination/display systems organize and process the sensor's observed data. Data from multiple sensors feed forecast models whose output can be disseminated and integrated in national and local processing and display systems to interpret broad weather trends affecting aviation operations. This information can then be sent to air traffic controllers, traffic flow managers, dispatchers, and pilots. Figure 32 shows the current and planned status of weather sensors.

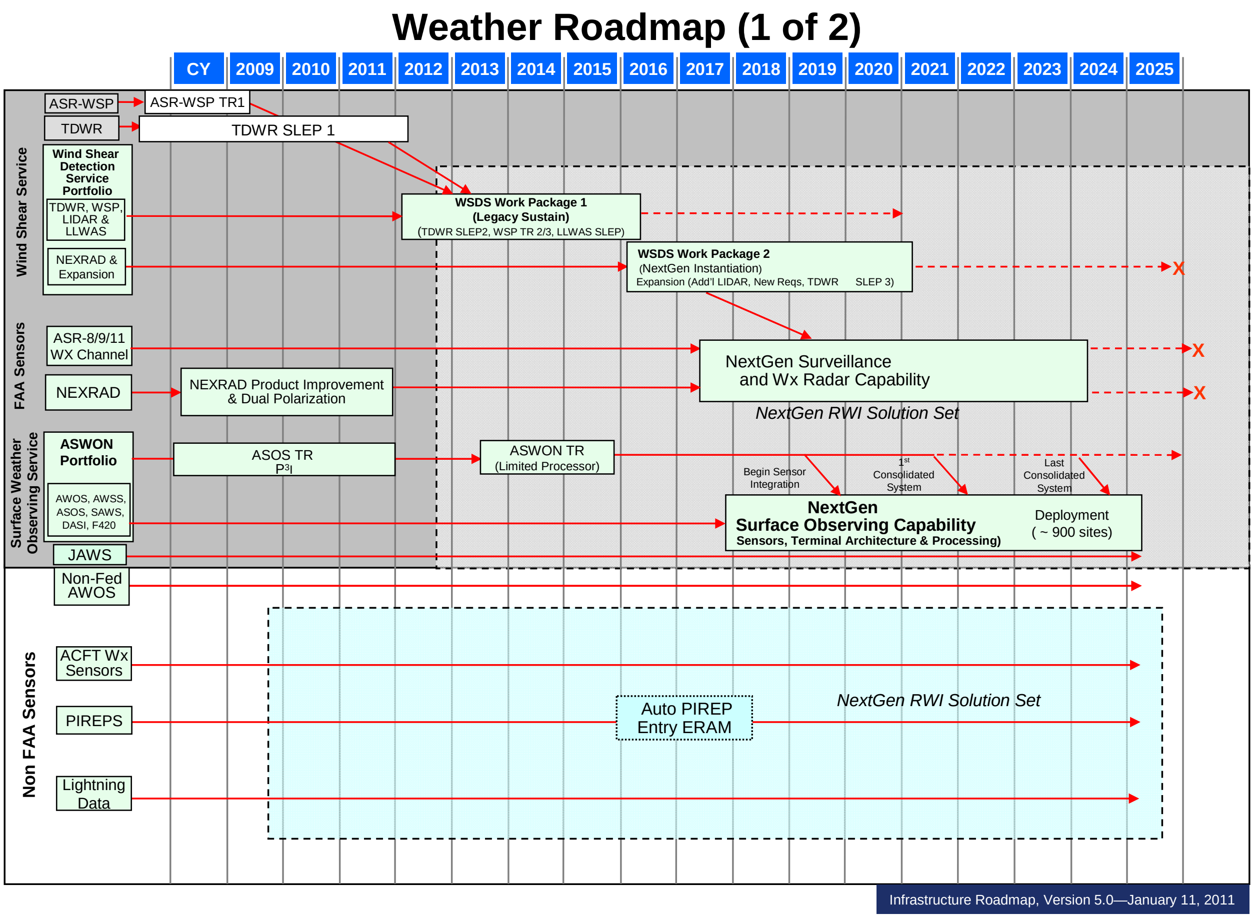


Figure 32 Weather Sensor Roadmap

The Wind Shear Detection Services Portfolio and radar system shown at the top of the roadmap includes: the Airport Surveillance Radar – Weather System Processor (ASR-WSP); the Terminal Doppler Weather Radar (TDWR); and the Low Level Wind Shear Alerting System (LLWAS). All these systems detect wind shear conditions near the runways and approach areas of airport to alert controllers, who can then warn pilots of gust fronts and wind shear in the vicinity of the airport. The Light Detection and Ranging (LIDAR) system uses lasers to detect dry microbursts and gust fronts that radar systems such as TDWR may not detect. Evaluation of LIDAR is underway at airports located in dry high plains or mountain environments, where wind shear is not always accompanied by sufficient precipitation for the TDWR to detect with 90 percent reliability.

The most sophisticated wind shear detection system is the TDWR. There are 46 operational TDWR sites on or near the largest airports with the most risk of wind shear. Using Doppler technology, the radars can detect the rapid changes in wind speed and direction that indicate existence of wind shear hazards for an aircraft approaching or departing a runway. Airports with significant wind shear risk that have a lower volume of air traffic are served by a lower cost alternative, the ASR-WSP which processes the six-channel weather from the two dimensional

Doppler search radar signals of the ASR-9 to detect wind shear and approximate the output of the TDWR.

LLWAS supplements these radar systems, and it consists of wind sensors located at 6 to 29 points around the runway thresholds to measure surface wind direction and velocity. The LLWAS computer systems compare the wind velocity and direction detected by these sensors at different locations to determine whether wind shear events are occurring at or near the runways. The sensors can only measure surface winds and do not detect wind shear in the approach or departure paths as a radar would. LLWAS both serves airports that do not have a TDWR or WSP, and at several locations, the system supplements the weather radars with point-specific wind measurements to verify the presence and location of wind shear. The FAA is in the process of deciding whether to replace all current wind shear sensors with a NextGen weather and surveillance radar system.

