National Airspace System Capital Investment Plan

FY 2014–2018

Federal Aviation Administration

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Federal Aviation Administration National Airspace System Capital Investment Plan for Fiscal Years 2014–2018

1 Introduction

1.1 The Capital Investment Plan

The Federal Aviation Administration (FAA) Capital Investment Plan (CIP) describes the planned investments in the National Airspace System (NAS) for the next five years. The Continuing Appropriations Act of 2013 continues the requirement from the 2012 Appropriations Act to submit the five Year CIP. The language within the 2012 Consolidated and Further Continuing Appropriations Act, 2012 H.R. 2112 states ‘That upon initial submission to the Congress of the fiscal year 2013 President’s budget, the Secretary of Transportation shall transmit to the Congress a comprehensive capital investment plan for the Federal Aviation Administration which includes funding for each budget line item for fiscal years 2013 through 2017, with total funding for each year of the plan constrained to the funding targets for those years as estimated and approved by the Office of Management and Budget.’

Section 1 continues with discussions on Strategic Planning and the CIP and Important Factors Affecting the Planning for the Future. Section 2 - Key Considerations in Capital Planning provides considerations in the development of the plan. Section 3 - Capital Investment Plan Summary provides an overview of the FY 2014 budget request and funding amounts for fiscal years (FY) 2015 through FY 2018. Section 4 - Next Generation Air Transportation System (NextGen) Operational Improvements and Implementation Timelines describes and outlines the implementation timelines for the NextGen Operational Improvements (OIs). Section 5 - Enterprise Architecture Roadmaps contains the Roadmaps describing the programs and systems within the architecture and shows relationships and timelines for all NAS systems.

Appendix A links capital investment programs to FAA strategic goals, outcomes, and performance metrics. Appendix B provides the capital investment program descriptions, links programs to performance metrics and provides program milestones and implementation schedules. Appendix C provides the FY 2014 President’s budget request and outyear funding amounts from FY 2015 through FY 2018 by Budget Line Item (BLI). Appendix D lists major new investment and facility programs and identifies any cost or schedule changes from the original baseline. Major programs are those classified as Acquisition Category (ACAT) 1, 2 or 3 which typically are programs with total Facilities and Equipment (F&E) costs greater than $100M. For more information on ACAT see, http://fast.faa.gov/AcquisitionCategories.cfm?p_title=Special Topics. Appendix E provides acronym and abbreviation definitions.

In accordance with Presidential Sequestration Order dated March 1, 2013, sequestration impacts the Facilities and Equipment account in FY 2013, and funding impacts this year will likely have a continuing effect in FY 2014 and beyond for program plans (e.g. implementation schedule delays and out year cost estimate adjustments).

1.2 Strategic Planning and the CIP

Capital programs support the FAA's Strategic Plan (Destination 2025) Goals, Outcomes and Performance Metrics. The Strategic Plan includes the most important goals for improving performance in the delivery of aviation services. These goals guide the FAA in upgrading NAS systems and operating procedures to meet the demands of current and future growth. Outcomes and Strategies have been developed with Performance Metrics to track progress towards accomplishment of the Strategic Goals. These Outcomes and Strategies often require capital investments to meet the Performance Metrics. To measure success of capital investments actual performance is compared to the Performance Metrics and the results are used to determine whether adjustments need to be made to achieve the targeted performance.

The FAA strategic plan (Destination 2025) describes five goal areas as follows:

- **Move to the Next Level of Safety —** *"By achieving the lowest possible accident rate and always improving safety, all users of our aviation system can arrive safely at their destinations. We will advance aviation safety worldwide."*
- **Workplace of Choice —** *"We will create a workplace of choice marked by integrity, fairness, diversity, accountability, safety and innovation. Our workforce will have the skills, abilities, and support systems required to achieve and sustain NextGen."*
- **Delivering Aviation Access through Innovation —** *"Enhance the flying experience of the traveling public and other users by improved access to and increased capacity of the nation's aviation system. Ensure airport and airspace capacity are more efficient, predictable, cost-effective and matched to public needs."*
- **Sustaining our Future —** *"To develop and operate an aviation system that reduces aviation's environmental and energy impacts to a level that does not constrain growth and is a model for sustainability."*
- **Improved Global Performance through Collaboration —** *"Achieve enhanced safety, efficiency, and sustainability of aviation around the world. Provide leadership in collaborative standard setting and creation of a seamless global aviation system."*

Each capital investment program summary in Appendix B identifies the primary Goal, Outcome and Performance Metric that the program supports. Many FAA programs will contribute to more than one Goal, Outcome or Performance Metric; however, the program linkage in the CIP (appendices A and B) is for the program's most significant contribution. In the summary tables in appendix A, several programs normally appear under each performance measure because many programs are interdependent; one program may not be successful in meeting a performance metric without completing other supporting programs. Also, in the complex system used for air traffic control (ATC), system improvements must address several different operating conditions to reach the overall performance target, and often it takes multiple programs to address each of the variables, which individually contribute to overall system improvements.

To better explain how a program contributes to a strategic goal, a section titled "Relationship of Program to FAA Performance Metric" in Appendix B gives more specific information about how each program helps meet a Strategic Plan Performance Metric.

1.3 Important Factors Affecting Planning for the Future

1.3.1 Economic Considerations

Implementing NextGen will contribute to economic growth. NextGen modernizes the existing ATC system by introducing new technologies and advanced decision support tools to make air travel more efficient, safer and environmentally friendly. A study by the ATO Performance Analysis Service Unit, "The Economic Impact of Civil Aviation on the U.S. Economy," published in August 2011, estimated that aviation accounted for over $1.3 trillion in economic activity in 2009, which is 5.2 percent of the total U.S. economic activity. The spending on aviation-related economic activity supported an estimated 10.2 million aviation-related jobs, and air carriers transported over 53 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.

Aviation spending also has a significant impact on the economy of most states as shown in figure 1-1 below. It encourages the growth of local economies and supports employment opportunities in a variety of occupations. Civil aviation's contribution to state economies is as high as 20.1 percent in Hawaii. A significant factor in the amount of the economic impact of aviation is the contribution from tourism. Spending on air services and the related spending on food, hotels and entertainment provide a boost to several segments of local economies. In addition, in states like Alaska, air service is an economic necessity for transporting a wide variety of goods and services due to lack of other modes of transportation. In several states, economies benefit from a large manufacturing base dedicated to producing aircraft and related aviation equipment.

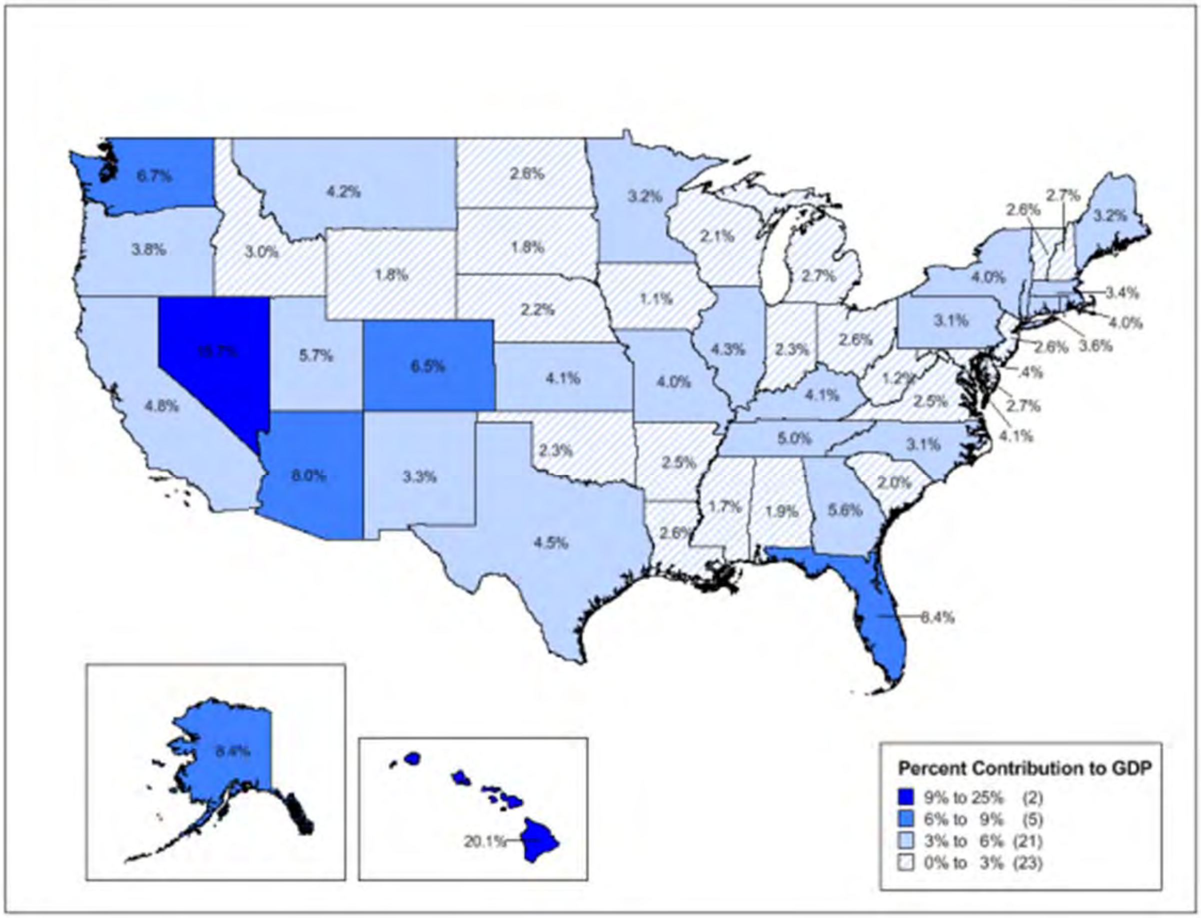

Figure 1-1 Aviation Percent of State Gross Domestic Product[1]

1.3.2 Air Travel Demand

Historically, the demand for air travel is closely related to changes in the economy. As figure 1-2 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 slower than normal pace of economic recovery. Based on the data available for calendar year 2012, economic growth is still positive. FAA expects 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, therefore advanced

[1] Source: "The Economic Impact of Civil Aviation on the U.S. Economy," August 2011.

NextGen capabilities to provide the improved services must be implemented to handle this growth.

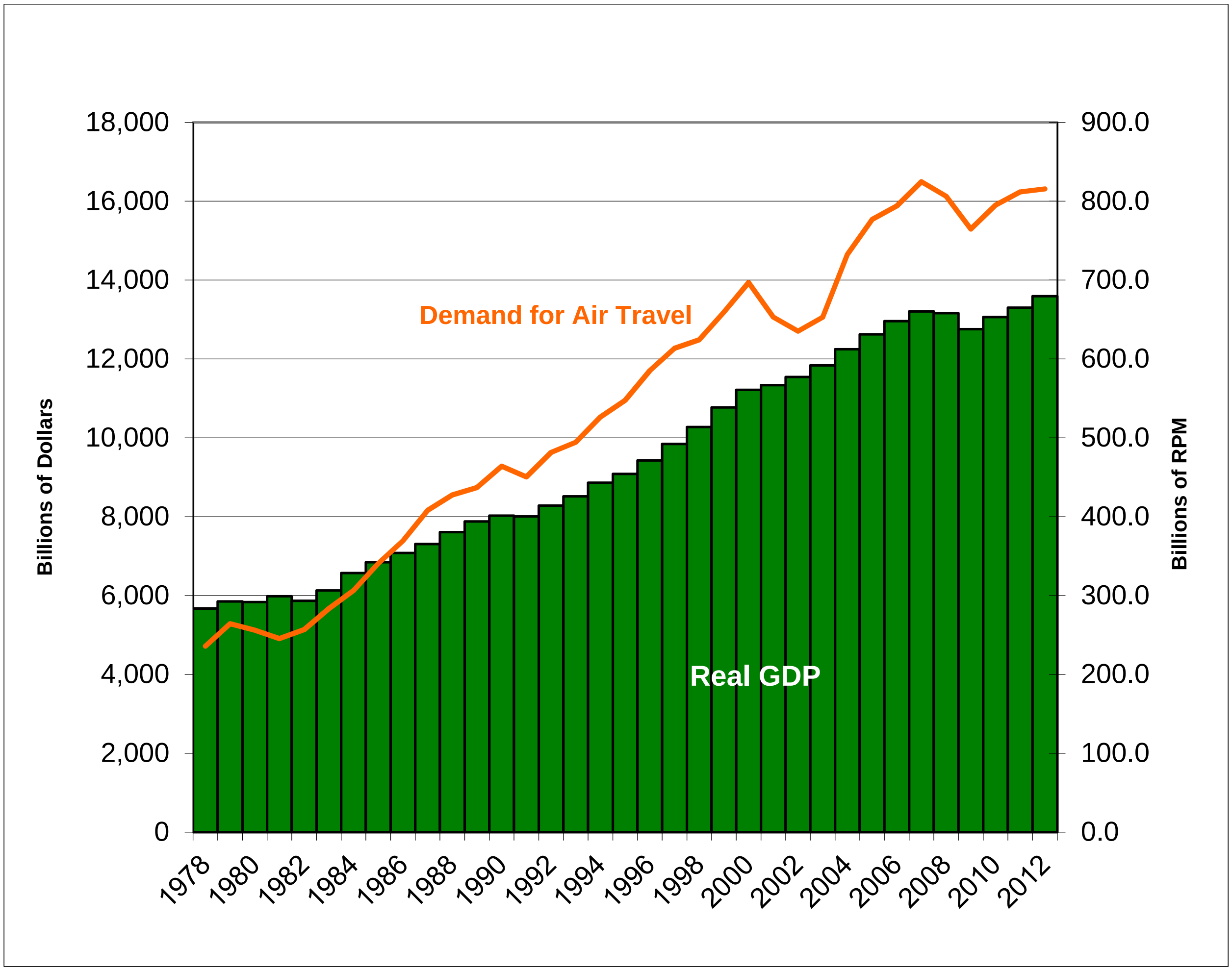

Figure 1-2 Air Travel Demand Growth Compared to Growth in GDP

1.3.3 Airport Expansion Projects

An ongoing effort to increase airport capacity affects the need for capital investment, especially at the core airports, which are experiencing delays. Fort Lauderdale has an active project to extend a runway to support air carrier operations. Columbus is nearing completion of its runway relocation project. Chicago O'Hare and Philadelphia airports have major airport reconfiguration projects underway, and Denver is planning a new runway to improve efficiency of operations. Increasing capacity at large, delay-prone airports is critical to overall NAS performance because delays at the large airports may propagate to other airports where passengers are waiting for incoming flights. In addition passengers on delayed flights may miss connections for their next flight. The 29 large hub airports handle about 60% of airline enplanements. The combined total of 65 large and medium hubs supports about 88% of all U.S. passenger enplanements.

When local airport authorities (in coordination with FAA) build new runways or otherwise expand capacity, sometimes the FAA may need to consider adding supporting equipment and developing procedures to make that capacity fully usable. New or relocated 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, approach lights must be installed and visibility sensors positioned 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. Capital investment may also be needed to expand or relocate air traffic control facilities. In cases where significant increases in demand may be accommodated, additional controller positions may eventually be needed.

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 before they can be used for air traffic control. To be prepared for future increases in air traffic, capital investments to improve the capacity of the NAS must be made many years in advance of the anticipated growth.

Capital investing must also be balanced between adding new capabilities and ensuring the existing systems operate reliably until they can be replaced. FAA must provide adequate funding to sustain the performance of the current air traffic control system until a more capable system to handle future growth is in place.

2.1 Sustaining Current System Performance while transitioning to NextGen

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 communication, navigation and surveillance systems. Each system in the NAS has a high level of redundancy to support system reliability and to minimize service disruptions. Much of this equipment must be replaced regularly to avoid the problems of obsolescence and to reduce the potential for system failures that cause deterioration in system performance.

The air traffic control infrastructure is a complex system made up of several thousand components. There are 21 air route traffic control centers (ARTCC) that house automation equipment used by air traffic controllers to control en route air traffic. There are over 500 towers and 167 terminal radar control (TRACON) facilities that control air traffic approaching, landing and departing airports. The flow of air traffic is assisted by several hundred surveillance and weather radars; navigation systems for en route and airport approach guidance, and thousands of communication radios that allow pilots and air traffic controllers to be in continuous contact during an aircraft's flight.

NextGen will incrementally replace much of this equipment to introduce new efficiencies in handling air traffic control, but some existing systems will remain in service. Many of the buildings housing existing ATC equipment will remain in service to house the new replacement NextGen systems. Communication, navigation and surveillance equipment will stay in operation in the future and will supplement or back up NextGen capabilities. To sustain the high level of reliability and availability required for the safety of flight, a continued level of investment in this valuable infrastructure will be necessary.

There are ongoing reviews to identify the level of support needed to renovate and replace existing infrastructure so that the air traffic control system can continue to operate efficiently. Preliminary data indicates that:

- Many en route control facilities require renovations and physical plant upgrades to protect equipment and employees from potentially unsafe working conditions,
- Tower renovations and replacements to meet operational needs and correct material defects in existing facilities will have costs that exceed $100 million per year,
- Many of the radar systems were replaced in the 1990s will be retained as a back up for NextGen so they must be modernized and eventually replaced,
- Many navigation systems will be retained as either a back up to NextGen or to support operational improvements. These systems are old and a portion will have to be replaced over the next ten years,
- Radio communications between pilots and controllers is a key element of air traffic control and the radios must be updated with the newer technology that supports NextGen operations,
- Virtually all of the communications, navigation and surveillance systems are housed in FAA constructed shelters which must be renovated regularly. Defects that endanger the equipment inside must be addressed quickly to avoid disruptions to the flow of air traffic.

Reliable electrical power is critical for the operation of the system. Super Storm Sandy is a recent example of commercial power failing and impacting the operation of the NAS and how the FAA Power Services minimize the impact. Massive commercial power outages occurred across the middle and northern Atlantic states starting on October 29, 2013. NAS facilities were without commercial power for a total of 9,438 hours. The FAA's backup power systems provided power to the NAS facilities for over 4,500 hours of those hours. Because of the backup power capability, no flight operations were affected and there were no delays.

Emergency power generators have been installed at most air traffic facilities, and maintaining this backup power requires constant attention and replacement of both the power generators and the systems that condition the power so it doesn't damage ATC automation systems.

The FAA has numerous other facilities that support operations including:

- A large training facility for new air traffic controllers and maintenance technicians,
- A logistics center that warehouses and ships parts to operational facilities,
- Repair shops that rebuild complex components that can be reused, and
- Several facilities that support research, test and evaluation of safety systems and new equipment.

2.2 Planning for the Future through NextGen Investments

NextGen is an umbrella term for the ongoing, wide-ranging transformation of the NAS to ensure that future safety, capacity and environmental needs are met. NextGen will fundamentally change the way air traffic is managed by combining new technologies for surveillance, navigation, and communications with automation system enhancements, workforce training, procedural changes, and airfield development. The movement to the next generation of aviation is being enabled by a shift from air traffic control to air traffic management, satellite-based navigation and surveillance, data communications, enhanced weather predictions and new procedures that combine to make air travel more convenient, predictable and environmentally friendly. NextGen will enhance safety, reduce delays, save fuel and reduce aviation's adverse environmental impact. NextGen advances will enable precise monitoring of aircraft on the ground and in flight, direct routes for travel between cities, improved decision support to manage traffic flows strategically on busy routes, and precise navigation aids for fuller use of existing airspace and runway capacity. The transition to NextGen is happening now, and the FAA is making meaningful progress with the implementation of technologies and procedures on the ground and in the airspace surrounding our nation's airports, at air traffic control facilities, and in the cockpit.

The NextGen Implementation Plan provides more information concerning the vision, benefits and implementation details. http://www.faa.gov/nextgen/implementation/plan/

3 Capital Investment Plan Summary

3.1 FAA's FY 2014 President's Budget Request

FAA's total FY 2014 Budget Request is $15.6 billion, which includes $9.7 billion for Operations, $2.8 billion for Facilities and Equipment, $2.9 billion for Airport Improvement Grants and $166 million for Research, Engineering and Development. This capital investment plan outlines the out-year projections for only the F&E account. It begins with a base funding request of $2.778 billion in FY 2014 reflecting the President's Budget Request and outyear funding totals of $2.852 billion for FY 2015, $2.906 billion for FY 2016, $2.971 billion for FY 2017 and $3.036 billion for FY 2018. The FAA's FY 2014 Budget Request can be found at the following: http://www.dot.gov/mission/budget/faa-fy-2014-budget-estimates

3.2 Five Year Capital Plan Overview

Capital investments are typically multi-year investments to support long term Agency goals and objectives. New systems or facilities can take several years to plan, procure and implement. When a program is approved and baselined, the long term funding requirements to accomplish the program are identified and committed. A program may have interdependencies with other programs and its success may depend upon the delivery of systems or interfaces implemented by other programs. Successful completion of many programs requires a long term commitment.

FAA's capital investment portfolio is divided into maintaining Legacy Systems and Infrastructure ($1,408M, 51% of CIP funding in FY 2014), Field Installation – program management and personnel supporting the installation of equipment for both legacy and NextGen systems (Personnel Compensation, Benefits, and Travel (PCB&T)) ($482M, 17% of CIP funding FY 2014), and new capabilities through NextGen ($887M, 32% of CIP funding FY 2014). Figure 3-1 shows the balance between legacy systems and infrastructure investment and NextGen over the 5 year window of the CIP.