The ASR-9/11 Weather Channel and the Next Generation Weather Radar (NEXRAD) detect precipitation, wind, and thunderstorms that affect aircraft in flight; and the ASR-8 displays weather that reflects its radar signal. Replacing the weather information that the ASR-8/9 radars generate will be necessary only if the ASR-8/9 radars do not remain in operation. The FAA plans to decide in 2017 whether to combine these functions into a NextGen weather radar replacement. Development of the currently operating Next Generation Weather Radar (NEXRAD) occurred under a joint program of the Department of Commerce National Weather Service, Department of Defense, and FAA. These systems are Doppler weather radars that detect and produce over 100 different long-range and high-altitude weather observations and products, including areas of precipitation, winds, thunderstorms, turbulence, and icing. The NEXRAD radars are essential for forecasting future weather. In the short term, we are funding upgrades such as Dual Polarization (Dual Pol) and software improvements. Dual Pol is an important addition to NEXRAD that improves detection of in-flight icing and is expected to improve the forecasting of areas where in-flight icing will occur. Working with our partner agencies, we will also decide by 2017 whether to incorporate planned long-range NEXRAD capabilities into the combined NextGen weather and surveillance radar system that will have intermediate range gap-filler capabilities.

The Automated Surface Weather Observation Network (ASWON) Portfolio includes several surface sensors (AWOS/ASOS/AWSS/SAWS) that measure weather parameters on the surface and report conditions to air traffic facilities and pilots. The data they collect is important to pilots and dispatchers as they prepare and file flight plans, and it is vital for weather forecasting. The Automated Surface Observing Systems (ASOS) and other variants — such as the Automated Weather Observing System (AWOS); the Automated Weather Sensor Systems (AWSS); and the Stand Alone Weather Sensing (SAWS) system — have up to 14 sensors that measure surface weather data, including temperature, barometric pressure, humidity, type and amount of precipitation, and cloud bases and amount of sky cover. These systems feed data directly to air traffic control facilities and support automated broadcast of weather information to pilots. They also provide regular updates for the forecast models that predict future weather conditions including adverse weather. A technical refresh is underway to keep these systems operating reliably until we make a decision to implement the NextGen Surface Observing Capability.

The Juneau Airport Weather System (JAWS) is unique to the Juneau Alaska, area. It provides wind hazard information from mountain-peak wind sensors located around Juneau to the Flight Service Station and Alaska Airlines to improve the safety of aircraft arriving at and departing the airport.

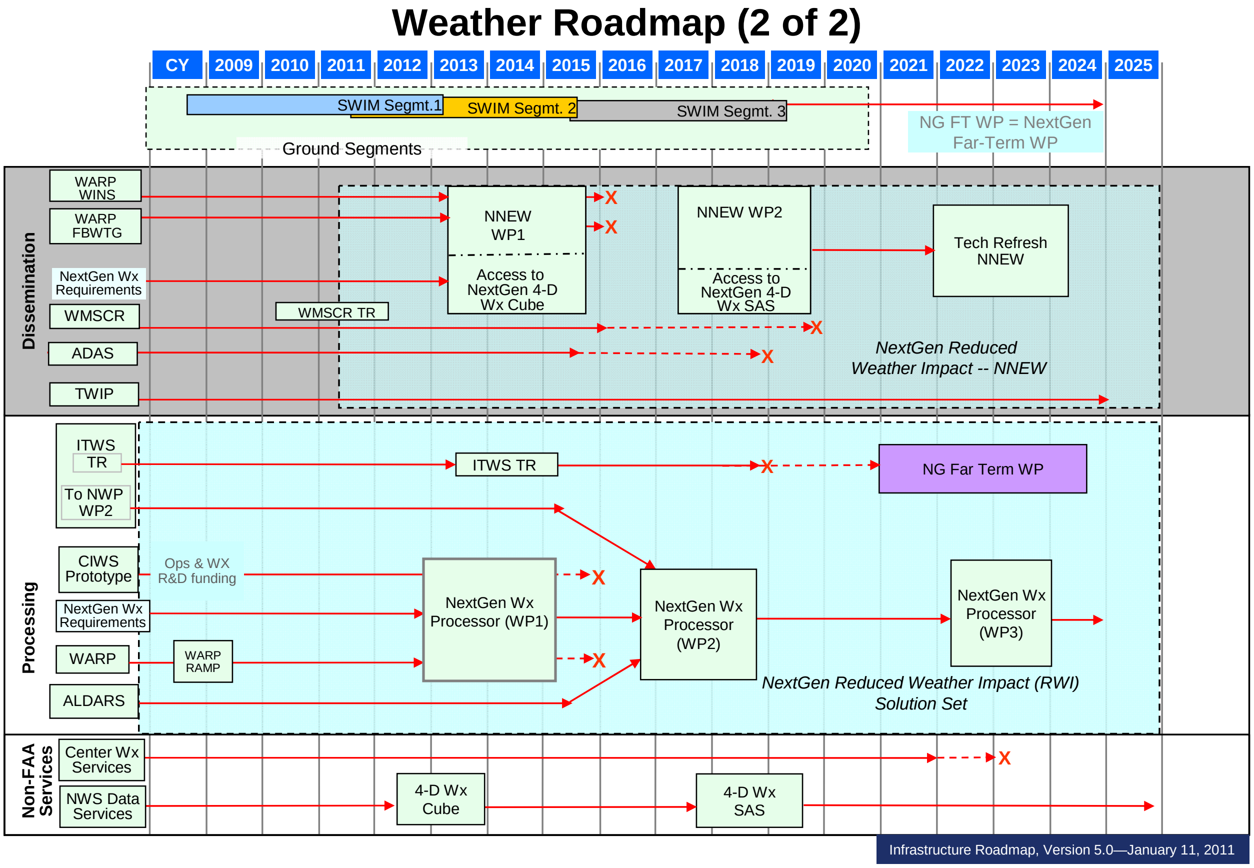


Figure 33 Weather Dissemination, Processing, and Display Roadmap

Figure 33 shows that NextGen requires efficient consolidation of large volumes of weather observations and forecast information for processing, display, and dissemination. Weather forecasts are integrated into decision support system algorithms to produce the more sophisticated forecasts of how weather will impact NAS operations. We are developing NNEW and the NextGen 4-D Weather Cube to enhance the collection and dissemination of weather information and provide access to all users throughout the NAS.