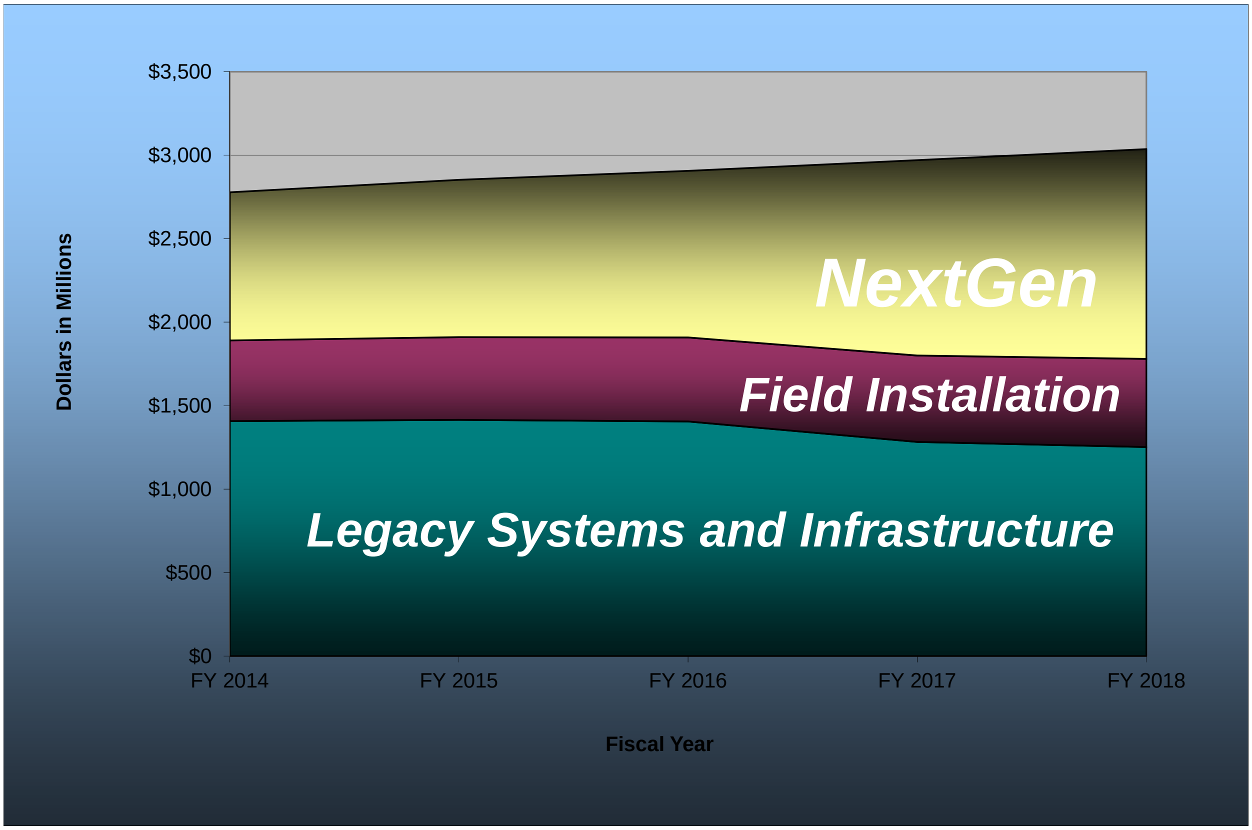

Figure 3-1 FAA's Capital Investment Portfolio

3.3 Facilities and Equipment Budget Activities

Within the F&E account, the budget is broken down into five different activities. Activity 1 programs support the initial design, engineering, development, test and evaluation activities associated with producing end-product systems, technologies and capabilities for the NAS. Activity 2 supports major systems acquisitions and facilities infrastructure programs in the implementation phase. Activity 3 supports modernization of systems and support infrastructure for non-air traffic control facilities. Activity 4 provides mission support services across the FAA organization. Activity 5 covers PCB&T.

Activity 5 funding is included in the CIP but is not described as a stand alone program plan in Appendix B because this activity supports the management and implementation of most of the programs in the CIP.

Table 3-1 presents the Capital Investment Portfolio allocated to budget Activities. The breakout shows yearly funding amounts for Activities 1 through 4 by NextGen and Legacy Systems and Infrastucture. Activity 5 Field Installation is broken out by NextGen and Legacy for FY 2014 only. NextGen personnel costs are refined each year in support of the budget submission.

	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
Activity 1 - NextGen	$339.8	$412.7	$479.4	$595.7	$601.3
Activity 1 - Legacy	$52.5	$51.3	$52.2	$57.6	$59.9
Activity 2 - NextGen	$523.9	$498.4	$488.3	$551.1	$630.0
Activity 2 - Legacy	$999.3	$1,014.1	$994.4	$878.2	$836.4
Activity 3 - NextGen	$15.0	$15.0	$15.0	$15.0	$15.0
Activity 3 - Legacy	$133.6	$117.9	$124.3	$109.3	$106.8
Activity 4 - NextGen	$9.1	$15.0	$15.0	$10.0	$10.0
Activity 4 - Legacy	$222.6	$231.8	$233.5	$237.5	$249.2
Activity 5 - NextGen	$41.0	*	*	*	*
Activity 5 - Legacy	$441.0	$495.9	$503.9	$516.7	$527.4

NextGen Total	$887.7	$941.0	$997.7	$1,171.8	$1,256.3
Legacy Total	$1,408.0	$1,415.1	$1,404.4	$1,282.5	$1,252.3
Field Installation Total	$482.0	$495.9	$503.9	$516.7	$527.4
	$2,777.8	$2,852.0	$2,906.0	$2,971.0	$3,036.0

Table 3-1 Capital Investment Portfolio allocated to Budget Activities ($M)

A more detailed breakdown of funding amounts for each budget line item within each Activity is provided in Appendix C. Outyear programs are grouped and aligned to the FY 2014 budget line item structure and as the budget is revised each year the BLI titles and numbers may change to adjust for programs that are ending or new programs that are added.

3.4 Legacy Systems and Infrastructure

The FAA has a large base of automation, navigation, surveillance, communications, and weather systems and thousands of facilities to house personnel and systems. These systems and facilities provide the basic infrastructure for the future NAS and must be maintained and replaced as they age or when operational needs change. The FY 2014 budget request provides $1,408M for legacy systems and infrastructure is distributed to Activities 1 through 4 as shown in Table 3-1. The total funding amounts in this area for FY 2015 through 2018 is $5,354M. Most of the program funding in FY 2014 have continuing funding requirements in the succeeding years.

Some areas for investment in 2014 that are key to supporting the NAS long term system modernization are:

- **Terminal automation –** A long term effort is underway to upgrade all of the terminal automation systems. This effort is needed to replace systems that are not sustainable and do not provide the capability to support NextGen operational improvements. In addition, tower cab information systems will be upgraded and replaced to provide tower controllers information needed to better manage surface flow.
- **Enroute automation –** The new ERAM platform is planned to be installed and operational at all sites by the end of FY 2014. This new platform will have continuing enhancements to support implementation of many NextGen operational enhancements.
- **Navigation/Landing –** The WAAS program will continue to augment Global Positioning System (GPS) to support the implementation of many operational improvements dependent on satellite navigation capabilities. Instrument Landing System (ILS) and other Navaid systems will be installed to replace older unreliable and unsupportable systems.
- **Surveillance/Weather –** Modernization of enroute and terminal primary and secondary surveillance radars will be implemented to upgrade or replace aging unsupportable systems. Weather sensing and processing equipment will also be renewed.
- **Air Traffic Control Facilities –** Air Route Traffic Control Centers, Air Traffic Control Towers and Terminal Radar Approach Control Facilities need continual renewal and replacement as those facilities age. These upgrades are needed to support installation and operation of future systems.
- **Power systems –** NAS systems are dependent on reliable and high quality power. Emergency backup systems and power system components must be replaced as they age in order to maintain overall system reliability. New NAS systems supporting NextGen have increased sensitivity to power fluctuations so upgrading and replacing power systems is essential for future equipment investments.
- **Decommissioning –** The FAA has embarked on a concerted effort to eliminate those systems and facilities that are no longer needed. Decommissioning will reduce system maintenance, utilities and lease costs.

More details on all of the legacy systems and infrastructure are provided in Appendix B.

3.5 NextGen

The total NextGen F&E FY 2014 budget request includes $887M for NextGen programs and $41M for personnel costs totaling $928M. The $887M for NextGen programs is distributed to Activities 1 through 4 as shown in Table 3-1. NextGen includes programs for the development and implementation of operational improvements (OIs) and the implementation of transformational programs. The total funding amount for FY 2015 through 2018 is $4,366M.

Development of NextGen operational improvements can include concept development, modeling, safety analyses, demonstrations, international coordination, standards development, and other pre-implementation activities. When a concept matures and a solution is determined the improvement is implemented by procedure changes, system enhancements, air space changes, training, and avionics as necessary to support the improvement. Development of operational improvements will involve participation by Operations, Research and Development, and F&E organizations and NAS users. Capital investment programs in Activity 1 develop the solutions for NextGen OIs and support the activities leading up to the initial investment management decisions for implementation. A solution, when fully developed, is baselined for acquisition and implementation. Activities 2 through 4 support the implementation of the solutions by developing system enhancements or new systems. Descriptions of the operational improvements in each solution set are provided in Section 4.

The developmental NextGen work is conducted in support of the following Solution Sets:

- **Trajectory Based Operations (TBO) –** Efforts in this set will be developing oceanic tactical trajectory management and conflict advisory concepts and procedures (BLI 1A08),
- **Arrival/Departures at High Density Airports (HD) –** Concepts and procedures to improve surface tactical flow and surface conformance monitoring will be developed in this solution set (BLI 1A10),
- **Flexible Terminal Environment (FLEX) –** This set will address wake turbulence, closely space runways, ground based augmentation, and alternative positioning, navigation and timing (BLI 1A12),
- **Collaborative Air Traffic Management (CATM) –** This solution set includes efforts to improve strategic flow management, develop concept and procedures for flight object information and to standardize and disseminate NAS information (BLI 1A11),
- **Reduce Weather Impact (RWI) –** Efforts in this set will be developing improvements to weather observation and forecast capabilities (BLI 1A09),
- **Safety, Security and Environment (SSE) –** This set will develop concepts to identify airborne security threats (BLI 1A16X); and
- **Transform Facilities (FAC) –** Efforts in this set will develop concepts for system networked facilities (BLI 1A13, System Networked Facilities).

NextGen Activity 1 BLIs for Demonstrations and Infrastructure Development (BLI 1A06), System Development (BLI 1A07) and System Networked Facilities (1A13) provide cross cutting support to the above solution sets and do not have Solution Set diagrams.

NextGen transformational programs are core technologies to provide the foundation that allows introduction of new NextGen operational improvements. Each of these technologies supports multiple OIs are described below. The six transformational programs are:

- **ADS-B –** Automatic Dependent Surveillance-Broadcast provides more accurate and timely surveillance data needed to improve NAS operations (BLI 2A13),
- **DataComm –** Provides data link communications between controller and pilot to facilitate information transfer (BLI 1A05),
- **NVS –** The NAS Voice System will provide a nationwide network of digital voice switches for terminal and en route air traffic facilities. These new systems will provide voice switch configuration flexibility required to support NextGen operational improvements (BLI 2B13),
- **CATMT –** Collaborative Air Traffic Management Technologies provides improvements to the traffic flow management decision support tools that are required to support NextGen operational improvements (BLI 2A16),

- **SWIM –** System Wide Information Management provides the standards and software to enable information management and data sharing required to support NextGen operational improvements (BLI 2A12), and
- **CSS-Wx –** Common Support Services – Weather provides the FAA and NAS users with same-time access to a unified aviation weather picture via the System Wide Information Management network, allowing the flexibility to proactively plan and execute aviation operations ahead of weather impacts (BLI 2A12).

More details on all Nextgen programs are provided in Appendix B.

4 NextGen Operational Improvements and Implementation Timelines

This section describes the operational capabilities and benefits that have already been realized in the solution set. The OI description also identifies significant capital programs and systems that support the OI. For information concerning the supporting systems and capital programs, refer to the NAS Enterprise Architecture Roadmaps in Section 5. To obtain more information on NextGen accomplishments visit the following site: *http://www.faa.gov/nextgen/snapshots/*

The publicly released NextGen Implementation Plan (NGIP) provides the overall roadmap for how and when the FAA will accomplish the NextGen operational improvements and capabilities. The OI timelines illustrated below are consistent with FAA's 2013 NGIP (available at *http://www.faa.gov/nextgen/implementation/plan/*), while the grouping of OIs are depicted by Solution Sets, consistent with the budget request.

In the diagrams below, green triangles represent OIs that have been delivered. The bars depict the timeframe of when the OI is expected to become available. Note that activities will not necessarily be occurring during the entire timeframe, it represents a window of anticipated delivery of the improvement. Green bars represent OIs that have been deployed to at least one location in the NAS and additional locations or enhancements are planned for implementation. OIs planned for development through 2020 are identified and briefly described. Far-term OIs shown on the diagrams are still under development and will be described in future plans as they mature.

Each OI has a 6 digit number assigned and these numbers are included as a reference in the text below. The first 3 digits identify the NAS Service, for example, ATC Separation Assurance/ Separation Management. The second 3 digits are a unique ID. The OIs are grouped by NAS Service within the solution set diagrams. Additional information can be found on the NAS Enterprise Architecture Web site at: https://nasea.faa.gov

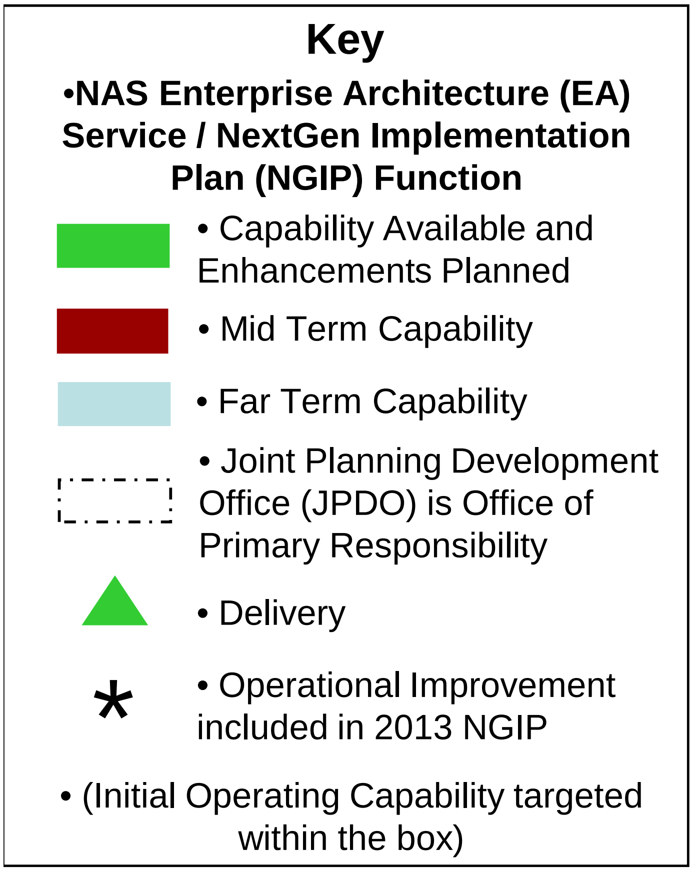

Figure 4-1 Service Roadmap Legend

4.1 Initiate Trajectory Based Operations

Summary Description:

Trajectory-Based Operations (TBO) improve efficiency. 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 with pilots via DataComm 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.

TBO Operational Capabilities and Benefits Accomplished to Date

Oceanic In Trail Climb and Descent operational trials have been successfully completed which will allow aircraft to achieve user preferred flight level changes improving flight efficiency.

Automatic Dependent Surveillance-Broadcast (ADS-B), continues steady deployment of ground based installations to provide surveillance services, with full coverage of the NAS projected by 2014. NAS users benefiting from this system include:

- UPS employs ADS-B to maximize the flow of its cargo planes into the Louisville, KY hub and improve flow rates at its Philadelphia hub.
- Helicopter operators experience fewer and shorter delays flying over the Gulf of Mexico to and from oil platforms because controllers use ADS-B to gain a more accurate depiction of their location.
- General aviation aircraft on the East Coast have access to broadcasts of air traffic near their aircraft and other flight information including up-to-date weather.

Required Navigation Performance (RNP) departure routes and approaches have been developed at several airports. Properly equipped aircraft can fly more precise routes saving time and fuel. Airports where RNP benefits have been achieved include Houston, Atlanta, Seattle, Minneapolis, Portland and Newark. Some examples of RNP benefits:

- Redesigned departure and arrival routes for Houston reduce average distance traveled by 9 miles and time flown by 2 minutes for the new approaches.
- Atlanta is using RNP procedures to reduce congestion for planes taking off that are projected to save the airlines approximately $10 million per year.
- A major airline has adopted NextGen arrival procedures and estimates savings of 18 gallons of fuel per flight by flying routes defined by precision satellite navigation.
- RNP approach procedures were established in Seattle to provide integrated optimal decent for reduced fuel consumption and avoidance of noise sensitive areas.

Use of satellite based navigation is expected to cut a total of seven million nautical miles from flight plans around metroplex cities each year. Shorter routes and gradual descents are projected to save more than 20 million gallons of fuel annually, resulting in 220,000 metric tons less carbon – or the equivalent of taking 43,000 cars off our roads.

Timeline:

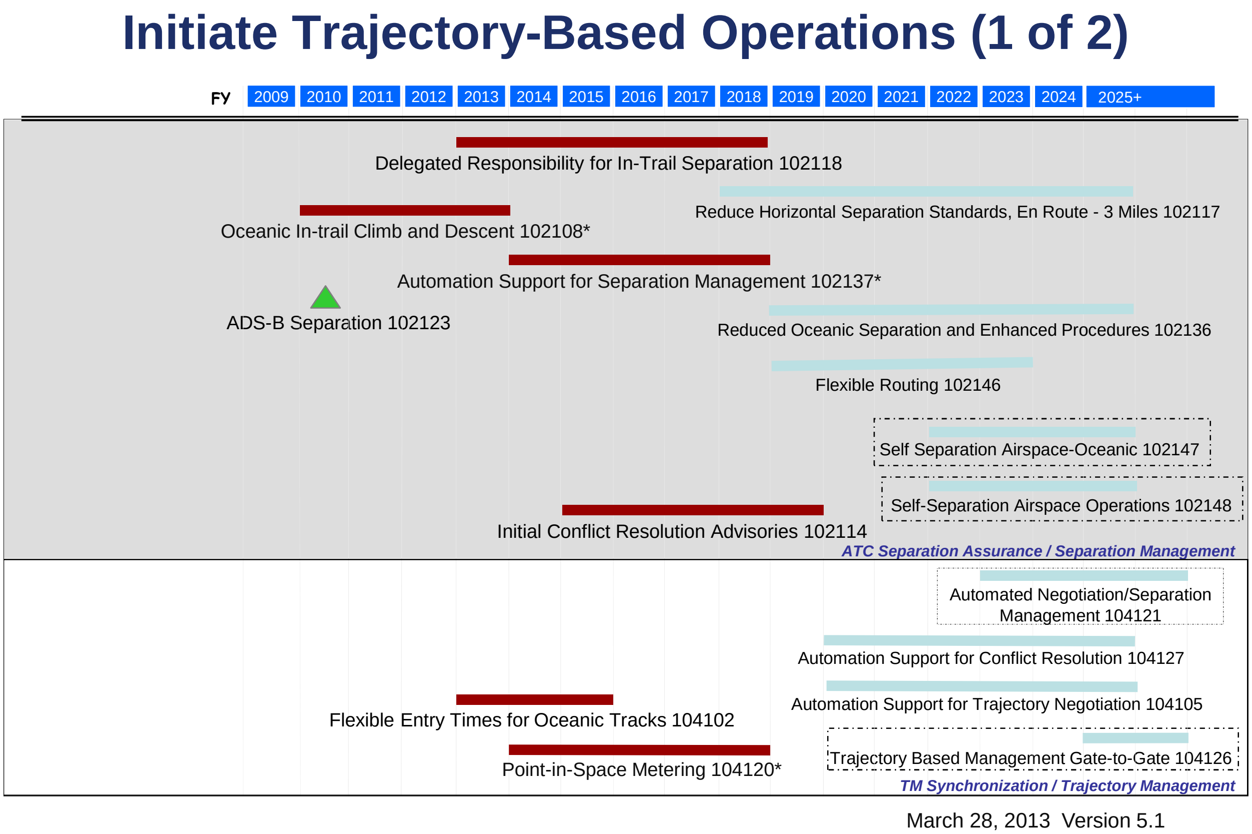

Figure 4-2 Trajectory Based Operations (1)

Operational Improvements

This section describes the mid-term-planned operational improvements associated with TBO. In figure 4-2, the ATC Separation Assurance/ Separation Management services area, planned improvements are the following:

1. Delegated Responsibility for In-Trail Separation (102118) 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 provides a cockpit display of surrounding aircraft. Improvements supporting this improvement are En Route Automation Modernization (ERAM) Mid-Term Work Package and ADS-B.

2. Oceanic In-Trail Climb and Descent (102108), 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 also fly more optimal descent profiles on arrival to save fuel. Separate procedures for ADS-B and ADS-C based In-Trail Climb and Decent are being evaluated via trials in the Pacific. The aircraft would have to be equipped with ADS-B or 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).

3. ADS-B Separation (102103) provides aircraft position data in non radar airspace allowing controllers to provide radar like separation standards and services. The ADS-B positional reports are incorporated into the surveillance data processing systems and displayed to the controller. The ADS-B program provides the surveillance service and the automation upgrades needed to process the surveillance data.
4. Automation Support for Separation Management (102137) 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. Investment supporting this improvement is the En Route Automation Modernization (ERAM) mid-term work package.
5. Initial Conflict Resolution Advisories (102114) 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. The investment supporting this improvement is ERAM Mid Term Work Package.

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

1. Flexible Entry Times for Oceanic Tracks (104102) will allow aircraft to reach their preferred trajectories sooner, which will minimize fuel burn. The investments supporting this improvement are Time Based Flow Management (TBFM), Dynamic Ocean Track System (DOTS) or 4D Oceanic Trajectory Management (OTM4D) system and the accelerated Terminal Data Link System (TDLS). DOTS analyzes weather data and calculates the most efficient tracks for oceanic flights, and the TDLS provides automated departure clearances to aircraft.
2. Point-in-Space Metering (104120) uses scheduling tools to ensure smooth flow of traffic and efficient use of airspace. 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. Investments supporting this improvement are Collaborative Air Traffic Management Technologies (CATMT); ERAM D-Position Upgrade and System Enhancements (ERAM System Enhancements and Technology Refreshments and ERAM Sector Enhancements); System Wide Information Management (SWIM) and the TBFM tool.