The NextGen 4-D Weather Cube is a distributed "virtual" database that will receive weather data directly from sensors and other sources and, either automatically or by request, send data to FAA facilities and users so that observations and forecasts can be more widely and consistently distributed via network-enabled communications. The 4-D Weather Cube will be part of the NextGen Networked Enabled Weather program and will support the Reduce Weather Impact solution set. The 4D Weather Cube will host the Single Authoritative Source (4-D Wx SAS), which ensures that the most accurate and consistent data will be distributed to users so that they can make decisions based on correct and coherent weather information. Decision support tools will use this weather information to assist users in understanding weather constraints and taking actions to reduce risk for aviation operations.

Currently, the Weather and Radar Processor Weather Information Network Server (WARP WINS) stores data from multiple NEXRAD radars for en route control facilities to use. SWIM may allow retrieval of this data as a NextGen capability in the future. WARP compiles information from a number of sources for interpretation by the Center Weather Service Unit forecasting stations. WARP also provides NEXRAD precipitation intensity data to controllers' displays. The Automated Weather Observation System Data Acquisition System (ADAS) is a communications link that transmits AWOS/ASOS/AWSS data to air traffic facilities. ADAS also correlates lightning groundstroke information to AWOS/ASOS/AWSS data to better determine the location of nearby thunderstorm activity. The FAA-operated Weather Message Switching Center Replacement (WMSCR) is a network with distribution nodes in Salt Lake City and Atlanta that collects and distributes nationwide weather information. The Terminal Weather Information for Pilots (TWIP) system transfers TDWR weather imagery to airline dispatchers via an airline's communication provider for uplink to pilots for use in analyzing terminal weather conditions at major airports. The FAA will decide during 2014 whether to migrate WMSCR functionality into the NNEW for weather information distribution.

The Integrated Terminal Weather System (ITWS) consolidates weather information from automated sensors and surrounding radars (TDWR and NEXRAD) to provide real-time weather information for terminal control facilities. The system also projects movement of thunderstorms and gust fronts up to 20 minutes into the future. Tower and Terminal Radar Approach Control (TRACON) controllers use the information to make more precise estimates of when runways should be closed and subsequently reopened. They also use the information to plan for a switch in terminal arrival patterns to avoid inefficient maneuvering to accommodate a runway change as aircraft approach an airport. We have installed ITWS at 23 airports. ITWS will receive technical refresh in the near term, and we will incorporate its weather inputs and processing power into the NextGen Weather Processor by 2018.

The Corridor Integrated Weather System (CIWS) gathers weather information along the busiest air traffic corridors to help air traffic specialists select the most efficient routes when they must divert traffic to avoid severe weather conditions. The CIWS prototype tested a predictive capability that would refine the decisions regarding when normal (direct) routes will be available. CIWS functionality will become part of the NextGen Weather Processor and support the Traffic Flow Management automation software.

The NextGen Weather Processor will incorporate the functionality of the existing Weather and Radar Processing (WARP) system; implement the CIWS functionality (0-2 hour convective weather forecast) and develop a 0-6 hour forecast for the TFM system. Work Package 2 (WP 2) will enhance the display of weather information by using new algorithms to portray icing conditions, turbulence, and other hazards. We will incorporate ITWS capabilities as part of WP 3. Further upgrades of weather-predicting algorithms will also be added in WP 3 to include Wind Shear/Microburst and Wake Vortex Detection and prediction advisories.

Figure 34 shows the planned expenditures included in the CIP for weather sensors and weather dissemination and processing systems. Expenditures are in Millions of Dollars.

BLI Number	Program Name	FY 2012 Manda-tory	FY 2012 Discre-tionary	FY 2012 Budget Total	FY 2013	FY 2014	FY 2015	FY 2016
	Weather Functional Area	**$18.4**	**$63.3**	**$81.7**	**$52.4**	**$49.9**	**$41.2**	**$37.2**
1A05	NextGen Network Enabled Weather (NNEW)	$0.0	$27.4	$27.4	$25.0	$25.0	$10.0	$10.0
1A10	Next Generation Air Transportation System (NextGen) - Reduce Weather Impact*	$18.4	$14.6	$33.0	$14.6	$20.0	$20.0	$20.0
2A04	Next Generation Weather Radar (NEXRAD)	$0.0	$2.8	$2.8	$3.3	$1.2	$1.3	$1.2
2A15	Windshear Detection Service	$0.0	$1.0	$1.0	$0.0	$0.0	$0.0	$0.0
2A16	Weather and Radar Processor (WARP)	$0.0	$2.5	$2.5	$0.5	$0.7	$0.0	$0.0
2B02	Terminal Doppler Weather Radar (TDWR) - Provide	$0.0	$7.7	$7.7	$4.6	$0.5	$0.0	$0.0
2B18X	Integrated Terminal Weather System (ITWS)**	$0.0	$0.0	$0.0	$0.0	$1.3	$9.7	$5.9
2C01	Automated Surface Observing System (ASOS)	$0.0	$2.5	$2.5	$0.0	$0.0	$0.0	$0.0
2C03	Weather Camera Program	$0.0	$4.8	$4.8	$4.4	$1.2	$0.2	$0.1

Figure 34 Expenditures in the Weather Functional Area[6]

4.6 Facilities

The Air Traffic Organization maintains and operates thousands of staffed and unstaffed operational facilities that we must regularly upgrade and modernize. The largest facilities are the 21 en route centers, that house hundreds of employees and the equipment they use to control aircraft flying in the en route airspace. The other operational facilities with significant staffing are the more than 500 towers and 167 TRACON facilities that control traffic departing and arriving at airports.

There are also more than 16,000 unstaffed facilities—many in very remote locations—supporting communications, navigation, and surveillance equipment and weather sensors. Much of this equipment is housed in shelters and buildings that have exceeded their service lives and need renovation. Many have deteriorating steel towers and foundations. Some newer unstaffed buildings and structures frequently need renovation because they are in remote and/or hostile locations near the ocean or on mountaintops. Replacing roofing, power, heating/cooling, and structural and security components of these structures is essential to successful operation of the NAS.

The William J. Hughes Technical Center (WJHTC) in Atlantic City, NJ, and the Mike Monroney Aeronautical Center (MMAC) in Oklahoma City, OK, each have many buildings. Each year, these complexes receive funds to both sustain and replace infrastructure and to improve and modernize buildings to support training, logistics, research, and management functions. The MMAC operates under a lease from the Oklahoma City Airport Trust, and funds are requested to pay the annual lease costs. The MMAC also receives infrastructure funding for building renovation and updated infrastructure. The WJHTC supports research programs to determine the feasibility of NextGen concepts, and it also supports the testing of new equipment that will be installed in the NAS. The FAA has requested funding for 2012 and beyond to upgrade buildings and infrastructure such as roads. Annual funding is provided to reconfigure the research

---

[6] *BLI's that support the mandatory General Fund appropriation request and include a breakout of the funding amount for Mandatory, Discretionary and Total request. ** BLI numbers with X represent outyear programs not requested in the FY 2012 President's Budget. FY 2013 – 2016 Out-year funding amounts are estimates.

laboratories to accommodate acceptance testing for new equipment and to test modifications to existing equipment.

There are two budget line items for tower and TRACON investments, which have significant funding. The first is the Terminal Air Traffic Control Facilities – Replace program, which includes funding for both airport traffic control towers (ATCT) and TRACON facilities. This line item funds both replacement of existing towers and TRACONs and construction of towers for new airports. In most years, there are between 10 and 20 projects to replace towers that are either too small to handle the traffic growth that has occurred since they were built or have inadequate visibility of runways and taxiways due to construction of new runways or new hangers. The second line item is the Terminal Air Traffic Control Facilities – Modernize program. It replaces specific exterior or interior components of existing towers, such as elevators; heating ventilation and cooling equipment; roofs; or other infrastructure that the FAA must upgrade to keep towers functioning.