Timeline:

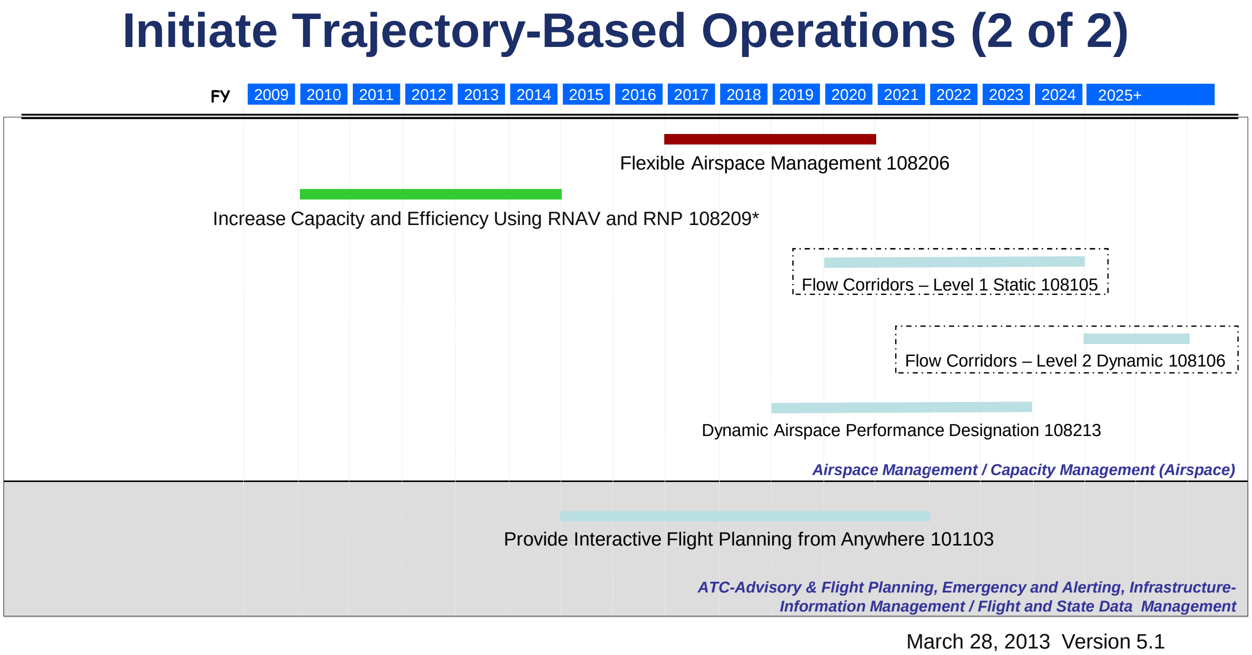

Figure 4-3 Trajectory Based Operations (2)

In figure 4-3, the Airspace Management/Capacity Management service area's planned mid-term improvements are:

1. Flexible Airspace Management (108206) 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 are Airspace Information Management (AIM) system, the ERAM Mid Term Work Package, Surveillance Interface Modernization (SIM), System Wide Information Management (SWIM) including Common Support Services, and the NAS Voice System (NVS).
2. Increase Capacity and Efficiency Using Area Navigation (RNAV) and Required Navigation Performance (RNP) (108209) expands the number of approach and departure routes at airports for those aircraft equipped with highly accurate aircraft navigation systems and qualified pilots. The FAA investments to implement this capability include CATMT, ERAM mid-term work package and additional Distance Measuring Equipment (DME) systems.

4.2 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 use of runway capacity is not possible. Differences in aircraft arrival speed or the effect of wake turbulence from heavy category aircraft can require increased separation between aircraft. Wake turbulence from a heavy category aircraft requires controllers to increase separation to 5 miles or more between the two aircraft when a small aircraft is following a heavy category 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.

High Density Airport Operational Capabilities and Benefits Accomplished to Date

Implementing updated criteria for Closely Spaced Parallel Runways have resulted in improvements at some of the most challenged airports. In San Francisco, updated criteria will enable departure increases of potentially 25 to 50 percent per hour.

Approved changes for simultaneous dependent parallel approach procedures have been approved at Newark and San Francisco resulting in increased airport capacity.

Enhancements to surface operations at JFK were tested successfully and procedural changes are now in use. Holding aircraft at the gate reduces taxi time and congestion on taxiways, and saves fuel. Systems that allow improved control of surface operations have also been tested at Dallas-Ft. Worth airport.

Traffic Management Advisor’s (TMA’s) Adjacent Center Metering (ACM) capability is delivering efficiency benefits by providing to controllers better estimates of arrival times resulting in more efficient slot and delay allocation. It also enables controllers to better manage ground operations which increases the airlines ability to depart on time. Atlanta and Newark airports have experience significant saving in miles in trail restrictions (80% reduction at Atlanta) and holding events (70% reduction at Atlanta) as a result of ACM. ACM has been installed at 19 major airports.

Timeline:

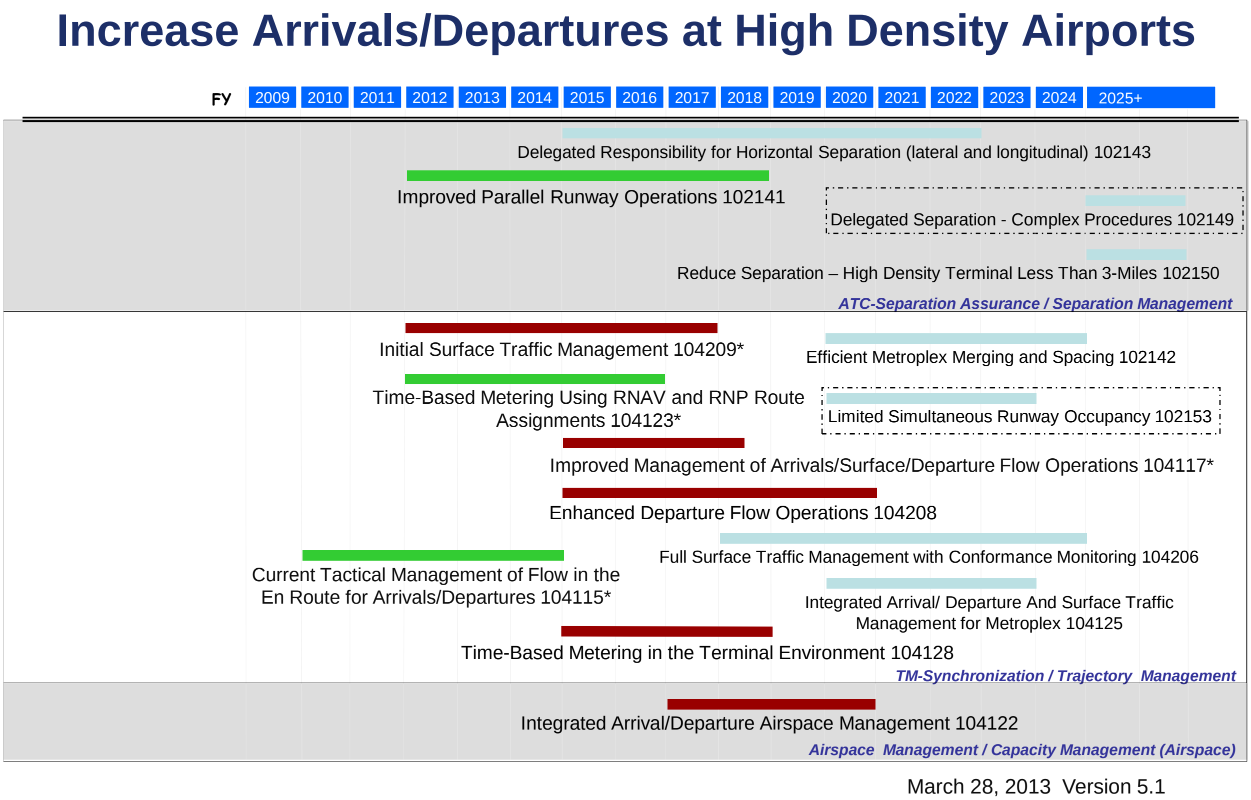

Figure 4-4 Increase Arrivals/Departures at High Density Airports

Operational Improvements

This section describes the mid-term planned improvements associated with Increase Arrivals/ Departures at High Density Airports. In figure 4-4 the ATC Separation Assurance/Separation Management service area's planned improvement is:

> Improved Parallel Runway Operations (102141) will 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. 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. The investments supporting this capability are Terminal Automation Modernization Replacement (TAMR) and Wake Turbulence Mitigation Arrivals (WTMA).

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

1. Initial Surface Traffic Management (104209) 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 improvement are Time Based Flow Management (TBFM), Tower Flight Data Manager (TFDM), Airport Surface Detection Equipment (ASDE), CATMT, and System Wide Information Management (SWIM).

2. Time Based Metering Using RNAV and RNP Route Assignments (104123) 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 improvement include the ERAM Mid Term Work Package, TBFM, and Distance Measuring Equipment (DME).
3. Improved Management of Arrivals/Surface Departure Flow Operations (104117) 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 improvement are Collaborative Air Traffic Management Technologies (CATMT), TFDM, and SWIM.
4. Enhanced Departure Flow Operations (104208) 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. Current Tactical Management of Flow in the En Route for Arrivals/Departures (104115) provides controllers the tools to sequence and space air traffic thereby maximizing NAS efficiency and capacity in the arrival and departure phases of flight. Controllers synchronize aircraft by monitoring flows, making control decisions, and modifying flight trajectories to meet operational objectives and accommodate user preferences. The investment supporting this capability is Time Based Flow Management (TBFM).
6. Time Based Metering in the Terminal Environment (104128) 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. Investments that support this improvement include the ERAM mid-term work package, TBFM and TAMR.

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

Integrated Arrival/Departure Airspace Management (104122) 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 improvement are CATMT, ERAM Mid Term Work Package, TBFM, TAMR, SWIM, and Surveillance Interface Modernization (SIM).

4.3 Increase Flexibility in the Terminal Environment

Summary Description:

This solution set concentrates on improvements in the access, situational awareness, and separation services at airports. 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. 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.

Flexible Terminal Operational Capabilities and Benefits Accomplished to Date

Optimized Profile Descent (OPD) is operational at Anchorage, Atlanta, Charleston, El Paso, Honolulu, Las Vegas, Los Angeles, Louisville, Miami, Philadelphia, Phoenix, Raleigh-Durham, Reno, Sacramento, San Diego, San Francisco, Seattle and Washington DC. The vertical profiles are designed to allow aircraft to descend using reduced thrust settings from the top of descent to final approach. OPDs reduce fuel consumption, emissions, and noise during descent. Preliminary data from Washington indicate a fuel burn savings of $2.3M per year.

Traffic Situational Awareness with Alerts (TSAA) is available at Boston, Chicago and Denver to warn controllers if a ground vehicle is entering an active runway.

Expanded Low Visibility Operations lowers RVR minima from 2400 feet to 1800 feet (or lower, depending on the airport and requirement) at selected airports. This reduced minima increases airport capacity during inclement weather.

Re-Categorized Wake Separation Standards are in effect at Memphis. Estimates are that wake re-categorization will allow up to 20 percent more runway throughput when airports are operating under IFR.

Category I Ground Based Augmentation System (GBAS) is operational at Houston and Newark which provides precision landing guidance without traditional ILS capability.

Timeline:

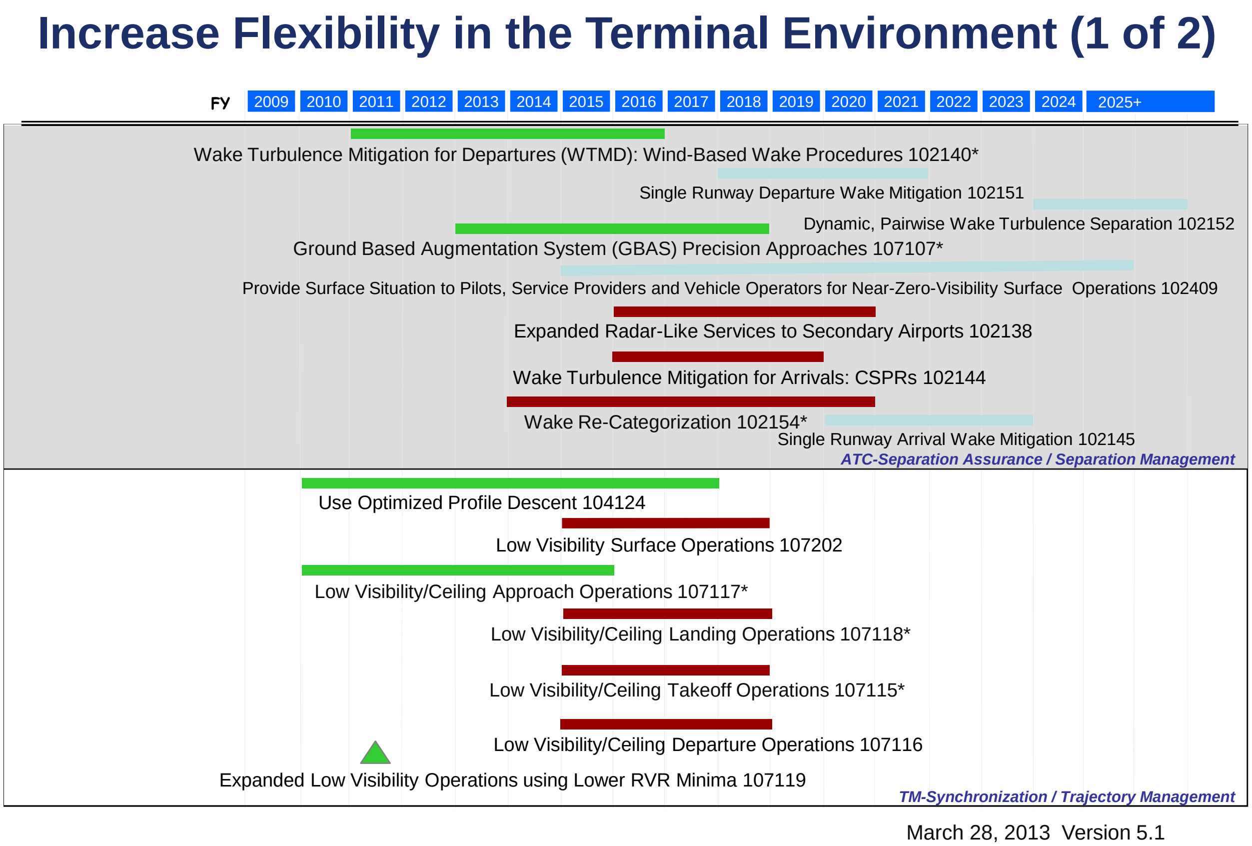

Figure 4-5 Increase Flexibility in the Terminal Environment (1)

Operational Improvements

This section describes the mid-term planned improvements associated with Increase Flexibility in the Terminal Environment. In figure 4-5 the ATC Separation Assurance/Separation Management services area planned improvements are the following:

1. Wake Turbulence Mitigation for Departures (WTMD): Wind-Based Wake Procedures (102140). Based on wind measurements, 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. Observed and forecasted airport wind information can be processed and displayed in the tower to indicate which runways can be used for immediate departures after a heavy category aircraft departs on an adjacent CSPR. 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 (107107) is a capability for airports to provide GPS augmentation to support precision approaches to

Category I and eventually Category II/III minimums for properly equipped runways. GBAS can support curved precision approaches and high-integrity surface movement requirements. This is an economical way to increase the number of runways with instrument approaches that allow operations in low-visibility conditions. Investment by airports in GBAS supports this improvement.

3. Expanded Radar-Like Services to Secondary Airports (102138) 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): CSPRs (102144) allows controllers to reduce the instrument flight rules wake mitigation 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 cannot be transported into the path of the following aircraft, controllers can reduce wake mitigation separations. Observed and forecasted airport wind information will be processed and provided to controller displays to show the minimum diagonal separation between approaching aircraft. Investments that support this improvement are: Terminal Automation Modernization Replacement (TAMR), WTMA, and Integrated Terminal Weather System (ITWS).

5. Wake Re-Categorization (102154) - Legacy world-wide air traffic control wake mitigation separation standards have been updated based on data collected and subsequent analysis of aircraft wake generation, wake decay, and wake encounter effects for representative aircraft. The updated standards allow more efficient use of existing airport runways. As more automation and information sharing NextGen capabilities are enabled, even more efficient wake separation standards can be established that consider real-time atmospheric and aircraft configuration information.

The Traffic Management Synchronization/ Trajectory Management service area (shown in figure 4-5) planned improvements are the following:

1. Use Optimized Profile Descent (104124) permits aircraft to minimize power settings during descent to an airport to save fuel. These descent profiles are being used, and they save significant fuel. Investments that support this improvement include ERAM mid-term work package and TAMR.

2. Low Visibility Surface Operations (107202) will use ground surveillance systems to inform controllers of surface movements and runway status lights will alert pilots when it is unsafe to enter or cross a runway. Investments that support this improvement are: TFDM, ADS-B, Airport Surface Detection Equipment (ASDE-X), Airport Surface Surveillance Capability (ASSC) and Runway Status Lights (RWSL).

3. Low Visibility/Ceiling Approach Operations (107117) improves the ability of aircraft to complete approaches in low visibility/ceiling conditions. The user investment that supports this improvement is the Enhanced Flight Vision System (EFVS).

4. Low Visibility/Ceiling Landing Operations (107118) permit aircraft to land in low visibility/ceiling conditions when equipped with EFVS.

5. Low Visibility/Ceiling Takeoff Operations (107115) 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 (107116) allows appropriately equipped aircraft to depart in low visibility conditions. The user investment that supports this improvement is the EFVS.
7. Expand Low Visibility Operations Using Lower RVR Minima (107119) provides greater access to selected airports during low visibility conditions by lowering RVR minima from 2400 feet to 1800 feet (or lower, depending on the airport and requirement). A greater number of aircraft can complete scheduled flights thereby reducing diversions or delays which can cause a rippling impact throughout the NAS.

Timeline:

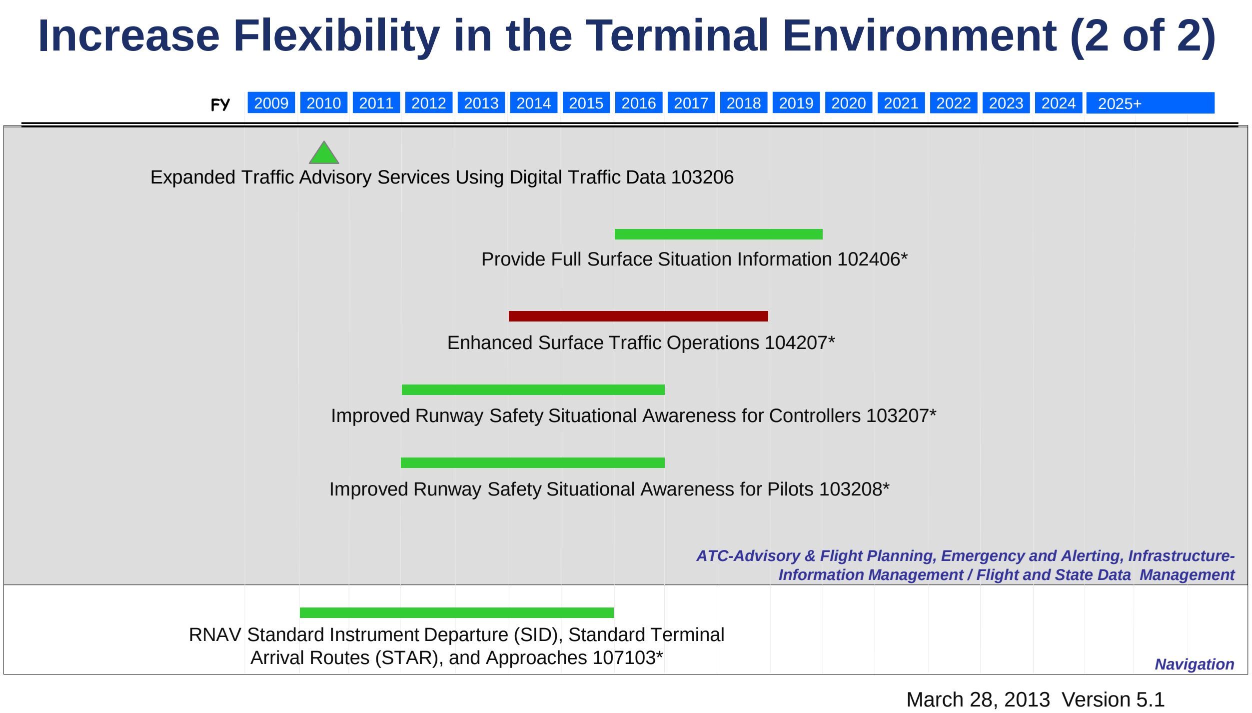

Figure 4-6 Increase Flexibility in the Terminal Environment (2)

In figure 4-6, 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. Expanded Traffic Advisory Services Using Digital Traffic Data (103206) provides traffic information to the flight deck, including automatic dependent surveillance (ADS) information, the rebroadcast of non-transmitting targets and traditional traffic advisories. This improves situational awareness in the cockpit by providing more accurate and timely digital traffic data directly to aircraft.

2. Provide Full Surface Situation Information (102406) 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 operational improvement are TFDM, ASDE X, ASSC and ADS-B.
3. Enhanced Surface Traffic Operations (104207) would use data communications 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 improvement are DataComm and TFDM.
4. Improved Runway Safety Situational Awareness for Controllers (103207) will develop additional ground based capabilities 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 improvement are TFDM and ASDE.
5. Improved Runway Safety Situational Awareness for Pilots (103208) 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 improvement are TFDM, ASDE-X, ADS-B, and Runway Status Lights (RWSL).

The Navigation service area (shown in figure 4-6) planned improvement is the following:

Area Navigation (RNAV) Standard Instrument Departure (SID), Standard Terminal Arrival Route (STAR), and Approaches (107103) supports the development of departure and approach procedures using Global Positioning System (GPS) and Distance Measuring Equipment (DME) based avionics to provide the required aircraft position accuracy along a specified route. The resulting procedures provide more efficient (time and fuel) arrivals and departures.

4.4 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 when 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.

CATM Operational Capabilities and Benefits Accomplished to Date

The Enhanced Congestion Prediction tool matches user preferences to airspace with available capacity. This capability provides accurate planning of traffic management initiatives (TMIs) to match strategic prediction of congestion and capacity.

Execution of Flow Strategies provides controllers the ability to make flight specific changes incrementally with the ability to observe the effect before taking additional action. This capability protects the flight plan from additional reroutes and negotiated trajectories.

Collaborative Departure Queue Management (CDQM) assigns times to departing aircraft based on exchanging airport capacity and aircraft readiness information at Memphis and Orlando. This reduces taxi time by providing an efficient flow of aircraft to the runway.

Broadcast of Flight and Status Data to Pilots is operational at 10 ARTCCs which provides on-demand NAS information to pilots.

SWIM is currently providing weather information and enterprise messaging services for airport surface products to 17 users.

Timeline:

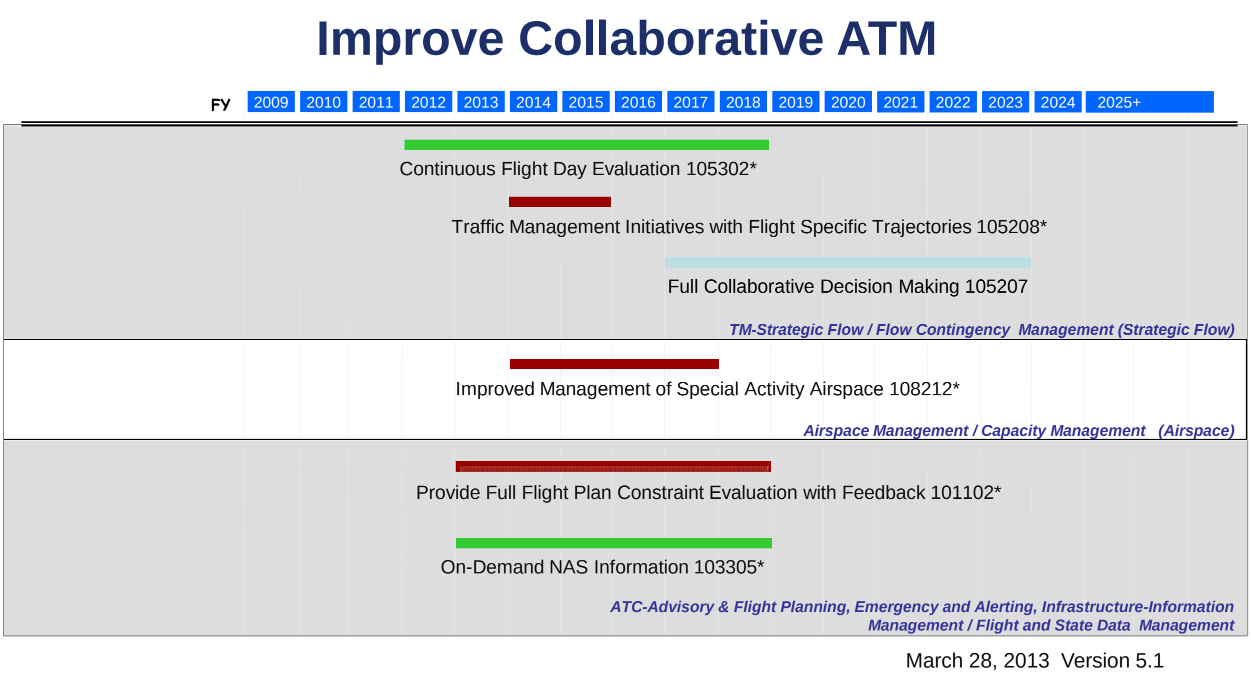

Figure 4-7 Improve Collaborative ATM

Operational Improvements

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

In figure 4-7, the Traffic Management Strategic Flow/Flow Contingency Management service area's planned improvements are the following:

1. Continuous Flight Day Evaluation (105302) 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 improvement are the Aeronautical Information Management (AIM), CATM, and System Wide Information Management (SWIM).
2. Traffic Management Initiatives with Flight Specific Trajectories (105208) 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 ability to adjust and respond to dynamically changing conditions such as severe weather, air traffic congestion, and system outages. Investments that support this improvement are CATM, ERAM, and SWIM.

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

Improved Management of Special Use Airspace (108212) calls for upgrading the automated links used to transfer information concerning status of airspace reserved for special purposes such as military operations. Status changes are transmitted to the flight deck via voice or DataComm. Trajectory planning can then be managed dynamically based on real-time information. 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 improvement are AIM, CATMT, ERAM, ADS-B and SWIM.

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 (101102) 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 improvement are Future Flight Service Program (FFSP), AIM, ERAM mid-term work package, CATMT and SWIM including Common Support Services.

2. On-Demand NAS Information (103305) will provide NAS status and aeronautical information to authorized users and equipped aircraft on demand. This will allow pilots to make informed decisions on routes and conditions at departure and destination airports. Investments that support this improvement include FFSP, AIM, CATMT, ERIDS, Information Display System (IDS), ADS-B, and SWIM including Common Support Services.

4.5 Reduce Weather Impact:

Summary Description:

Currently, 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 proactive planning operations rather than 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. 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 developing the best response to potential weather-related operational effects, thus minimizing the level of traffic restrictions required in 0–8 hours planning horizons.

The FAA will deploy a Common Data Distribution capability as part of its enterprise solution for information management in conjunction with the SWIM Segment 2 Enterprise Solution. The Common Data Distribution capability will provide as its first products the dissemination of weather information to support both real-time operations as well as strategic planning products to enhance collaborative and dynamic NAS decision making. It will provide network access to weather information from many different sources.

Weather Operational Capabilities and Benefits Accomplished to Date

Integration of the Convective Weather Avoidance Model (CWAM) for the Route Availability Planning Tool (RAPT) is operational. CWAM helps air traffic controllers and airline dispatchers determine which departure routes will be affected by operationally significant convective weather up to 90 minutes into the future.

Corridor Integrated Weather System (CIWS) aviation weather has extended forecast capability from 0-2 hours out to 8 hours and provided this capability to Airlines on a trial basis. Airlines have estimated a savings of $26M per year since 2010.

Flight Information Service – Broadcast (FIS-B) is providing weather information to general aviation pilots to provide situational awareness of weather conditions and forecasts.

Timeline:

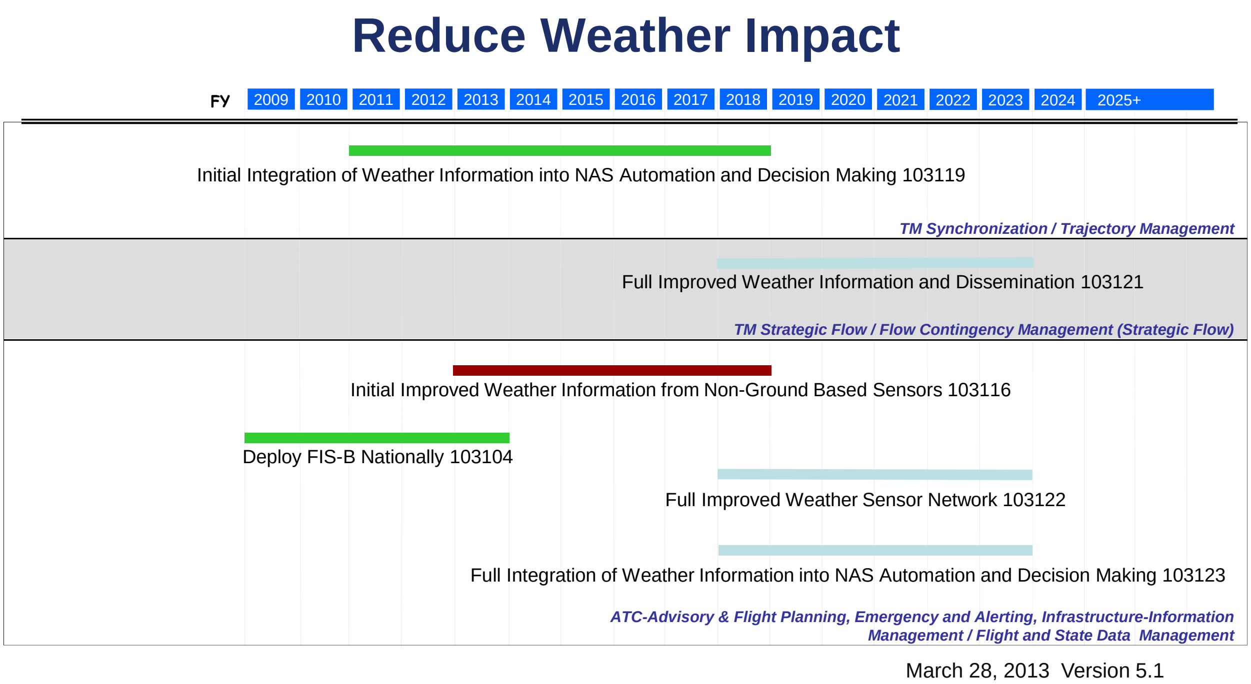

Figure 4-8 Reduce Weather Impact

Operational Improvements

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

In figure 4-8, 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 (103119) will disseminate timely, more accurate weather information to the FAA and

airline dispatch decision support tools. Better access to improved weather forecasts and integrating this information into decision support tools will improve efficiency of operations by avoiding unnecessary deviations from planned flight paths resulting in time and fuel savings. Investments that support this improvement are Collaborative Air Traffic Management Technologies (CATMT), ERAM Mid Term Work Package, Tower Flight Data Manager (TFDM), Time Based Flow Management (TBFM), System Wide Information Management (SWIM) and SWIM Common Support Service.

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 (103116) would collect weather information from aircraft in flight and satellites to supplement the existing network of ground sensors. It will increase the reliability of forecasts of turbulence, convective weather, and in-flight icing. The improved accuracy of this weather information will be route and altitude specific improving both safety and efficiency. Investments that support this improvement are SWIM and Common Support Service.

4.6 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. This also includes individual system safety risk assessments to ensure that system and procedure related specific hazards are identified and controlled. 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 groups 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, Security, and Environmental Performance Operational Capabilities and Benefits Accomplished to Date

Aviation Environmental Design Tool Version 2A was completed providing capabilities for integrated environmental analysis for fuel burn, emissions, and noise. The software is available for use by external stakeholders.

Drop-In 50-50% HRJ/HEFA Blend Fuels. ASTM International approved a 50-50 blend of hydroprocessed renewable jet (HRJ)/hydroprocessed esters and fatty acids (HEFA) and Jet-A fuel for use in aviation.

Safety Timeline:

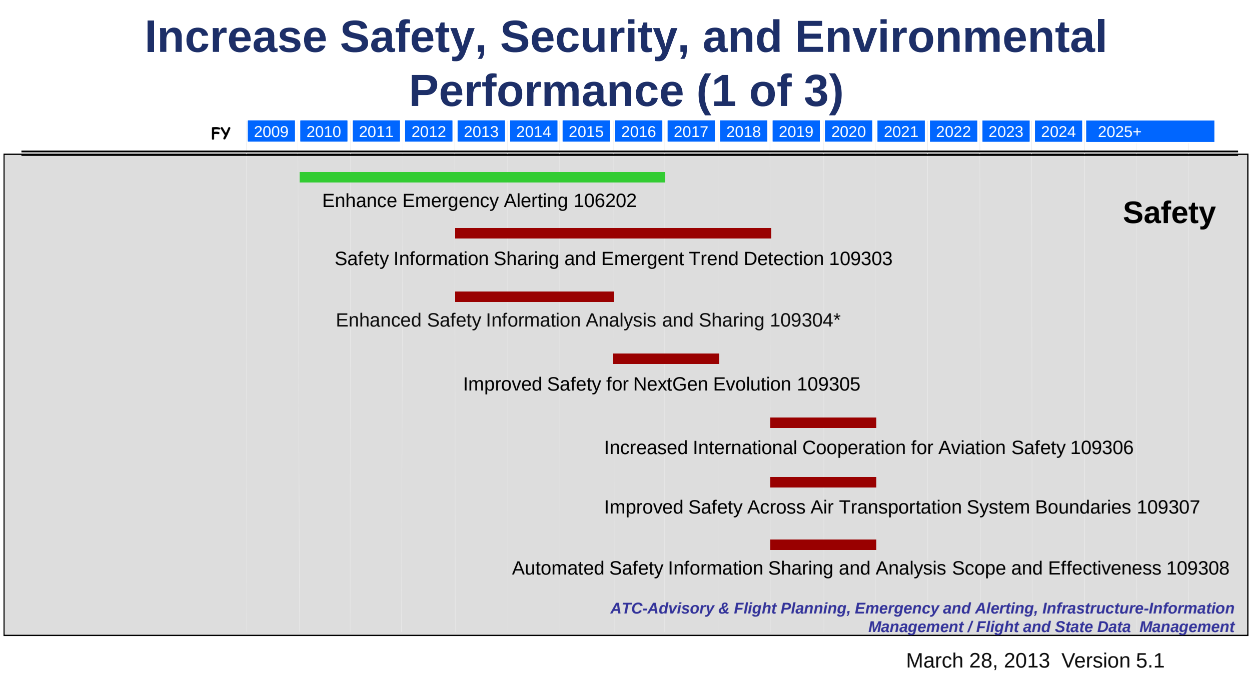

Figure 4-9 Increase Safety

Operational Improvements

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

In figure 4-9, 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 (106202) improves a controllers' ability to assist in locating a downed aircraft and in identifying and tracking flights not under ATC control. 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. Aircraft using ADS-B report their position frequently, and the coverage can be more comprehensive than radar. Investments that support this improvement are Future Flight Services Program (FFSP), ADS-B and the integration of ADS-B into all automation systems.

2. Safety Information Sharing and Emergent Trend Detection (109303). The System Safety Management Transformation and the Aviation Safety and Information Analysis and Sharing (ASIAS) activities will integrate, evaluate and share high-quality, relevant, and timely safety information that is critical to the success of the Safety Management System (SMS). These activities directly support safety promotion and safety assurance initiatives with analytical results such as baseline information and trends. They also support safety risk management through identifying issues and providing tools for analysis of hazards.
3. Enhanced Aviation Safety Information and Analysis and Sharing (109304) will improve system-wide risk identification, integrated risk analysis and modeling, and implementation of risk management.
4. Improved Safety for NextGen Evolution (109305) 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 improvement are Performance Data Analysis and Reporting System (PDARS), Integrated Reporting Information System (IRIS), System Safety Management Transformation, implementation of SMS, Independent Operational Test and Evaluation (IOT&E) and ASIAS.
5. Increased International Cooperation for Aviation Safety (109306) 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 (109307) will address similar issues to item 5 above.
7. Automated Safety Information Sharing and Analysis Scope and Effectiveness (109308) will automate risk identification and notification processes. This capability will be expanded to include additional data sources and enhanced by actions that improve data security, quality and scope. Investment required for this operational improvement is ASIAS.

Security:

Summary Description:

NAS operations require facility and information security. Facility security deals with protecting air traffic control, communication, and navigation facilities. Information security protects the data within the NAS and is a baseline requirement of each new and existing NAS program. Continuous upgrades are provided as information security technology and best practices improve.

Security Timeline:

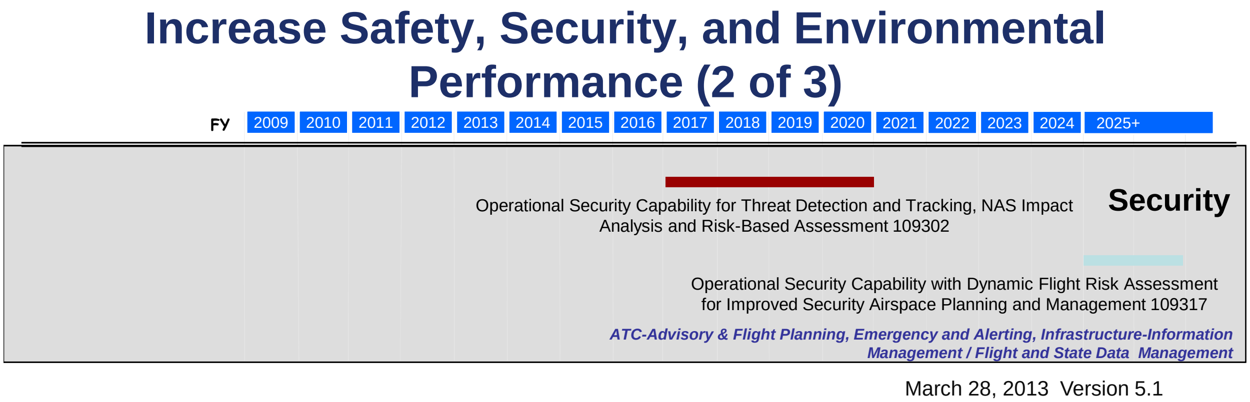

Figure 4-10 Improve Security

Operational Improvements

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

In figure 4-10 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 (109302) address NAS airborne 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.

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 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 planning must consider and minimize environmental consequences of emissions and noise caused by NextGen operational improvements while improving energy efficiency.

Environmental Timeline:

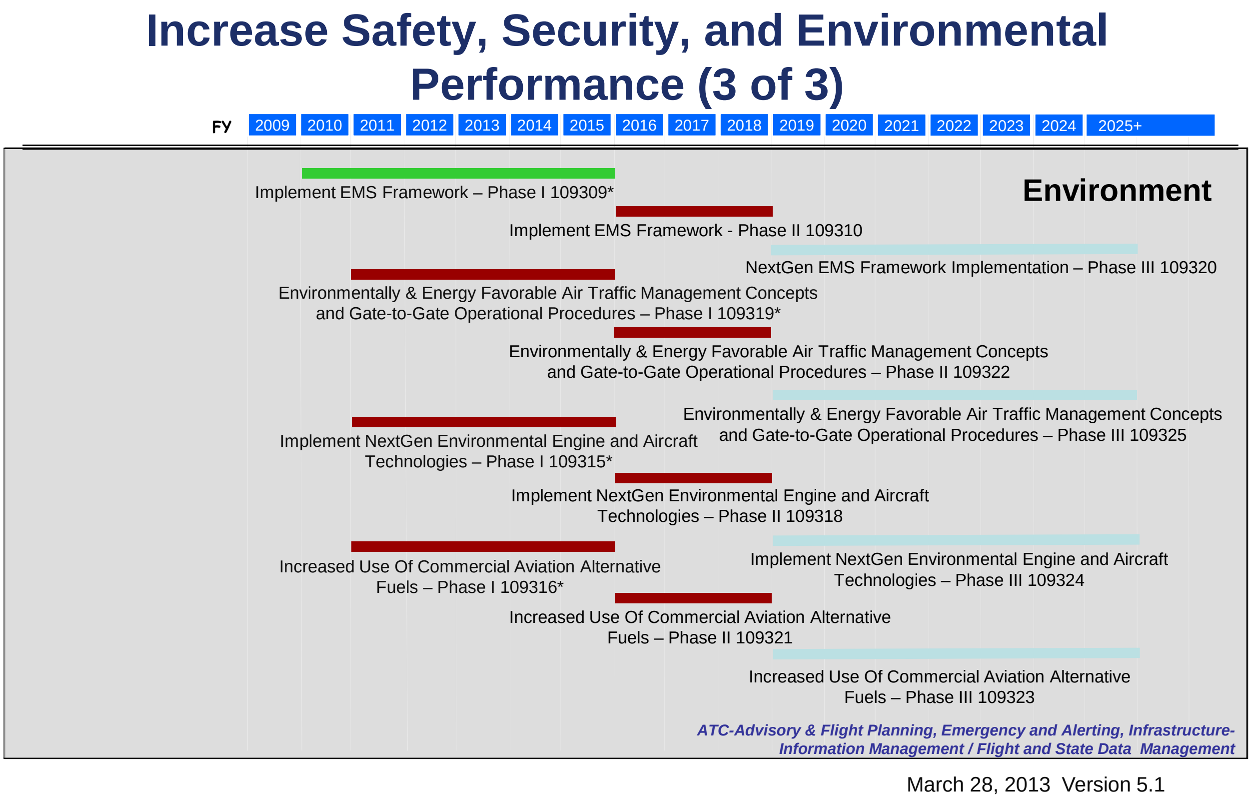

Figure 4-11 Improve Environmental Performance

Operational Improvements

This section describes the mid-term planned improvements associated with the Improve Environmental Performance timeline, figure 4-11. Many of the Operational Improvements shown below are supported by the program – Environment & Energy – which provides the funds to model and demonstrate the initiatives aimed at achieving these improvements.

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

1. Implement Environment Management System (EMS) Framework – Phases I and II (109309-109310) will refine EMS framework, communication and outreach activities for stakeholders' coordination and participation in developing decision support tools to mitigate environmental issues.
2. Environmentally and Energy Favorable Air Traffic Management Concepts And Gate to Gate Operational Procedures Phases I and II (109319-109322) will explore, develop, demonstrate, evaluate and support the implementation and deployment of operational changes to the NAS that have the potential to reduce the environmental impacts of aviation.
3. Implement NextGen Environmental Engine and Aircraft Technologies Phases I and II (109315-109318) 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.

4. Increased Use of Commercial Aviation Alternative Fuels Phases I and II (109316-109321) will determine the feasibility and market viability of alternative aviation fuels for civil aviation use. This effort will seek to obtain certification of alternate jet 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.

4.7 Transform Facilities

Summary Description:

Future air traffic control facilities will be more flexible, scalable and maintainable. Airspace boundaries will no longer be based on geographical boundaries. Infrastructure, automation, equipage, procedures and regulations will support a seamless operational concept as the NAS evolves from a geographic focus to a broader air traffic management concept.

To support this new approach to the NAS, Future Facilities will optimize resources by establishing new facilities, changing the number and sizes of existing facilities and combining/eliminating other facilities. Allocation of staffing and facilities, continuity of operations and training the workforce will also be considered.

To support the transformation to NextGen facilities, FAA operates specialized test and evaluation facilities to support the development and implementation of NextGen capabilities. These facilities are unique in their flexibility to assess multiple capabilities; integrate new technologies into a realistic NAS environment and assess groups of capabilities.