The FAA invests over $50 million a year to upgrade and improve Air Route Traffic Control Center (ARTCC) facilities. Projects include expanding facility size, replacing heating and cooling systems, and upgrading electrical power distribution systems.

The FAA is evaluating the design and configuration of future NextGen facilities to support the planned NextGen improvements in service and the potential changes in airspace that these facilities control. It is important that these new facilities are sized correctly so that we can realize the full benefits of the NextGen Architecture. The potential benefits include accommodating NextGen capabilities such as Integrated Arrival and Departure Services, High Altitude Generic En Route Services, Flexible Airspace Management, Staffed NextGen Towers, and integrated business continuity services. If the studies show that benefits will exceed costs, the FAA may begin transforming facilities starting in 2017.

Figure 35 shows the planned expenditures for facilities projects for the air traffic control system. Expenditures are in Millions of Dollars.

BLI Number	Program Name	FY 2012 Manda-tory	FY 2012 Discre-tionary	FY 2012 Budget Total	FY 2013	FY 2014	FY 2015	FY 2016
	Facilities Functional Area	**$31.5**	**$410.1**	**$441.6**	**$455.9**	**$496.5**	**$542.7**	**$657.1**
1A03	William J. Hughes Technical Center Facilities	$0.0	$15.0	$15.0	$12.0	$12.0	$12.0	$12.0
1A04	William J. Hughes Technical Center Infrastructure Sustainment*	$4.9	$7.5	$12.4	$5.9	$6.0	$6.1	$6.2
1A15	Next Generation Air Transportation System (NextGen) - System Networked Facilities*	$1.0	$9.0	$10.0	$11.0	$11.0	$11.0	$11.0
1A16	Next Generation Air Transportation System (NextGen) - Future Facilities	$0.0	$19.5	$19.5	$10.0	$20.0	$70.0	$165.9
2A05	Air Traffic Control System Command Center (ATCSCC) - Relocation	$0.0	$3.6	$3.6	$0.0	$0.0	$0.0	$0.0
2A06	ARTCC Building Improvements/Plant Improvements*	$6.0	$46.0	$52.0	$50.9	$52.4	$52.4	$62.4
2B06	Terminal Air Traffic Control Facilities - Replace	$0.0	$51.6	$51.6	$100.0	$100.0	$100.0	$115.0
2B07	ATCT/Terminal Radar Approach Control (TRACON) Facilities - Improve*	$5.0	$56.9	$61.9	$47.7	$52.7	$52.1	$52.1
2C02	Flight Service Station (FSS) Modernization	$0.0	$4.5	$4.5	$10.5	$27.0	$32.0	$37.0
2E01	Fuel Storage Tank Replacement and Monitoring	$0.0	$6.4	$6.4	$6.6	$6.7	$6.8	$6.8
2E02	Unstaffed Infrastructure Sustainment*	$4.6	$18.0	$22.6	$27.8	$33.1	$33.8	$33.8
2E04	Airport Cable Loop Systems - Sustained Support	$0.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0
2E06	Facilities Decommissioning	$0.0	$5.0	$5.0	$5.0	$0.0	$0.0	$0.0
2E07	Electrical Power Systems - Sustain/Support*	$10.0	$85.6	$95.6	$95.0	$100.0	$100.0	$100.0
2E09	FAA Employee Housing and Life Safety Shelter System Services	$0.0	$2.5	$2.5	$2.5	$2.5	$0.0	$0.0
3A01	Hazardous Materials Management	$0.0	$20.0	$20.0	$20.0	$20.0	$20.0	$20.0
3A05	Facility Security Risk Management	$0.0	$18.0	$18.0	$18.0	$19.4	$12.0	$0.0
3A09	Data Center Optimization	$0.0	$1.0	$1.0	$0.0	$0.0	$0.0	$0.0
3B01	Aeronautical Center Infrastructure Modernization	$0.0	$18.0	$18.0	$10.5	$10.8	$11.1	$11.1
4A04	Mike Monroney Aeronautical Center Leases	$0.0	$17.0	$17.0	$17.5	$17.9	$18.4	$18.8