Timeline:

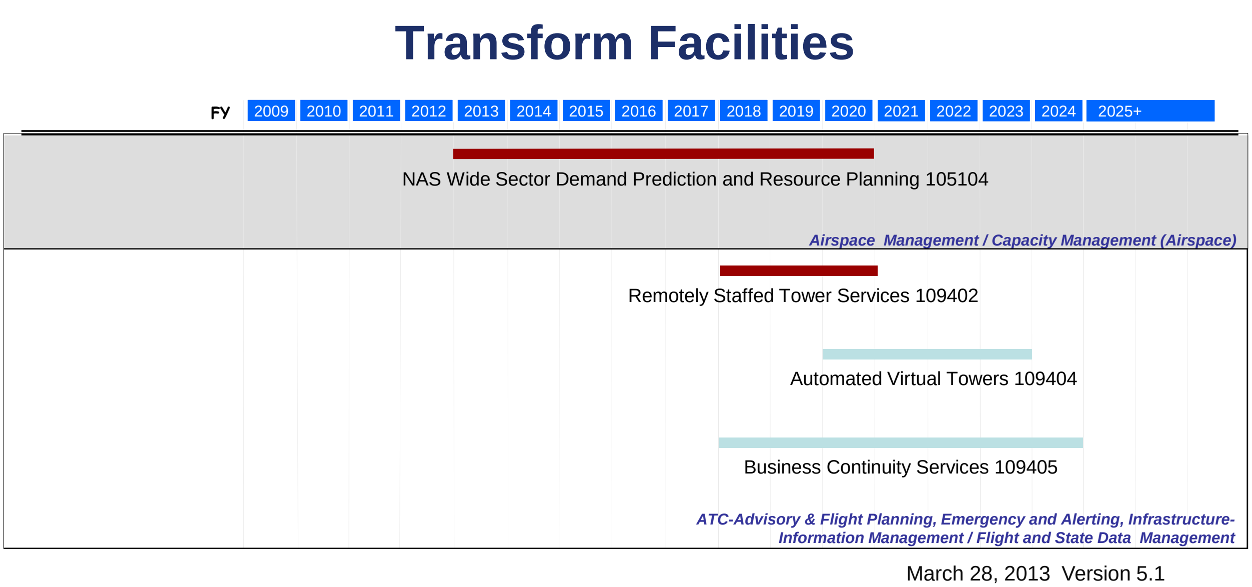

Figure 4-12 Transform Facilities

Operational Improvements

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

In figure 4-12, the Airspace Management/Capacity Management service area's operational improvement is:

> NAS Wide Sector Demand Prediction and Resource Planning (105104) 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 airline business decisions. Future traffic loads are modeled against various solutions to mitigate adverse impacts to users. These variables will affect the design and location of NextGen facilities.

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 (109402) 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 improvement are ERAM mid-term work package, Terminal Automation Modernization Replacement (TAMR), Tower Flight Data Manager (TFDM), NAS Voice System (NVS), ADS-B, Airport Surface Detection Equipment (ASDE), NextGen Facilities and System Wide Information Management (SWIM).

5 Enterprise Architecture Roadmaps

The detailed roadmaps appearing in the following subsections are an integral part of the NAS Enterprise Architecture and show progression from the present system to NextGen. The roadmaps show planned modernization that extends beyond the 5-year financial horizon covered in the CIP, because planning to meet new demands and technology improvements to the NAS is a continuing process. The roadmaps present an executive view of the schedule for modernizing or replacing systems and the length of time those systems or their replacements will remain in service. They help FAA anticipate future engineering and financial challenges and integrate the modernization efforts by showing program managers the schedule for updating systems that interact with their program.

Many changes shown in the roadmaps 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. These roadmaps are updated annually to reflect results of studies, demonstration projects, and economic analysis related to programs; however, the roadmaps are, and should be reasonably stable from year-to-year. For more detailed information on the roadmaps, view the Enterprise Architecture and Roadmaps (also called Infrastructure Roadmaps) at: https://nasea.faa.gov

The roadmaps in this section organize the architecture based on functional areas, so the programs cross into all four different F&E funding activities, which are described in Chapter 3. The funding tables within each section contain the BLIs for that functional area. They depict the FY 2014 budget request and outyear capital investments. To associate the BLIs with the programs and systems in the FAA Enterprise Architecture, BLI number references are included at the end of each of the descriptions contained within this section.

The remainder of this chapter is broken down into the following sections:

- Automation
- Communications
- Surveillance
- Navigation
- Weather
- Facilities

Figure 5-1 shows and defines the symbols used in the roadmaps. The solid red lines indicate the time the systems, or their replacements will remain in operation and the dashed lines indicate that a system is scheduled to be taken out of service and replaced by better technology. The boxes with names identify programs, functions or systems, which are either described in the text or, when they are not described, their acronyms are spelled out in appendix E.

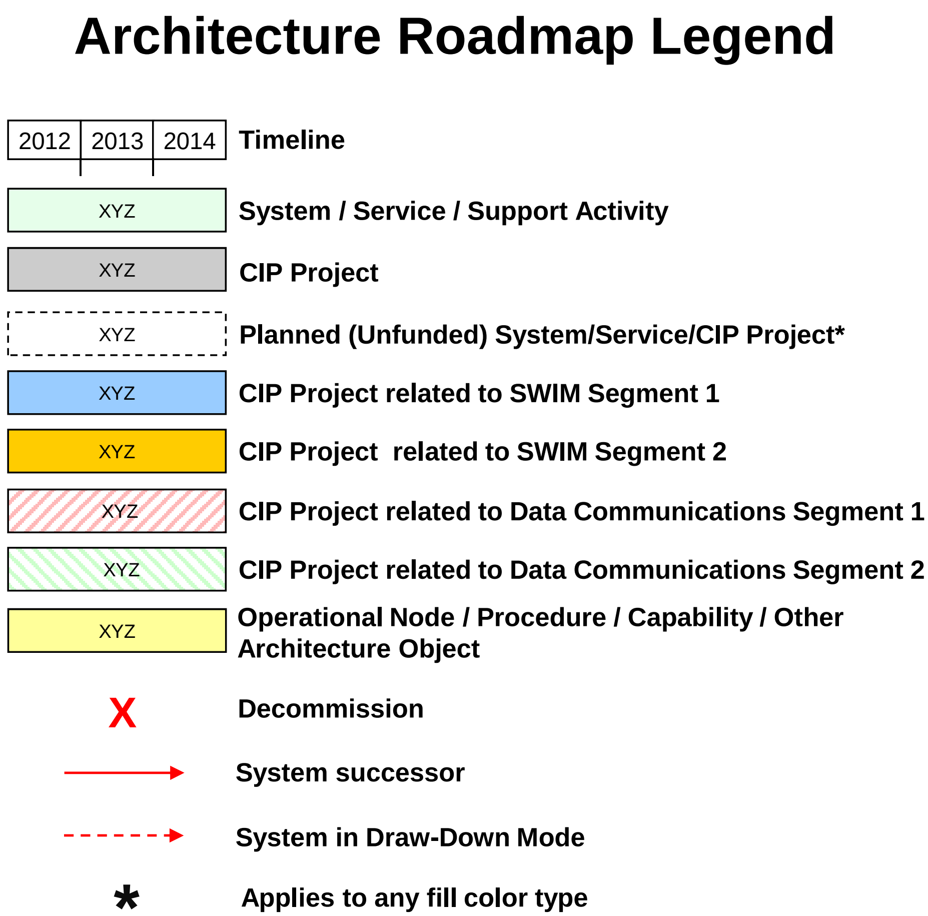

Figure 5-1 Architecture Roadmap Legend

5.1 Automation Roadmaps

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 daily flights safely separated. 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 that data to project an aircraft's future position.

Other important features of automation include the following:

- Maintaining flight information and controller-in-charge data from pre-flight to post-flight, 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.

- Generating symbols displaying information on routes, restricted areas, and several other fixed features of the controller's sector.
- Providing automated alerts to controllers regarding potential aircraft conflicts and warnings that an aircraft may be approaching a terrain hazard.
- Displaying data from weather sensors, giving the status of runway lights and navigational aids, and providing flight plan information on monitored aircraft.
- Providing traffic management capabilities and decision support tools to forecast and provide solutions for future demand. The solutions may involve adjusting routes or speed, controlling airport departures, or other actions.

Automation implementation is broken down into two different roadmaps:

1. Roadmap 1 (figure 5-2) - Air Traffic Control and Air Traffic Management
2. Roadmap 2 (figure 5-3) - Oceanic Air Traffic Control and NAS Information Management

The automation roadmaps in figures 5-2 and 5-3 depict the planned architecture from 2012 to 2025. They show how FAA will upgrade and ultimately replace current systems with more capable systems. 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.

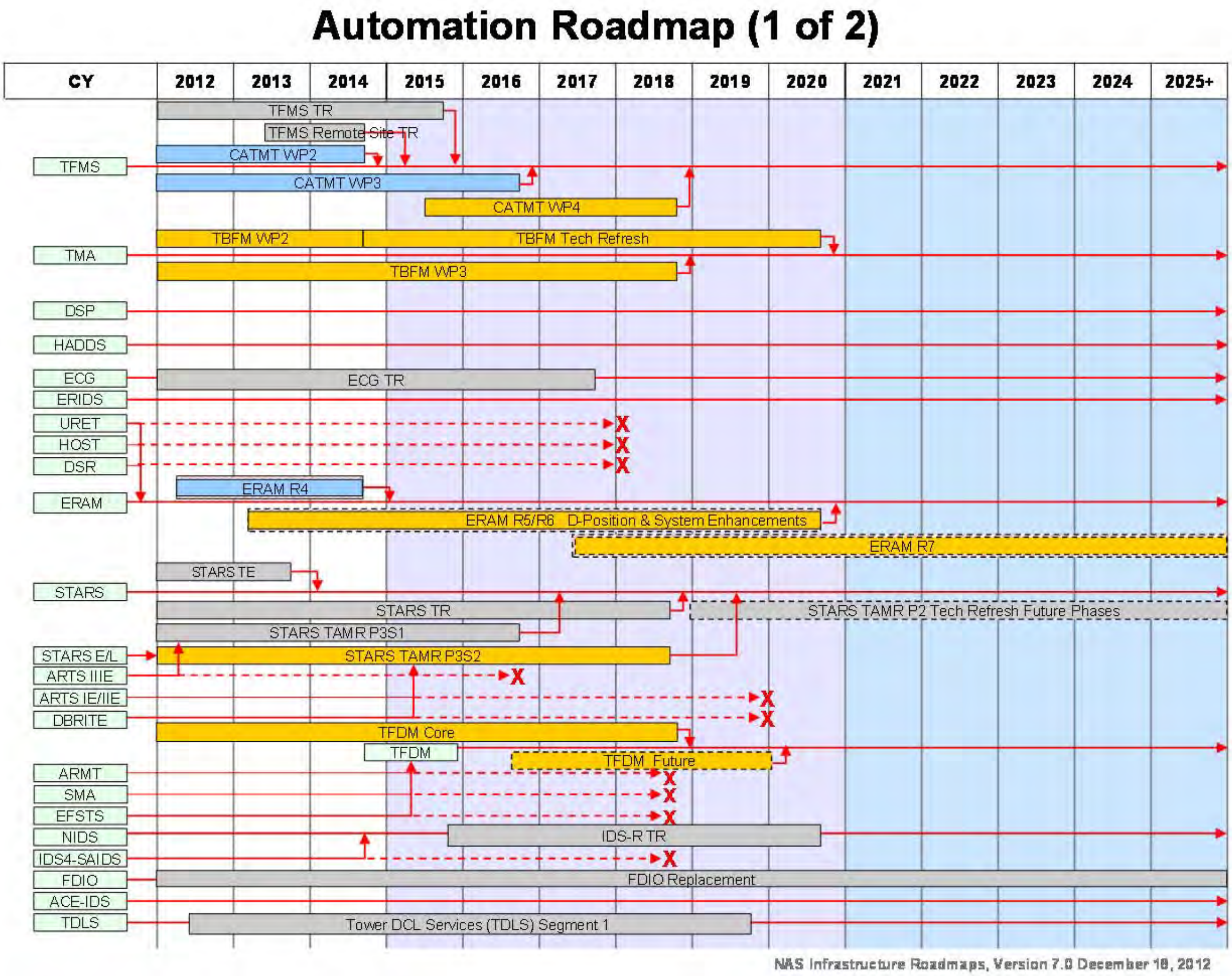

Figure 5-2 Air Traffic Control and Air Traffic Management Roadmap

The first three systems on the left side of the roadmap are used for traffic management. The Traffic Flow Management System (TFMS), Traffic Management Advisor (TMA) and Departure Spacing Program (DSP) are installed at air traffic control facilities including 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 TFMS and TMA with a combination of technology refreshment (TR) of the equipment and the Collaborative Air Traffic Management (CATM) and the Time Based Flow Management (TBFM) work packages which will expand collaboration to individual pilots and improve information exchange between the FAA and airline dispatch offices. The TMA will be enhanced to authorize trajectory based operations which allow aircraft to fly more direct routes with fewer deviations for conflicting air traffic. DSP used by airports will continue to optimize taxi and takeoff clearances to efficiently use available runway and airspace capacity. TFMS infrastructure and software enhancements are funded through BLIs 2A06 and 2A16. TMA infrastructure and software enhancements are funded through BLIs 1A10 and 2A18.

The next seven blocks on the left side are components of the en route control system. The Host ATM Data Distribution System (HADDS) supplies data to the air traffic management systems discussed above and will remain in operation throughout the roadmap timeframe. The En Route Communication Gateway (ECG), which formats data for the en route automation system, remains a separate program and will receive a technology refresh. The En Route Information Display System (ERIDS) will continue in service throughout the roadmap timeframe. The En Route Automation Modernization (ERAM) program incorporates three of the component pieces shown above it (User request Evaluation Tool (URET), Host Computer, and Display System Replacement (DSR)). These systems are components of the existing en route automation system and are being replaced with new hardware and revised ATC software. ERAM is in deployment, and it provides the foundation for the agency's transition to NextGen. ERAM and ECG are funded through BLIs 2A01 and 2A03 respectively.

Improvements to ERAM will be added with a series of releases to add new capabilities to support various elements of NextGen. ERAM D-Position Upgrade and System Enhancements is being restructured into 2 programs: ERAM System Enhancements and Technology Refresh and ERAM Sector Enhancements. The System Enhancements segment is intended to improve aircraft separation services by reducing levels of missed and false alerts from tactical and strategic conflict alerting functions. ERAM Technology Refresh consists of any necessary upgrades or modernization of system components; as well as enhancements outside the scope of the original core ERAM system. ERAM enhancements and technology refresh are funded through BLI 2A02.

ERAM Sector Enhancements provides software and hardware enhancements to the ERAM system for the En Route sector controller team. It is a multi-year effort to improve the efficiency and effectiveness of En-Route Sector operations by facilitating increased strategic and tactical cooperation between the Radar Controller position (R-Position) and the Radar Associate position (D-Position) as well as establish a common processing platform, with similar tool sets, that may be tailored for either position. ERAM Sector Enhancements is funded through BLI 2A02.

The next five systems (STARS, STARS E/L, ARTS IIIE, ARTS 1E/IIE, and DBRITE) are different terminal automation and display models that the FAA will maintain until the Terminal Automation Modernization and Replacement (TAMR) program replaces them. STARS TAMR Phase 3 Segment 1 (STARS TAMR P3 S1) will initially update 11 larger ARTS systems and STARS TAMR Phase 3 Segment 2 will replace all the remaining ARTS systems. The upgraded STARS systems will be able to process position information from the ADS-B system along with information from terminal radars. DBRITE is a tower display that allows tower cab controllers to determine the location of approaching traffic before it becomes visible to them. STARS is funded through BLIs 2B03 and 2B04.

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 NAS subsystems. TFDM Core is the initial capability that will integrate data from three existing systems. TFDM is funded through BLI 2B18.

The Airport Resource Management Tool (ARMT) provides an assessment of available airport capacity. The Surface Movement Advisor (SMA) provides the status of aircraft moving from the gates to the runways and improves taxiing efficiency. The Electronic Flight Strip Transfer System (EFSTS) is a system to transfer flight information to towers and TRACONs electronically rather than by paper.

Information Display Systems (IDS) and SAIDS sites will be updated by the NIDS (NAS IDS) program and receive a technology refresh beginning in 2015. The IDS and the System Atlanta Information Display System (SAIDS) provide weather and other information to tower controllers. IDS is funded through BLI 2B14.

Flight Data Input/Output (FDIO) provides flight plan and other data to operational facilities. It will be replaced incrementally throughout the roadmap timeframe. FDIO is funded through BLI 2B05.

The Automated Surface Observing System (ASOS) Controller Equipment-Information Display System (ACE-IDS) provides weather information to tower controllers. These services will be provided throughout the roadmap timeframe. The Tower Data Link Services (TDLS) provides datalink clearances to pilots preparing to depart an airport. The Departure Clearance (DCL) is being upgraded in segments.

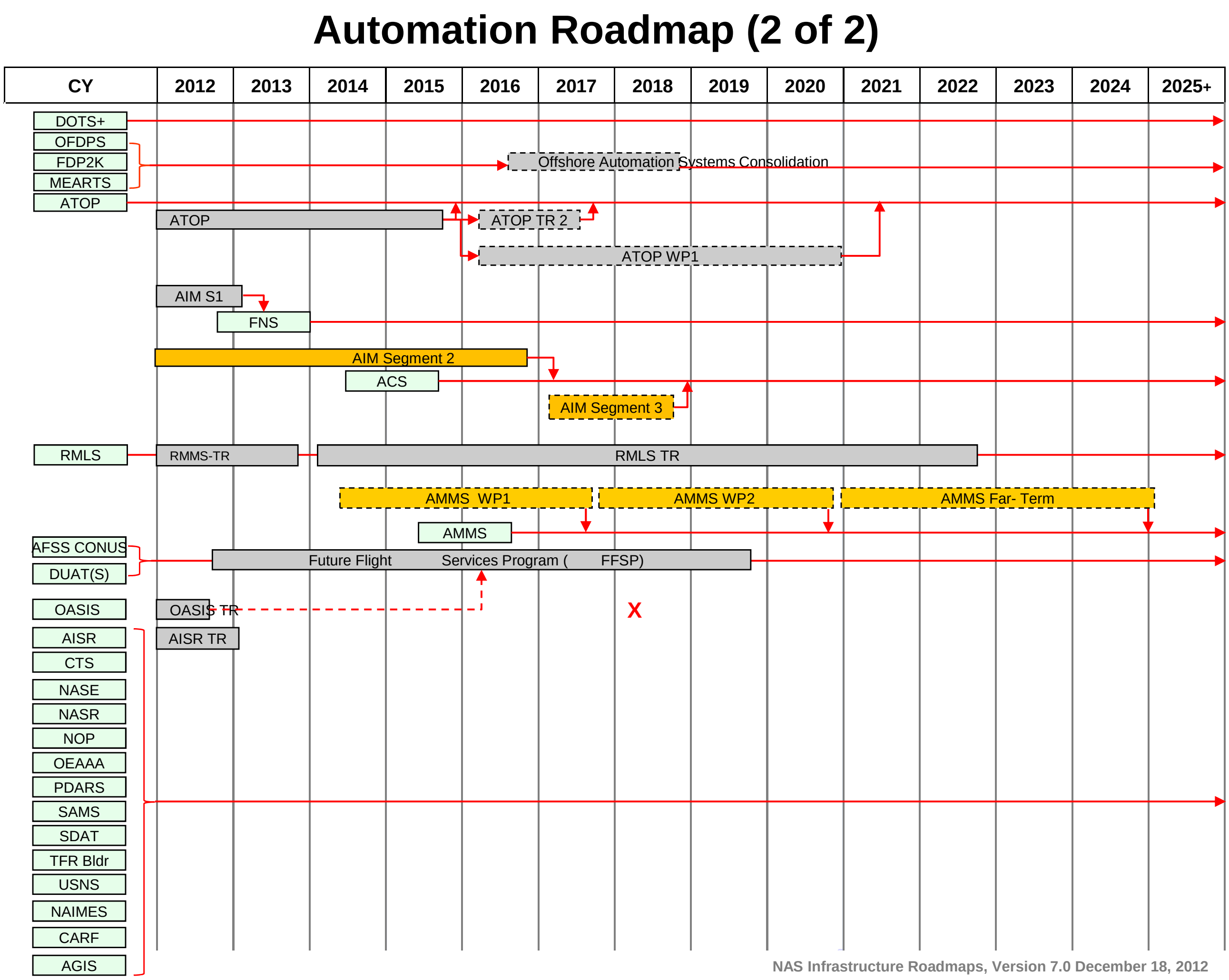

Figure 5-3 Oceanic Air Traffic Control and NAS Information Management Roadmap

Figure 5-3, the first group of five systems on the left side are support oceanic ATC. The DOTS+ system uses weather information to determine the most fuel-efficient routes based on wind velocity and direction. It will continue in operation through the timeframe of the roadmap. The oceanic automation systems process data regarding the position of aircraft on oceanic and offshore flights to aid controllers in separating flights in FAA controlled airspace. The FAA will be examining a potential replacement for the Offshore Flight Data Processing System (OFDPS), Flight Data Processing 2000 (FDP2K), and the Microprocessor En Route automated Radar Tracking System (MEARTS) in 2016. Three centers (New York, Oakland and Anchorage) house the oceanic control system, Advanced Technologies and Oceanic Procedures (ATOP), which remain in operation throughout the roadmap timeframe with ongoing technology refresh and upgrades. ATOP is funded through BLI 2A10.

The Aeronautical Information Management (AIM) Segments 1, 2, and 3 are funded through BLI 4A09 to consolidate and automate the storage and dissemination of aeronautical data used by pilots and aviation planners. They will upgrade the systems shown below:

- FNS – Federal NOTAM (Notice to Airmen) System – this system collects and provides access to NOTAMs, which are notices of temporary changes, such as temporary flight restrictions and runway closures for construction.
- ACS – The Aeronautical Common Services system stores information about airports, navigational aids and other aeronautical data.