Figure 35 Expenditures in the Facilities Functional Area[7]

4.7 Support Contracts and Automated Management Tools and Processes

The FAA has several support contracts and automated management tools that help our employees plan and manage modernization of existing systems; develop detailed transition plans to install new equipment; and oversee installing that equipment. The System Engineering 2020 contract and the Center for Advanced Aviation System Development contract help us plan overall modernization and simulate the impact of implementing new concepts and new equipment on our ability to manage air traffic. The Technical Support Services program provides field engineers who oversee site preparation and installation of new equipment as well as support environmental projects to remove asbestos, improve fire life safety, and abate environmental pollution. These engineers and technicians help the FAA keep installation and other NAS projects on schedule, including projects with equipment deliveries and those associated with relocation and/or removal of equipment. The National Implementation Support Contract helps plan our transition to new equipment. Since air traffic control functions must continue while we install new equipment, we must prepare detailed plans before we begin installation to minimize disruption to air traffic control services.

---

[7] *BLI's that support the mandatory General Fund appropriation request and include a breakout of the funding amount for Mandatory, Discretionary and Total request. ** BLI numbers with X represent outyear programs not requested in the FY 2012 President's Budget. FY 2013 – 2016 Out-year funding amounts are estimates.

Figure 36 shows planned expenditures for specific mission support projects. Expenditures are in Millions of Dollars.

BLI Number	Program Name	FY 2012 Mandatory	FY 2012 Discretionary	FY 2012 Budget Total	FY 2013	FY 2014	FY 2015	FY 2016
	Mission Support Functional Area	**$6.5**	**$340.9**	**$347.4**	**$300.9**	**$301.1**	**$303.5**	**$307.8**
1A01	Advanced Technology Development and Prototyping (ATDP)*	$1.5	$31.9	$33.4	$26.6	$24.5	$28.0	$26.2
1A02	NAS Improvement of System Support Laboratory	$0.0	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0
1A14	Next Generation Air Transportation System (NextGen) - Safety, Security and Environment*	$3.0	$5.0	$8.0	$0.0	$0.0	$0.0	$0.0
1A17	Joint Planning and Development Office (JPDO)	$0.0	$3.0	$3.0	$2.0	$2.0	$2.0	$2.0
2B09	NAS Facilities OSHA and Environmental Standards Compliance	$0.0	$26.0	$26.0	$26.0	$26.0	$26.0	$26.0
2B15	Remote Monitoring and Logging System (RMLS)	$0.0	$4.2	$4.2	$3.7	$0.0	$1.2	$1.1
2E03	Aircraft Related Equipment Program	$0.0	$11.7	$11.7	$10.1	$10.4	$9.0	$11.4
2E08	Aircraft Fleet Modernization	$0.0	$9.0	$9.0	$2.1	$0.0	$0.0	$0.0
2E10X	Independent Operational Test/Evaluation**	$0.0	$0.0	$0.0	$3.5	$3.5	$3.5	$3.5
3A03	Logistics Support Systems and Facilities (LSSF)	$0.0	$10.0	$10.0	$10.0	$10.0	$0.2	$0.0
3A06	Information Security*	$2.0	$17.0	$19.0	$12.0	$12.0	$12.0	$12.0
3A10	Aerospace Medical Equipment Needs (AMEN)	$0.0	$12.0	$12.0	$3.0	$3.0	$0.0	$2.5
3B02	Distance Learning	$0.0	$1.5	$1.5	$1.0	$1.0	$1.0	$1.0
4A01	System Engineering and Development Support	$0.0	$32.9	$32.9	$33.5	$34.1	$32.9	$33.3
4A02	Program Support Leases	$0.0	$41.7	$41.7	$40.9	$42.1	$55.2	$56.7
4A03	Logistics Support Services (LSS)	$0.0	$11.7	$11.7	$11.5	$11.5	$11.5	$11.0
4A05	Transition Engineering Support	$0.0	$13.0	$13.0	$15.0	$15.0	$15.0	$15.0
4A06	Technical Support Services Contract (TSSC)	$0.0	$22.0	$22.0	$25.0	$25.0	$25.0	$25.0
4A07	Resource Tracking Program (RTP)	$0.0	$4.0	$4.0	$4.0	$0.0	$0.0	$0.0
4A08	Center for Advanced Aviation System Development (CAASD)	$0.0	$80.8	$80.8	$70.0	$80.0	$80.0	$80.0
4A10	Permanent Change of Station (PCS) Moves	$0.0	$2.5	$2.5	$0.0	$0.0	$0.0	$0.0