The Remote Maintenance Logging System (RMLS) 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 technology refresh and will be supplemented by the Automated Maintenance Management System (AMMS). RMLS technology refresh and AMMS are funded through BLI 2B15.

AFSS CONUS, DUATS and OASIS are automation systems that provide aeronautical and weather data to support flight services. Flight services include flight planning and pilot weather briefings which are primarily used by general aviation pilots. Flight services in the lower 48 States and Puerto Rico are provided by contractor flight service personnel using the Automated Flight Service System (AFSS CONUS). The Direct User Access Terminal Service (DUATS) is a web-based service that allows pilots to access weather and aeronautical data for self-briefings and to file flight plans. The OASIS automation system is used at the Flight Service Stations in Alaska by FAA flight service specialists to provide flight services to general aviation pilots.

The Future Flight Service Program (FFSP) is expanding web services and in the long term plans to transition flight services away from human delivery to automation for all FSS facilities. FFSP is funded through BLI 2C02.

Figure 5-3 shows fourteen systems that continue in operation, without upgrades beyond technology refreshes, through the roadmap timeframe. A brief description of each system's capability and impact of providing service for airports, airspace, and navigation facilities is provided below:

- Aeronautical Information System Replacement (AISR) – distributes information on weather, flight plans, NOTAMS, Pilot Reports and other NAS status items to FAA facilities, DoD, and pilots;
- Coded Time Source (CTS) – program is identifying how to standardize the official source of time that synchronizes the information flows in the air traffic control equipment. The CTS program will also determine an appropriate backup to the primary source that can be used in case the primary source fails;
- NAS Adaptation Services Environment (NASE) – is a system that contains detailed information about the airspace, geography, equipment, and procedures required to make each ATC system work properly;
- National Airspace System Resources (NASR) – is a system that contains information pertaining to Instrument Approach Procedures (IAPs), Departure Procedures (DPs), Standard Terminal Arrival Routes (STARs), and Military Training Routes (MTRs);

- National Offload Program (NOP) – allows FAA to download radar information from en route automation systems for analysis and review;
- Obstruction Evaluation/Airport Airspace Analysis (OEAAA) – evaluation tool contains data about obstructions around airports that would present a hazard for aircraft taking off and landing;
- Performance Data Analysis and Reporting System (PDARS) – is a fully integrated performance measurement tool designed to help the FAA improve the NAS by tracking the daily operations of the ATC system and its environmental impact. PDARS is funded through BLI 1A01B;
- Special Airspace Management System (SAMS) – informs controllers when airspace ordinarily reserved for military use is available for civilian use;
- Sector Design and Analysis Tool (SDAT) – helps design the shape and size of air traffic control sectors;
- Temporary Flight Restriction Builder (TFR Bldr) – an automated system for establishing temporary flight restrictions that prohibit aircraft from flying over areas where special events such as the super bowl are being held;
- United States NOTAM (Notice to Airmen) System (USNS) – an automated system used to process, store and distribute NOTAM information. NOTAM information is that aeronautical information that could affect a pilot's decision to make a flight;
- NAS Aeronautical Information Management Enterprise System (NAIMES) – consists of a suite of NAS safety/mission critical systems and services that directly support the collection, validation, management, and dissemination of aeronautical information in the NAS;
- Central Altitude Reservation Function (CARF) – system used by military and civilian pilots to reserve altitudes for their planned flights; and
- Airport Geographic Information System (AGIS) – stores data on airport configuration and physical location and size of all elements of the airport. It is used to develop airport modernization plans, and it is necessary for developing new approach and departure procedures.

Figure 5-4 shows future capital investments for automation programs. Funding amounts are in Millions of Dollars.

BLI Number	Program Name	FY 2014 Budget	FY 2015	FY 2016	FY 2017	FY 2018
	Automation Functional Area	**$377.1**	**$371.5**	**$447.0**	**$463.4**	**$464.0**
2A01	En Route Automation Modernization (ERAM)	$26.1	$0.0	$0.0	$0.0	$0.0
2A02	En Route Automation Modernization (ERAM) – D-Position Upgrade and System Enhancements (ERAM System Enhancements and Technology Refreshments and ERAM Sector Enhancements)*	$65.0	$71.0	$110.0	$145.0	$187.5
2A03	En Route Communications Gateway (ECG)	$2.2	$8.7	$2.9	$2.0	$2.0
2A06	Air Traffic Management (ATM)	$13.8	$1.9	$0.0	$0.0	$0.0
2A10	Oceanic Automation System	$4.8	$2.0	$0.0	$0.0	$0.0
2A16	Collaborative Air Traffic Management Technologies (CATMT)*	$29.4	$3.3	$15.6	$18.0	$30.0
2A18	Tactical Flow Time Based Flow Management (TBFM)*	$10.5	$0.5	$3.6	$1.8	$0.1
2B03	Standard Terminal Automation Replacement System (STARS) (TAMR Phase 1)	$45.5	$56.7	$79.3	$60.0	$46.8
2B04	Terminal Automation Modernization/ Replacement Program (TAMR Phase 3)	$136.6	$143.6	$132.2	$89.7	$20.0
2B05	Terminal Automation Program	$2.6	$2.6	$2.7	$2.7	$2.8
2B14	Integrated Display System (IDS)	$4.1	$16.9	$13.3	$5.7	$1.1
2B15	Remote Monitoring and Logging System (RMLS) Technology Refresh	$1.0	$2.2	$1.1	$3.4	$4.5
2B18	Terminal Flight Data Manager (TFDM)*	$23.5	$42.0	$55.3	$107.1	$137.4
2C02	Future Flight Services Program (FFSP)	$3.0	$5.0	$16.0	$18.0	$21.8
4A09	Aeronautical Information Management Program*	$9.1	$15.0	$15.0	$10.0	$10.0

* Titles with asterix represent NextGen BLIs

** Additional funding to cover the cost of construction is included in the proposed Immediate Transportation Investment in FY 2014.

Note: BLI numbers with X represent outyear programs not requested in the FY 2014 President's Budget.

Note: FY 2015-2018 outyear funding amounts are estimates.

Figure 5-4 Funding amounts in the Automation Functional Area

5.2 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 the continued ability to maintain communications when the primary systems fail.

Communication system implementation is broken down into four different roadmaps:

1. Roadmap 1 (figure 5-5) - Telecom and Other Communications
2. Roadmap 2 (figure 5-6) - Voice Switches and Recorders
3. Roadmap 3 (figure 5-7) - Air to Ground Voice and Oceanic Communications
4. Roadmap 4 (figure 5-8) - Air to Ground Data Communications

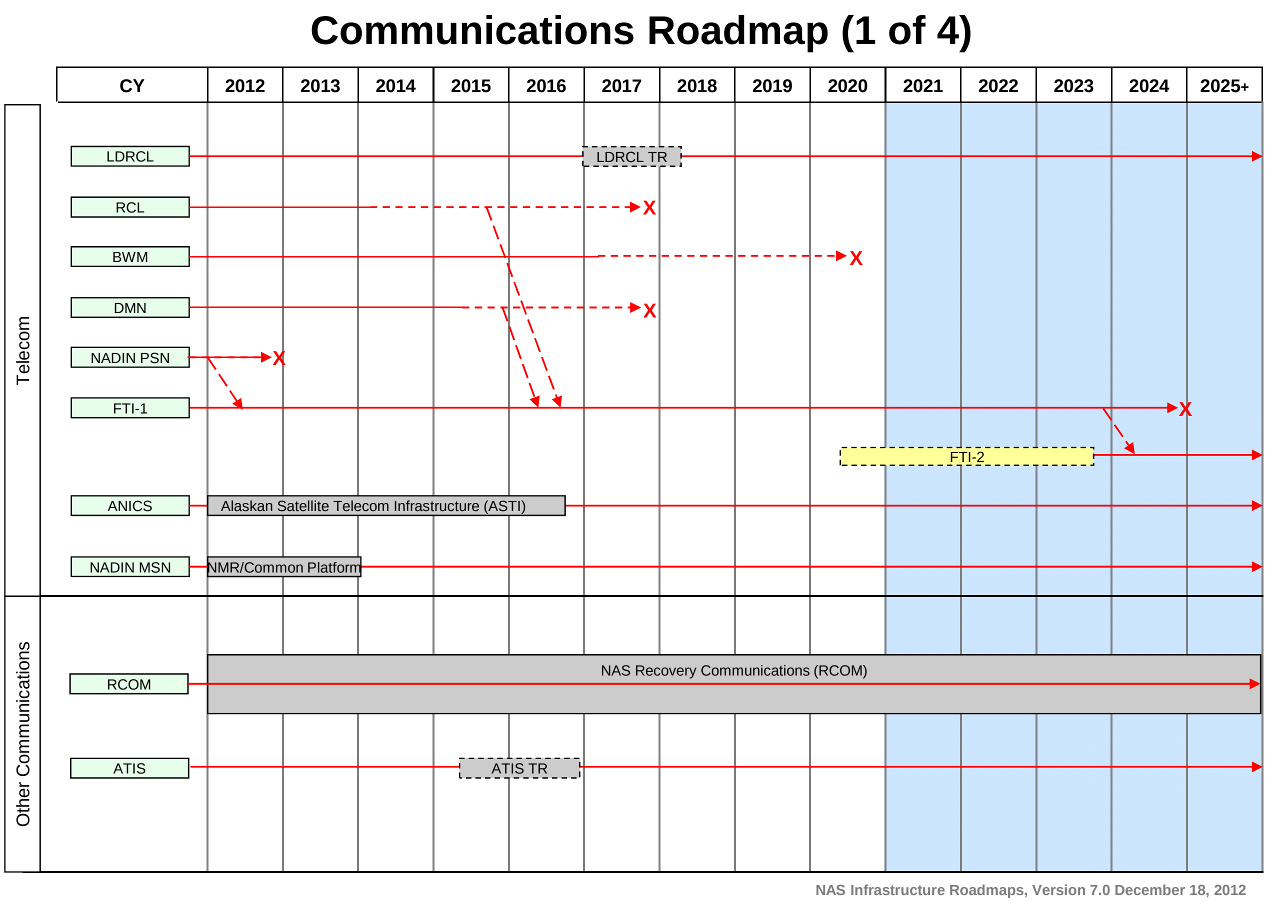

Figure 5-5 Telecom and Other Communications Roadmap

The Low Density Radio Communication Link (LDRCL) and the Radio Communication Link (RCL) 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. Many of the RCL communication links have already transitioned their functions to the FAA Telecommunications Infrastructure (FTI) to carry this data. The LDRCL will remain in service because they provide services in areas with limited commercial services. 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. The Data Multiplexing Network (DMN) and National Airspace Data Interchange Network – Package Switching Network (NADIN PSN) transmit flight plans and other important aeronautical information to air traffic facilities. The FAA will transition functions of DMN and NADIN PSN to the FTI network and its follow on contract. NADIN Message Switching Network (MSN) will be sustained by the NMR (NADIN MSN Rehost) to comply with international standards for transmitting flight plans.

The FTI is a contract service to provide communications services to and from FAA facilities. In 2020, work will begin on preparing for a transition to a new FTI - Phase 2 (FTI-2) contract.

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. It has been renamed Alaska Satellite Telecommunications Infrastructure (ASTI) program and it is the follow-on effort to ANICS to modernize the infrastructure. Because there are far fewer ground telecommunications connections in Alaska, a satellite system is used to ensure that important air traffic information is reliably transmitted between smaller and larger facilities. ASTI is funded through BLI 2E05.

Recovery Communications (RCOM) is an emergency network to be used for command and control of the ATC system when all other communications systems fail. RCOM is funded through BLI 3A04.

The Automated Terminal Information System (ATIS) broadcasts weather and other pertinent information to pilots as they approach an airport. We are planning a technology refresh in 2015 and will maintain the ATIS functions during the entire timeframe of the roadmap.

Figure 5-6 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.

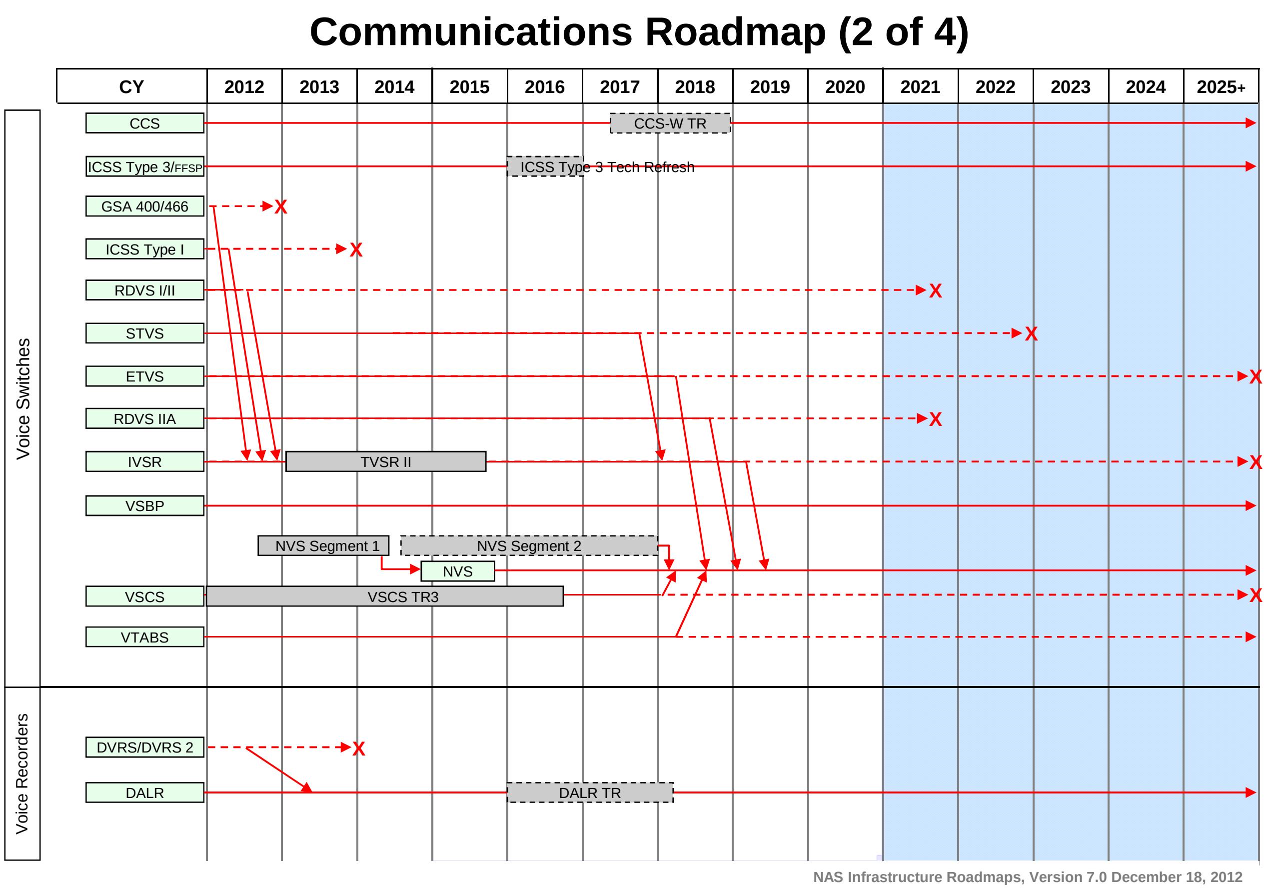

Figure 5-6 Voice Switches and Recorders Roadmap

The Command Center Conference Control Switch (CCS) installed at the facility in Warrenton, Virginia 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. They can coordinate with centers, TRACONs, and users to decide how best to implement traffic management initiatives and when to use severe weather avoidance programs. A technology refresh is planned to begin in 2017.

The voice switches shown below the CCS are used in terminal and flight service facilities. Voice switches enable air traffic controllers to select lines to communicate with pilots as well as other air traffic control facilities. They are:

- Integrated Communication Switching System (ICSS) Type 1 and 3 – The ICSS Type 3 will remain in operation and receive a planned technology refresh;
- GSA 400/466 – A voice switch developed by Litton/Amecom purchased through a national program/contract;
- The Terminal Voice Switch Replacement (TVSR) II program, funded through BLI 2B08, replaces terminal voice switches with Interim Voice Switch Replacement (IVSR) at the rate of about 5 per year, and installs new voice switches in newly constructed airport traffic control towers. TVSR II also refurbishes approximately 2 voice switches per year. The switches are:
  - Rapid Deployment Voice Switch (RDVS) I, II and IIA;
  - Small Tower Voice Switch (STVS);
  - Enhanced Terminal Voice Switch (ETVS);
  - IVSR; and
  - Voice Switch By Pass (VSBP) – is a backup voice switch that terminal controllers can use to stay in communication with pilots if there is a failure in the primary voice switch installed in their facility.

The FAA has awarded the contract for a two segment procurement of the NAS Voice System (NVS). The first segment will develop prototype switches for testing to determine operational suitability. The second segment will be for the procurement of switches to replace existing switches in FAA facilities. The NVS program will include voice switches, air/ground (A/G) radio control equipment, and the associated transmission services. 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, ATCT and TRACON voice switches and is funded through BLI 2B13.

The Voice Switching and Communications System (VSCS) is the voice switch used in ARTCCs. The FAA is upgrading VSCS with a technology refresh to replace components that have a high failure rate. The VSCS Training and Backup Switch (VTABS) will maintain critical air-to-ground and ground-to-ground communications if the main communications system becomes inoperable as a result of a power outage, a catastrophic system failure, or during system maintenance or upgrade activities. VSCS is funded through BLI 2A09.

The Digital Audio Legal Recorder (DALR) is the voice recorder that is replacing Digital Voice Recorder Systems (DVRS). DALR is also installed in newly constructed airport traffic control towers. These voice recorders provide a legally accepted recording capability for conversations between air traffic controllers, pilots, and ground-based air traffic facilities in all ATC domains and is used in the investigation of accidents and incidents and routine evaluation of ATC operations. DALR is funded through BLI 2B19.

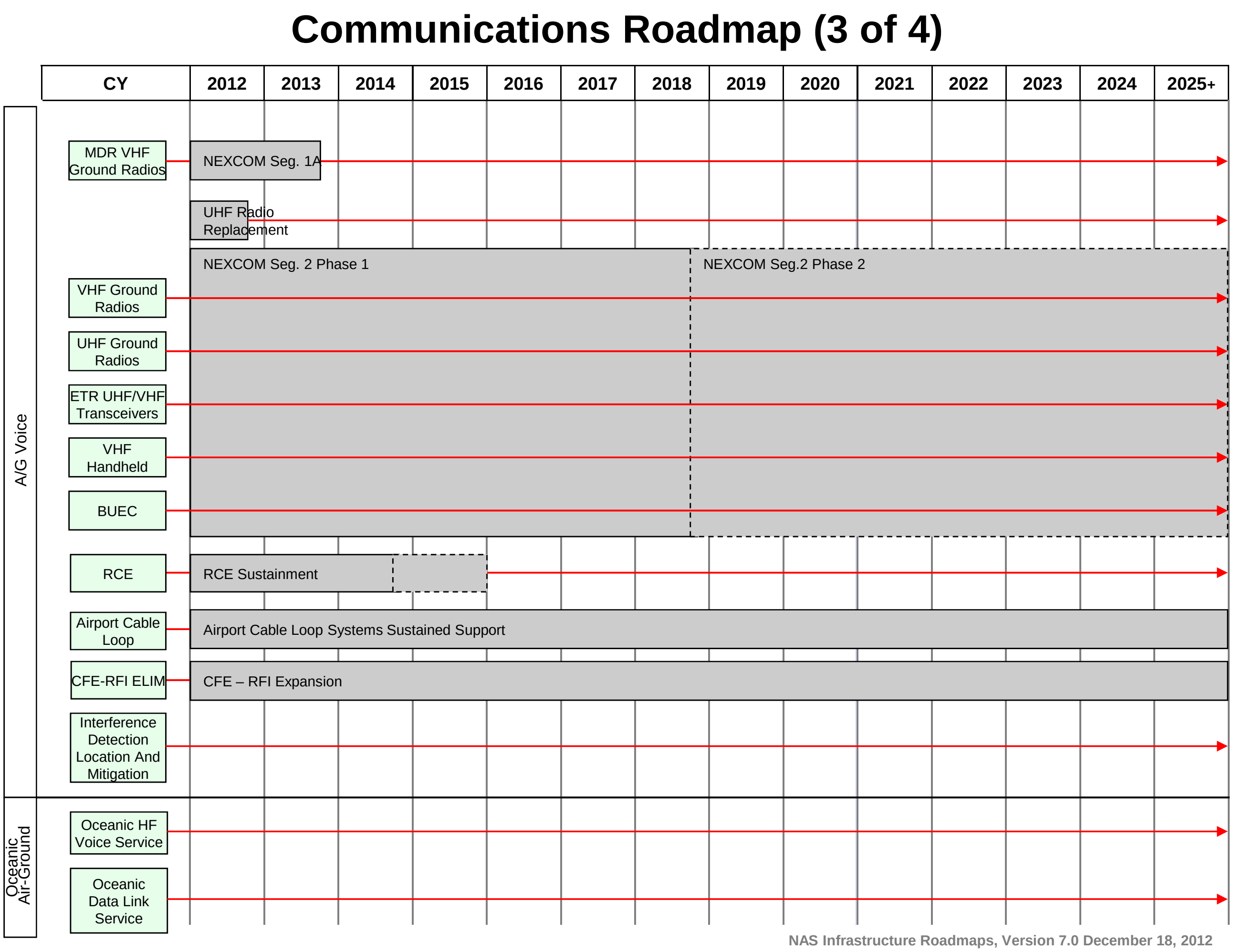

Figure 5-7 Air to Ground Voice and Oceanic Communications Roadmap

The third communications roadmap (figure 5-7) shows the replacement programs for 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 aviation and Ultra High Frequency (UHF) radios used by military aircraft. NEXCOM Segment 1A replaced the radios used for high and ultrahigh en route sectors. Segment 2 will replace the radios that terminal facilities use in a combined contract for both VHF and UHF radios. It will also upgrade emergency backup radios (ETR) used if the primary radios are not working. NEXCOM is funded through BLI 2A11. 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. RCE is funded through BLI 2A07.

The Airport Cable Loop program replaces the communications cables that control and report the condition of equipment necessary for airport operations such as the Airport Surveillance Radar. FAA is 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. The Airport Cable Loop program is funded through BLI 2E04.

The Air-to-Ground (A/G) Communications Infrastructure expansion program enhances operational efficiency and effectiveness by establishing, replacing and upgrading radio equipment. The program is funded through BLI 2A07.

The Radio Frequency Interference (RFI) and Interference Detection, Location and Mitigation (IDLM) programs investigate occurrences of non-FAA 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. The RFI and IDLM programs are funded through 2A07.

The last two items on the roadmap are communications systems used for oceanic air traffic control. The first one is the high frequency (HF) radio. 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 to and from aircraft flying over the oceans.

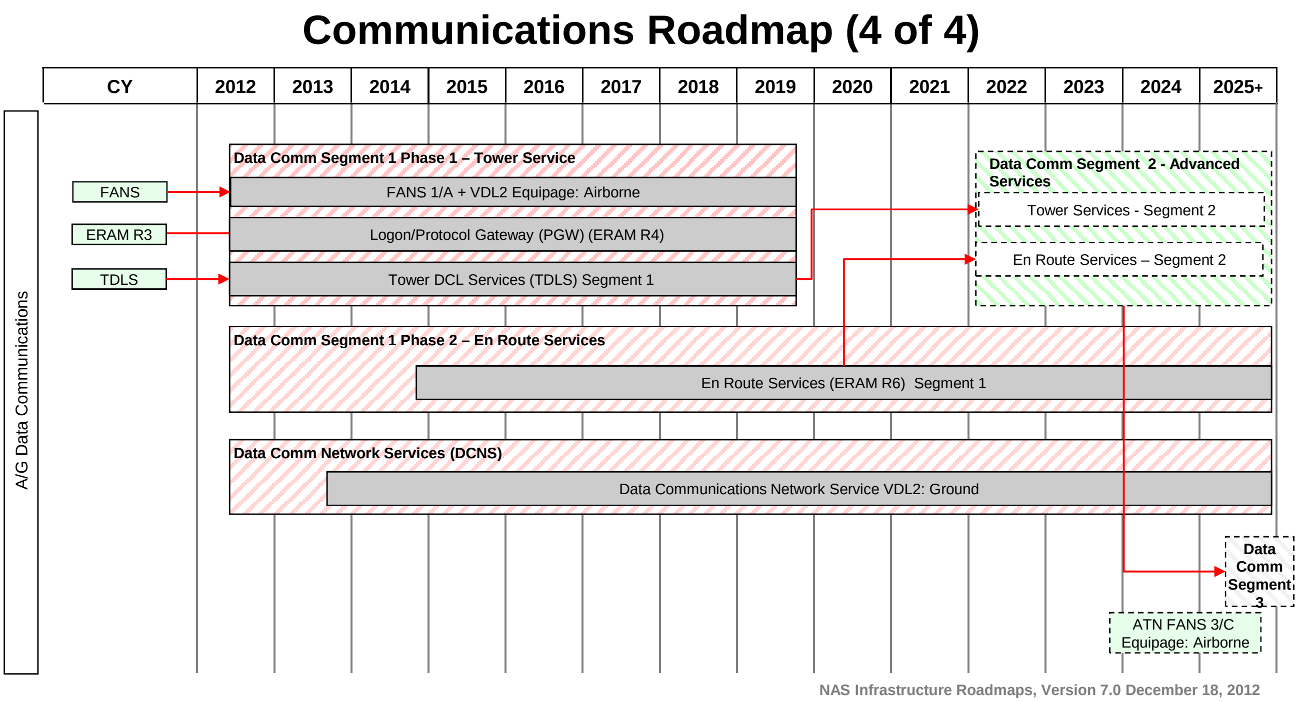

Figure 5-8 Air to Ground Data Communications Roadmap

The fourth communications roadmap (figure 5-8) shows the planned transition to data communications services for routine communications from controllers to pilots that can be data linked from en route and terminal ATC automation system.

Data Comm Segment 1 Phase 1 will provide service for three existing communication connections. Future Air Navigation System (FANS), a generic term for capabilities mainly used for overwater operations, will take advantage of already installed datalink capability. Aircraft that are FANS equipped will experience more sophisticated data link connections with ATC facilities as new systems evolve during the roadmap timeframe. The Logon/Protocol Gateway (PGW)(ERAM R4) upgrade will enable Data Comm to send information directly to pilots. A log-on protocol began development in 2012 to assure security of transmissions to pilots. The Terminal Data Link System (TDLS) is currently used to transmit departure clearances (DCL) and other information to aircraft preparing to depart the airport. It is being upgraded and modernized for the transition to Data Comm Segment 1.

Data Comm Segment 1 Phase 2 will provide en route services to pilots. More sophisticated applications will be developed through the entire period to 2025. Data Comm Network Services will establish the ground infrastructure necessary to support communication between aircraft and FAA facilities. Data Comm programs are funded through BLI 1A05.

Figure 5-9 shows the future capital investments for replacing communications systems and improving and modernizing communications channels. Funding amounts are in Millions of Dollars.

BLI Number	Program Name	FY 2014 Budget	FY 2015	FY 2016	FY 2017	FY 2018
	Communication Functional Area	**$216.4**	**$260.9**	**$275.7**	**$322.1**	**$331.4**
1A05	Data Communication in support of Next Generation Air Transportation System (NextGen)*	$115.5	$149.5	$177.4	$225.6	$230.0
2A07	Air/Ground Communications Infrastructure	$5.5	$3.0	$3.2	$3.2	$3.2
2A09	Voice Switching Control System (VSCS)	$20.0	$9.8	$9.9	$11.3	$11.2
2A11	Next Generation Very High Frequency Air/Ground Communications System (NEXCOM)	$20.3	$40.0	$42.0	$50.0	$50.0
2B08	Terminal Voice Switch Replacement (TVSR)	$5.0	$0.0	$0.0	$0.0	$0.0
2B13	National Airspace System Voice System (NVS)*	$16.0	$30.2	$15.1	$15.0	$15.0
2B19	Voice Recorder Replacement Program (VRRP)	$6.2	$0.0	$0.0	$0.0	$0.0
2E04	Airport Cable Loop Systems – Sustained Support	$5.0	$5.0	$5.0	$5.0	$10.0
2E05	Alaskan Satellite Telecommunication Infrastructure (ASTI)	$11.0	$11.4	$11.1	$0.0	$0.0
3A04	National Airspace System (NAS) Recovery Communications (RCOM)	$12.0	$12.0	$12.0	$12.0	$12.0

* Titles with asterix represent NextGen BLIs

** Additional funding to cover the cost of construction is included in the proposed Immediate Transportation Investment in FY 2014.

Note: BLI numbers with X represent outyear programs not requested in the FY 2014 President's Budget.

Note: FY 2015-2018 outyear funding amounts are estimates.

Figure 5-9 Funding amounts in the Communications Functional Area

5.3 Surveillance Roadmaps

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. Surveillance data is provided by the following technologies: Primary radar – The radar beam is bounced off the aircraft and reflected back to the radar receiver; Secondary radar – A reply is generated by the aircraft transponder back to the radar in response to a secondary radar signal; Multilateration – Multiple ground sensors receive aircraft electronic signals and triangulate this information to determine aircraft position; and ADS-B – The aircraft determines its location using GPS or other navigation equipment and broadcasts that information to an ADS-B ground station. Position data is relayed to automation systems which process the data and send it to the displays.

En route facilities use the Air Route Surveillance Radar (ARSR), and terminal facilities use 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. These 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 supplement the position display for each aircraft.

The FAA uses several 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 merges primary and secondary radar, multilateration and ADS-B information to improve detection of aircraft and provides a clear display of the positions of aircraft and vehicles on or near taxiways and runways. A third system which uses multilateration is the Airport Surface Surveillance Capability (ASSC), and it will replace nine of the ASDE-3 radars.

Surveillance systems are broken down into two different roadmaps:

1. Roadmap 1 (figure 2-10) - En Route and Terminal Surveillance
2. Roadmap 2 (figure 2-11) - Surface, Approach and Cross Domain Surveillance

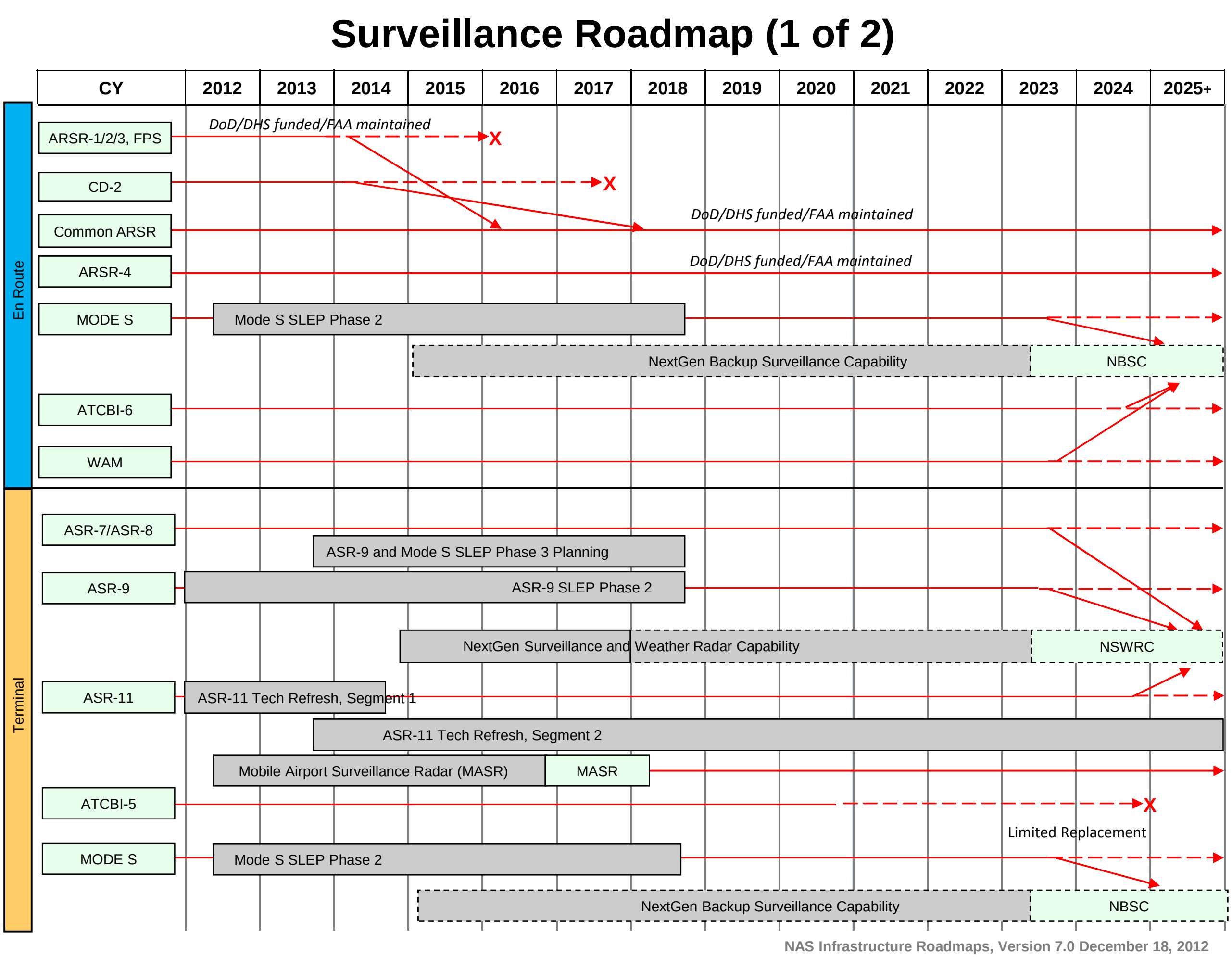

Figure 5-10 En Route and Terminal Surveillance Roadmap

Figure 5-10, the major systems shown in the en route block are the various ARSR models, the fixed position surveillance (FPS) system, 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. Existing long range radars are being converted to the Common Air Route Surveillance Radar configuration. The Department of Defense will fund FAA maintenance of the ARSR through 2025 due to aviation security concerns. ARSR infrastructure upgrades are funded through BLI 2A08.

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. Analysis of a Backup Surveillance Capability has been ongoing with a decision scheduled for 2017. ATCBI technology refresh and Mode S service live extension programs are funded through 2A19 and 2B16 respectively.

The Wide Area Multilateration (WAM) system uses electronic transmissions from an aircraft and multilateration technology to detect aircraft position in areas where the radar signal may be unavailable or blocked by mountainous terrain. A WAM system deployed in the Colorado mountains is funded through BLI 2A17.

Figure 5-10, there are four models of terminal radars currently in use. The Airport Surveillance Radar Model 11 (ASR-11) is the newest and has replaced radars that were not replaced by the ASR-9 program. The ASR-9 will have a Service Life Extension Programs (SLEP) to update and modernize its components, and the FAA will decide in 2017 whether to replace existing ASR 7-8-9 systems with new systems providing NextGen Surveillance and Weather Radar Capability (NSWRC). Current planning calls for keeping terminal primary radar systems as a backup to the other technologies to address safety, security, and weather detection requirements. ASR-9 service life extension and ASR-11 technology refresh programs are funded through BLI 2B10 and 2B11 respectively. Development of NSWRC is funded through BLI 1A01J.

The Mobile Airport Surveillance Radar (MASR) is a terminal surveillance radar that can be moved from site to site to support radar relocations, temporary planned outages of an existing radar for installation of upgrades and emergency operations when existing systems are damaged. MASR is funded through BLI 2B11.

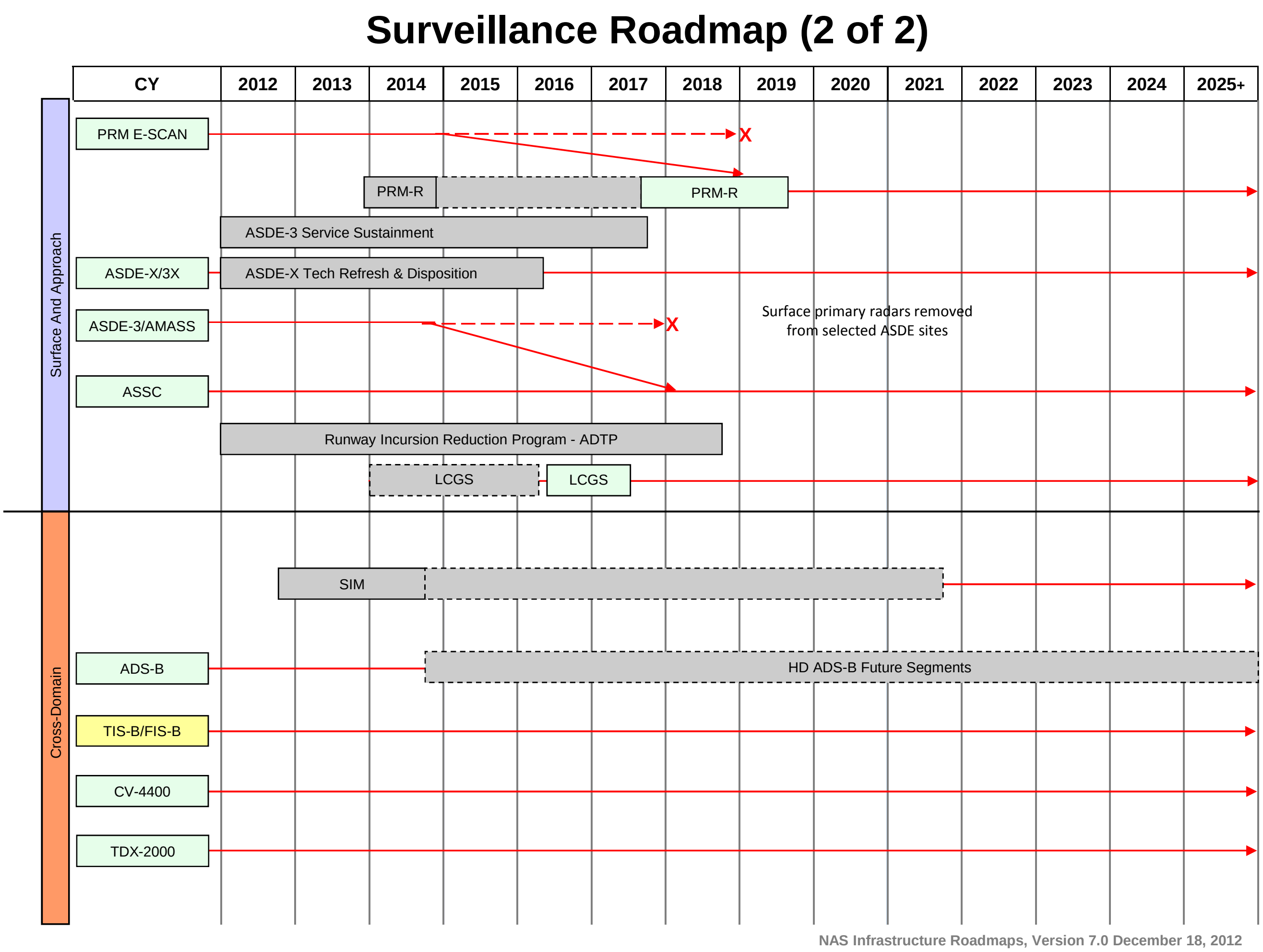

Figure 5-11 Surface, Approach and Cross Domain Surveillance Roadmap

The second Surveillance roadmap (figure 5-11) shows the systems used to track aircraft and vehicles on the airport surface and aircraft within the upper area called Surface and Approach. The ADS-B system shown in the lower area called Coss-Domain also is used on the airport surface and approach areas.

The Precision Runway Monitor (PRM) can be used to allow simultaneous approaches to closely spaced parallel runways. It is a secondary 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. The PRM-R refers to a program which is exploring alternatives that would keep the PRM systems at San Francisco and Atlanta operational. Both systems are facing obsolescence issues and increased maintenance costs. PRM-R is funded through BLI 2B20.

Controllers currently use two systems to maintain aircraft separation on the airport surface. Some airports have ASDE-3/AMASS, 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 18 of the 35 ASDE-X sites use an existing ASDE-3 radar. Seven ASDE 3 sites have been replaced by ASDE-X, and the Airport Surface Surveillance Capability (ASSC) program will replace nine of the ASDE-3 radar systems. The ASSC will use multilateration and ADS-B aircraft information to display aircraft location for the airport tower controllers. The ASDE-X system will have a technology refresh to update some of its components. The technology refresh program is funded through BLI 2B01. The ASSC program is funded through BLI 2A13.

The Runway Incursion Reduction Program (RIRP) is evaluating other technologies that could be used to track aircraft surface and approach movements. FAA is still evaluating the Low Cost Ground Surveillance System (LCGS) to determine whether it would be beneficial to install it at lower activity airports. LCGS is funded through BLI 1A01A.

Over the next 2 years, the FAA will be evaluating whether to install Surveillance Interface Modernization (SIM) equipment at terminal and en route radar locations. SIM will modernize the interfaces between FAA radars and automation systems, which will improve surveillance processing performance, reduce life cycle costs, and enable efficient distribution of radar data in the NAS. SIM is funded through BLI 2B17.

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. 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 Service (TIS-B) broadcasts information on the location of nearby aircraft, and the Flight Information Service (FIS-B) broadcasts weather and airspace information to aircraft that are equipped with the capability to receive it. Implementation of ADS-B, TIS-B and FIS-B are funded through BLI 2A13.

The CV-4400 is a legacy system that allows use of terminal radar information for en route automation systems, e.g., using terminal radar to fill gaps in en route radar coverage at selected en route centers. The TDX-2000 is also a legacy system that digitizes the output of legacy analog radars (for example, ASR-8) for use by more modern digital automation systems, such as STARS.

Figure 5-12 shows the future capital investments associated with upgrading the surveillance units. Funding amounts are in Millions of Dollars.

BLI Number	Program Name	FY 2014 Budget	FY 2015	FY 2016	FY 2017	FY 2018
	Surveillance Functional Area	**$353.1**	**$309.4**	**$227.1**	**$220.8**	**$211.6**
2A08	Air Traffic Control En Route Radar Facilities Improvements	$5.9	$5.9	$0.0	$0.0	$0.0
2A13	Automatic Dependent Surveillance - Broadcast (ADS-B) NAS Wide Implementation*	$282.1	$246.3	$188.4	$189.6	$174.9
2A17	Colorado ADS-B Wide Area Multilateration (WAM) Cost Share*	$3.4	$0.0	$0.0	$0.0	$0.0
2A19	ATC Beacon Interrogator (ATCBI) - Technology Refresh	$1.0	$0.0	$0.0	$0.0	$0.0
2B01	Airport Surface Detection Equipment - Model X (ASDE-X)	$12.1	$13.4	$10.5	$0.0	$0.0
2B10	Airport Surveillance Radar (ASR-9) Service Life Extension Program (SLEP)	$10.9	$13.6	$3.8	$3.5	$1.0
2B11	Terminal Digital Radar (ASR-11) Technology Refresh and Mobile Airport Surveillance Radar (MASR)	$19.4	$21.1	$10.1	$6.7	$4.4
2B16	Mode S Service Life Extension Program (SLEP)	$7.3	$8.1	$11.3	$14.0	$23.8
2B17	Surveillance Interface Modernization (SIM)	$6.0	$0.0	$0.0	$0.0	$0.0
2B20	Precision Runway Monitor Replacement (PRMR) – Multilateration Technology Upgrade	$5.0	$1.0	$3.0	$7.0	$7.5

* Titles with asterix represent NextGen BLIs

** Additional funding to cover the cost of construction is included in the proposed Immediate Transportation Investment in FY 2014.

Note: BLI numbers with X represent outyear programs not requested in the FY 2014 President's Budget.

Note: FY 2015-2018 outyear funding amounts are estimates.

Figure 5-12 Funding amounts in the Surveillance Functional Area

5.4 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 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.

As NextGen is implemented and more aircraft are equipped, 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.

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. 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 3,100 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.