Figure 36 Expenditures in the Mission Support Functional Area[8]

---

[8] *BLI's that support the mandatory General Fund appropriation request and include a breakout of the funding amount for Mandatory, Discretionary and Total request. ** BLI numbers with X represent outyear programs not requested in the FY 2012 President's Budget. FY 2013 – 2016 Out-year funding amounts are estimates.

5 Conclusion

The recession had a tremendous impact on the airline industry between 2007 and 2009, but the aviation industry has begun to rebound with cautious and optimistic expectations. Average yield (cents per passenger mile) declined during those years because of decreased business travel. The number of flight operations decreased by about 10 percent from 2008 to 2009, but operations in 2010 appear on the path to recovery compared to 2009 totals at major airports. The past decline in air travel has resulted in adjustments in the number of available seats offered for air travel and fewer seats have translated into reduced aircraft operations.

From recent reports, it appears that the industry is slowly recovering. Economic growth did resume in 2010, although air travel has been slower in responding. As mentioned in section 1.4.3, the economic forecast is for 3.4 percent growth in 2012 with continued growth in future years. Increased air travel has always followed economic recovery, and the FAA must assume that operations will increase and is planning to handle 30-40 percent more flights between now and 2025.

This near-term downturn in operations suggests that we could defer system modernization, but there are several reasons why that assumption is incorrect. Operational improvements that rely on capital investment often lag several years behind the appropriation of funding to carry out the supporting investment, because the complex equipment necessary to support changes in operational improvements takes time to develop, build, install, test and then train controllers to use. Capital investment must anticipate future growth. In addition, flight delays are still occurring on a regular basis at the Nation’s largest airports; so regardless of when future growth occurs, the need for additional capacity and improved efficiency and reduced environmental impact exists today.

Besides preparing for growth, we must deal with normal obsolescence. The computer systems and other technology that we use for air traffic control have an estimated life of 10 to 20 years. Regardless of whether there is growth or decline in air travel, we will have to replace several system components in the next 10 years. We are committed to modernizing the existing air traffic control system, and we will be doing that continuously into the future.

The NextGen transition to air traffic management introduces another significant pressure in capital planning. As the operational improvements to expand capacity become more complex, more time needs to be devoted to developing air traffic procedures and demonstrating the new technologies that enable more intense use of the NAS. Achieving all the planned operational improvements for NextGen including more efficiency, improved safety, reduced environmental impact and better use of available capacity will require consistent levels of investment over several years

6 Appendices

The CIP contains five appendices.

Appendix A
- Lists FAA strategic goals, objectives, and performance targets.
- Associates CIP projects with strategic objectives and performance targets.

Appendix B
- Provides CIP project descriptions and the relationship of projects to strategic goals.
- Describes the projects contribution to meeting the Strategic objective and performance target.
- Lists FY 2012–2016 — performance output goals.
- Shows system implementation schedules.

Appendix C
- Provides estimated expenditures from FY 2012 through FY 2016 by Budget Line Item (BLI). Expenditures are in Millions of Dollars.

Appendix D
- Response to GAO Report 08-42 - Identifies programs with baseline changes and explains the causes of those changes.

Appendix E
- Defines acronyms and abbreviations.