Navigational aid implementation is broken down into two different roadmaps:

1. Roadmap 1 (figure 5-13) - Precision Approach, Surface Navigation and Safety and Enhancements
2. Roadmap 2 (figure 5-14) - Approach and Runway Lights and En Route, Terminal and Non-Precision Approach

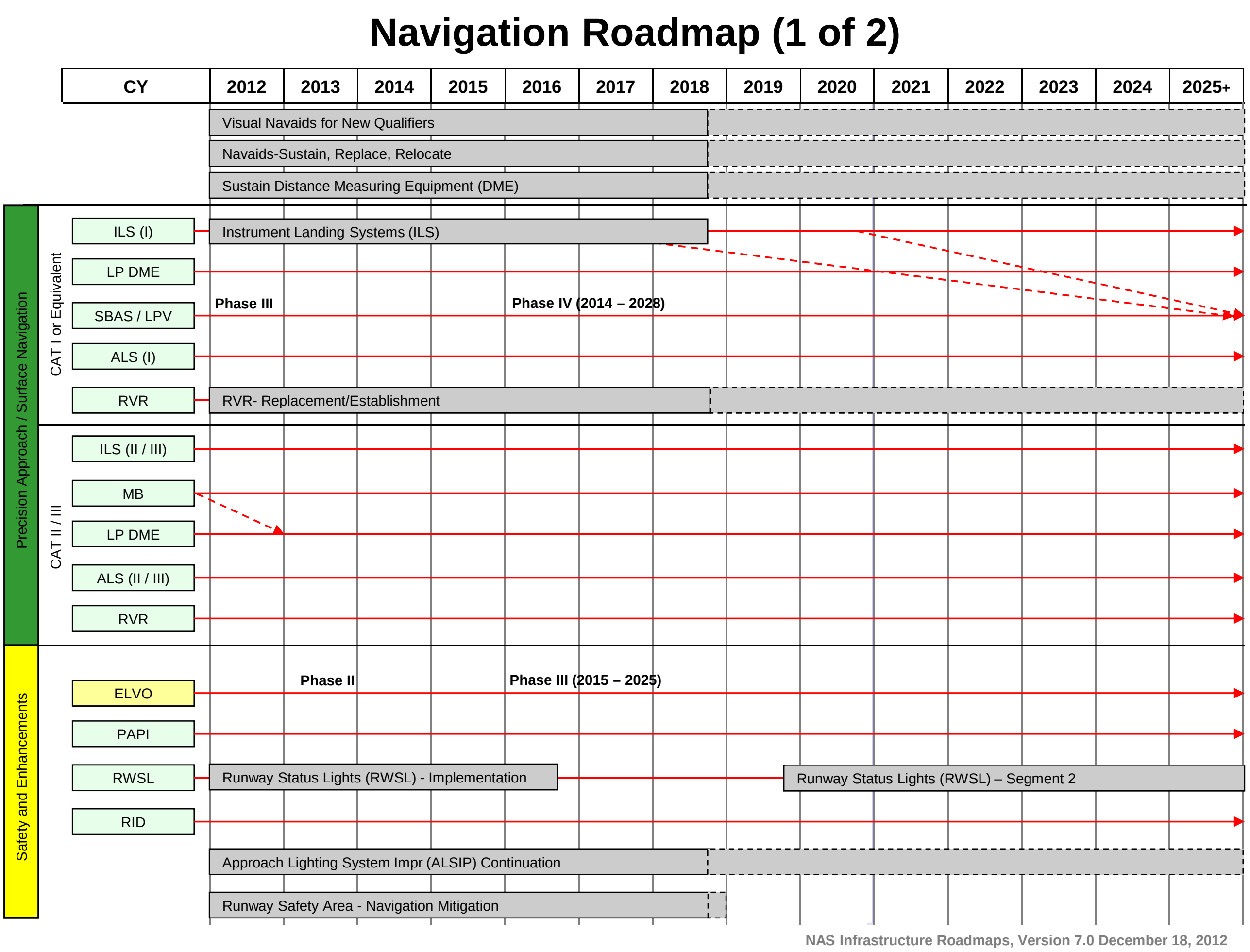

Figure 5-13 Precision Approach, Surface Navigation and Safety and Enhancements Roadmap

At the top of the roadmap (figure 5-13) are 3 programs that support the continued operation of existing systems. Visual navaids assist pilots in staying on the proper glide path. The navaids sustain program updates, replaces and augments the existing inventory of navigational aids. The Distance Measuring Equipment (DME) program both renovates and increases the number of installed DMEs. Visusal Navaids, navigation aids and DMEs are funded through BLIs 2D06, 2D07 and 2D09.

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 higher redundancy and reliability levels that reduce the risk of equipment failures and allow lower minimums. An alternative for precision approach guidance is the SBAS LPV. As this alternative comes into broader use, the FAA can consider decommissioning ILS. The FAA plans to make an initial decision in 2018 and 2020 on the drawdown of Category I ILS. ILSs are funded through BLI 2D02.

The Low Power DME (LPDME) is being installed to support advanced procedures requiring performance based navigation equipage and allow specially trained pilots to minimize approach paths and, as discussed below, to replace marker beacons. LPDMEs are funded through BLI 2D06.

In both Category I and 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 end of 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. In the Category II section the existing MB (Marker Beacon) installations are being evaluated to determine how many can be replaced by LP DMEs. The FAA is also 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. ALSs, RVRs and other approaching lighting systems are funded through BLI 2D04 and 2D09.

The Safety and Enhancements section of the roadmap shows several systems designed to assist pilots to operate safely in low visibility conditions. They are:

- Enhanced Low Visibility Operations (ELVO) – allows pilots to land with lower limited visibility conditions than standard procedures. Additional RVRs to support this capability is funded through BLI 2D04;
- Precision Approach Path Indicator (PAPI) – allows pilots to determine visually that they are on the proper glideslope for landing funded through BLI 2D10;
- Runway Status Lights (RWSL) – are designed to give pilots a stop signal if it is dangerous to enter or cross a runway, funded through BLI 2B12;
- Runway Incursion Devices (RID) – are various pieces of equipment to warn aircraft and other vehicles of potential runway incursions;
- Airport Lighting System Improvement Program (ALSIP) – a response to the National Transportation Safety Board recommendation to replace steel airport light supports with

frangible structures to minimize damage to aircraft that descend below the glidepath, funded through BLI 2D05; and

- Runway Safety Area (RSA) – a program to replace structures in the safety area surrounding a runway with low-impact supports to minimize damage to aircraft that veer off the runway, funded through BLI 2D12.

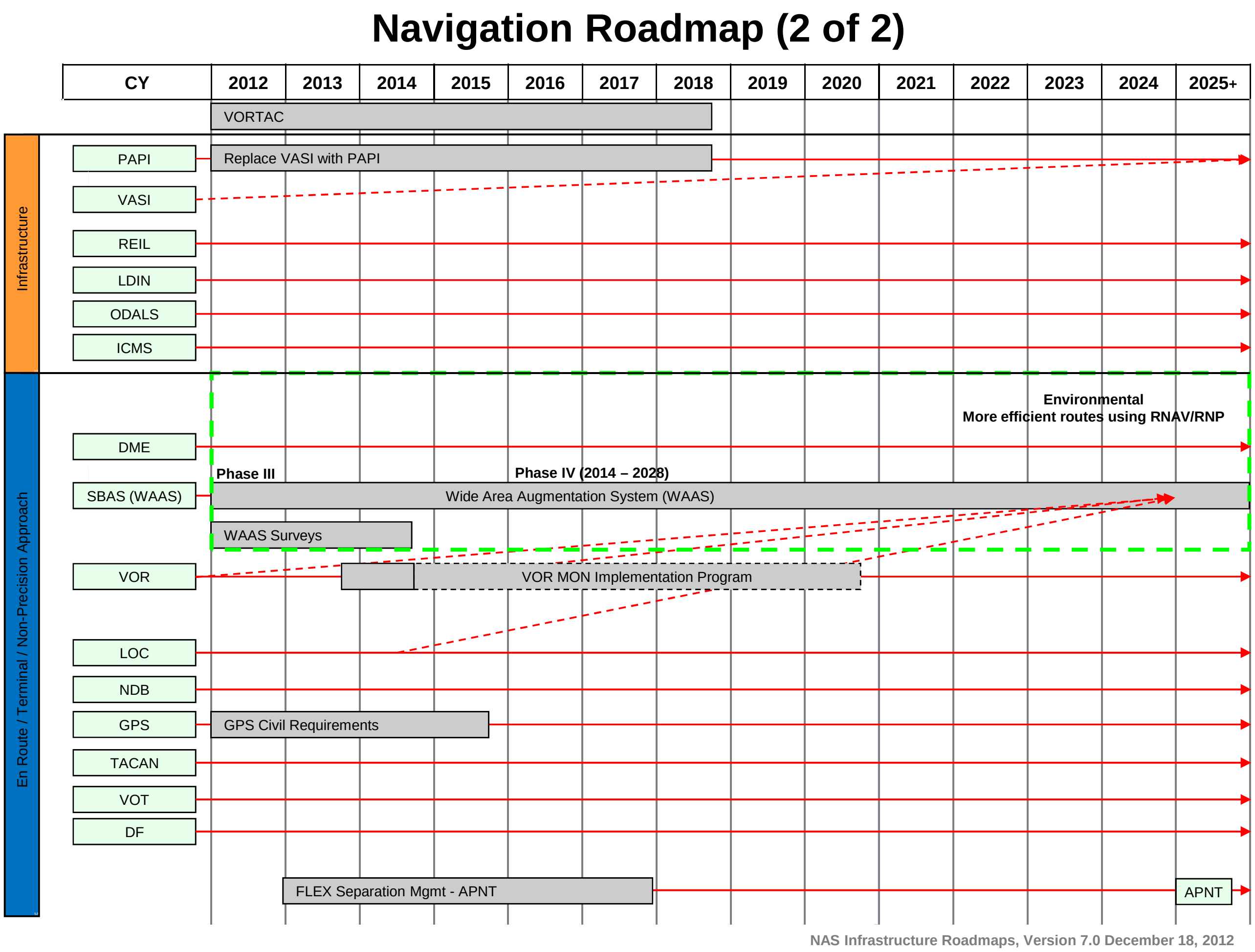

Figure 5-14 Approach and Runway Lights and En Route, Terminal and Non-Precision Approach Roadmap

The VORTAC program at the top of the roadmap shows that combined VOR and TACAN sites will be supported through 2018 and possibly longer if analysis shows a need to continue them. The VORTAC program is funded through BLI 2D01.

Precision Approach Path Indicator (PAPI) and the Vertical Approach Slope Indicator (VASI) will be continued until the PAPI replaces all of the current VASI systems, at a time well into the future. The PAPI system is funded through 2D10.

The Runway End Identification Lights (REIL) help pilots to visually align with the runway for both precision and non-precision approaches. The REIL will continue operating throughout the roadmap timeframe. The LDIN (Lead In Light System) and the ODALS (Omnidirectional Airport Lighting System) are installed at the end of runways to help pilots determine the active runway for landing. The Interlock Control and Monitoring System (ICMS) helps controllers rapidly activate and deactivate the navigational aids at an airport.

DME will support NextGen Nav Initiatives for both en route and terminal DME operations. The terminal DME will be installed beginning in the 2014 timeframe to support Area Navigation/Required Navigation Performance (RNAV/RNP) operations. NextGen Navigation Initiatives program is funded through BLI 1A12E.

Non-precision approaches provide guidance to pilots preparing to land on a runway when there is limited visibility; however they only provide lateral guidance, not vertical guidance. These approaches do not allow descent to the same minimum altitudes possible with a precision approach. VORs support many non-precision approaches; however, SBAS (WAAS) will support non-precision approach operations as the VOR population is reduced. The FAA has more than 5,000 GPS-WAAS non-precision approach procedures in place. The WAAS is funded through BLI 2D03.

The en route and terminal domains have traditionally relied on the system of VORs to define airways within the NAS. As GPS replaces the VOR as a navigation aid, FAA will decrease the number of VORs to a Minimum Operational Network (MON). The MON will serve as a backup for GPS and will be available for those aircraft that have not equipped with GPS navigation systems. The VOR technology refresh or replacement and the MON programs are funded through BLI 2D01.

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; SBAS (WAAS) will begin to replace that functionality at airports where only localizers are installed.

The FAA will continue operating Non-Directional Beacons (NDB), because NDBs are still used at some remote areas, where it is not economically justified to install modern navigational equipment.

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 the aircraft's antenna. Two GPS upgrades are expected in future years. The next generation of satellites 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 GPS Civil Requirements BLI 2D11 will fund the ground monitoring stations to measure the accuracy and reliability of the new civil frequencies.

The Tactical Navigation System (TACAN) is the military equivalent of VOR and DME systems installed jointly. TACAN is often collocated with VOR systems. The VOT (VOR Test Range) is used to check and calibrate VOR receivers in aircraft. The Direction Finder (DF) was used to help locate lost pilots, but it is being decommissioned because better technology is now available.

The Alternate Positioning Navigation and Timing System (APNT) is a program to determine the appropriate back up navigation system in case GPS service is disrupted. It is a NextGen initiative to ensure continuity of service if GPS is disrupted. The APNT program is funded through BLI 1A12F.

Figure 5-15 shows the future capital investments for navigation systems. Funding amounts are in Millions of Dollars.

BLI Number	Program Name	FY 2014 Budget	FY 2015	FY 2016	FY 2017	FY 2018
	Navigation Functional Area	**$238.6**	**$223.7**	**$197.8**	**$143.9**	**$135.0**
2B12	Runway Status Lights (RWSL)	$35.3	$26.2	$20.6	$0.0	$0.0
2D01	VHF Omnidirectional Radio Range (VOR) with Distance Measuring Equipment (DME)	$8.3	$2.5	$2.5	$2.5	$2.5
2D02	Instrument Landing Systems (ILS) – Establish	$7.0	$7.0	$7.0	$7.0	$7.0
2D03	Wide Area Augmentation System (WAAS) for GPS	$109.0	$105.0	$105.7	$97.9	$100.9
2D04	Runway Visual Range (RVR) & Enhanced Low Visibility Operations (ELVO)	$6.0	$6.0	$6.0	$6.0	$4.0
2D05	Approach Lighting System Improvement Program (ALSIP)	$3.0	$3.0	$3.0	$3.0	$3.0
2D06	Distance Measuring Equipment (DME)	$4.0	$3.0	$3.0	$3.0	$3.0
2D07	Visual Navaids - Establish/Expand	$2.5	$2.0	$2.0	$2.0	$2.0
2D09	Navigation and Landing Aids – Service Life Extension Program (SLEP)	$3.0	$3.0	$3.0	$3.0	$6.0
2D10	VASI Replacement – Replace with Precision Approach Path Indicator	$2.5	$5.0	$5.0	$5.0	$5.0
2D11	Global Positioning System (GPS) Civil Requirements	$20.0	$20.0	$0.0	$0.0	$0.0
2D12	Runway Safety Areas – Navigation Mitigation	$38.0	$41.0	$40.0	$14.5	$1.6

* Titles with asterix represent NextGen BLIs

** Additional funding to cover the cost of construction is included in the proposed Immediate Transportation Investment in FY 2014.

Note: BLI numbers with X represent outyear programs not requested in the FY 2014 President's Budget.

Note: FY 2015-2018 outyear funding amounts are estimates.

Figure 5-15 Funding amounts in the Navigation Functional Area

5.5 Weather Roadmaps

Timely and accurate weather observations and forecasts are essential to aviation safety and for making the best use of aviation capacity. They will be even more important when NextGen direct routing becomes routine. 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 FAA 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.

Weather system implementation is broken down into two different roadmaps:

1. Roadmap 1 (figure 5-16) - Weather Sensors
2. Roadmap 2 (figure 5-17) - Weather Dissemination, Processing, and Display

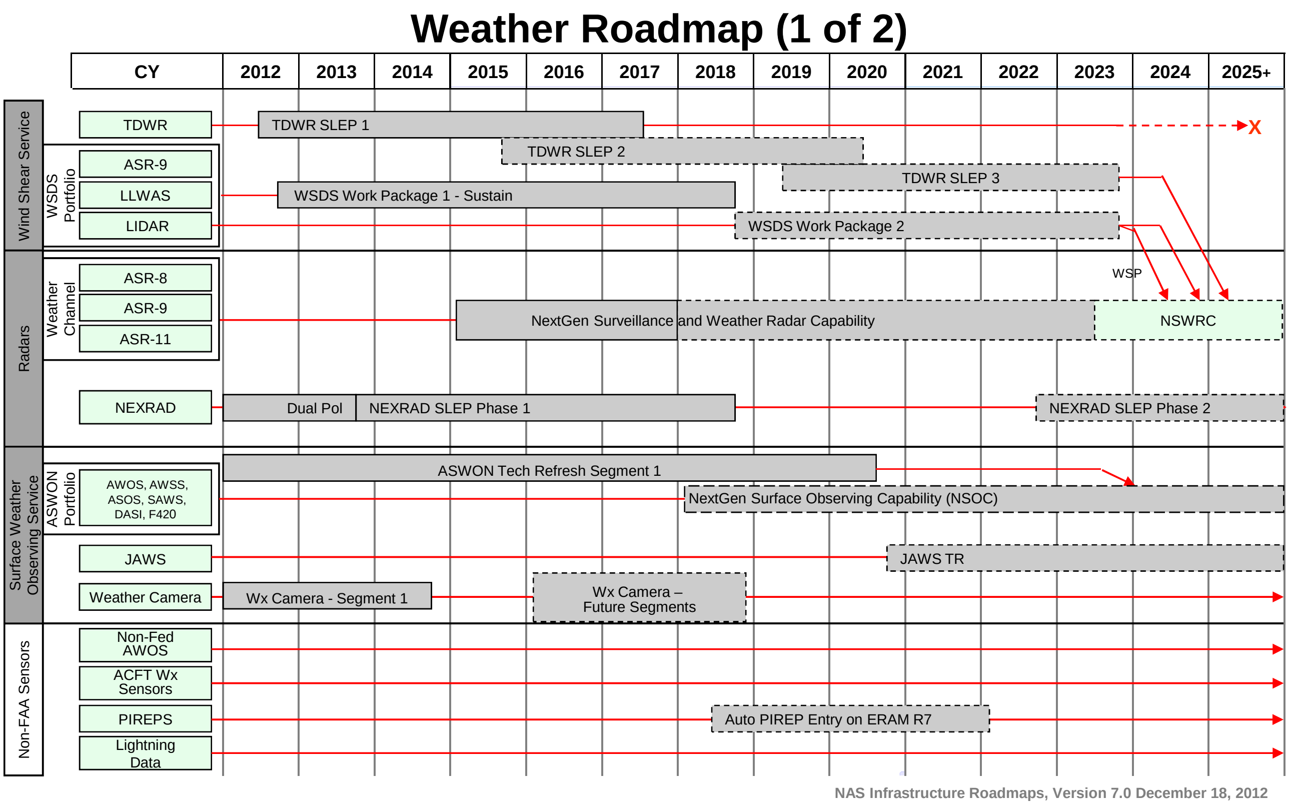

Figure 5-16 Weather Sensors Roadmap

Figure 5-16 shows the current and planned status of weather sensors. The Terminal Doppler Weather Radar (TDWR) is installed at 46 airports and detects windshear and microbursts so controllers can warn pilots of these hazards as they approach the runways and begin landing procedures. TDWR is the most sophisticated wind shear detection system. 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. TDWR service life extension program is funded through BLI 2B02.

The Wind Shear Detection Services Portfolio includes: the Airport Surveillance Radar – Weather System Processor (ASR-WSP); the Low Level Wind Shear Alerting System (LLWAS); and the Light Detection and Ranging (LIDAR) system. ASR-9 airport surveillance radars, wind sensors and lasers are used to detect wind shear conditions near the runways and approach areas of airport. Airports with significant wind shear risk that have a lower volume of air traffic are served by the ASR-WSP, a lower cost alternative to TDWR, 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. The Wind Shear Detection Portfolio is funded through BLI 2A14.

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 LIDAR (Light Detection and Ranging) 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 ASR-8/9/11 Weather Channel and the Next Generation Weather Radar (NEXRAD) detect precipitation, wind, and thunderstorms that affect aircraft in flight. Replacing the weather information that the ASR-8/9 radars generate will be necessary if these radars do not remain in operation. The FAA is evaluating the potential to combine these functions into a NextGen Surveillance and Weather Radar Capability (NSWRC) if the business case shows that solution to be viable. Development of NSWRC is funded through BLI 1A01J.

Development of the currently operating 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, upgrades such as Dual Polarization (Dual Pol) and software improvements are being funded. 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. A cooperative program with the partner agencies will upgrade the NEXRAD radars with a Service Life Extension Program (SLEP) to modernize and renovate the existing system of radars. The NEXRAD SLEP program is funded through 2A04.

The Automated Surface Weather Observation Network (ASWON) Portfolio includes several surface sensors (AWOS/ASOS/AWSS/SAWS/DASI/F-420) 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. The Digital Altimeter Setting Indicator (DASI) shows tower controllers the current barometric pressure so they can inform pilots of the proper setting so the aircraft's altimeter will read the correct runway elevation at touchdown. The F-420 is an indicator that shows the wind direction and velocity on the runways. 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. These systems will remain in operation until a decision is made to implement the NextGen Surface Observing Capability. The ASWON Portfolio is funded through BLI 2C01.

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.

The Weather Camera program installs cameras along flight routes in Alaska so pilots can have a visual picture of the weather they might encounter as they file their flight plans for a specific route. Flights can be cancelled if the cameras show poor weather along the planned route. The Weather Camera program is funded through 2C04.

The non-FAA sensors shown at the bottom of the roadmap are valuable sources of weather information that improve FAA's overall knowledge of weather conditions. Some states and smaller airports operate AWOS for weather observations. Inputs from these systems are valuable additions to the data from FAA sensors. Aircraft weather sensors can provide humidity, wind speed and atmospheric pressure readings that are helpful in forecasting weather conditions. Pilot Reports (PIREPS) are invaluable because they are real time reports on the weather along major flight routes. Lightning Data provides air traffic facilities important information about the location and intensity of thunderstorms.

Weather Roadmap (2 of 2)

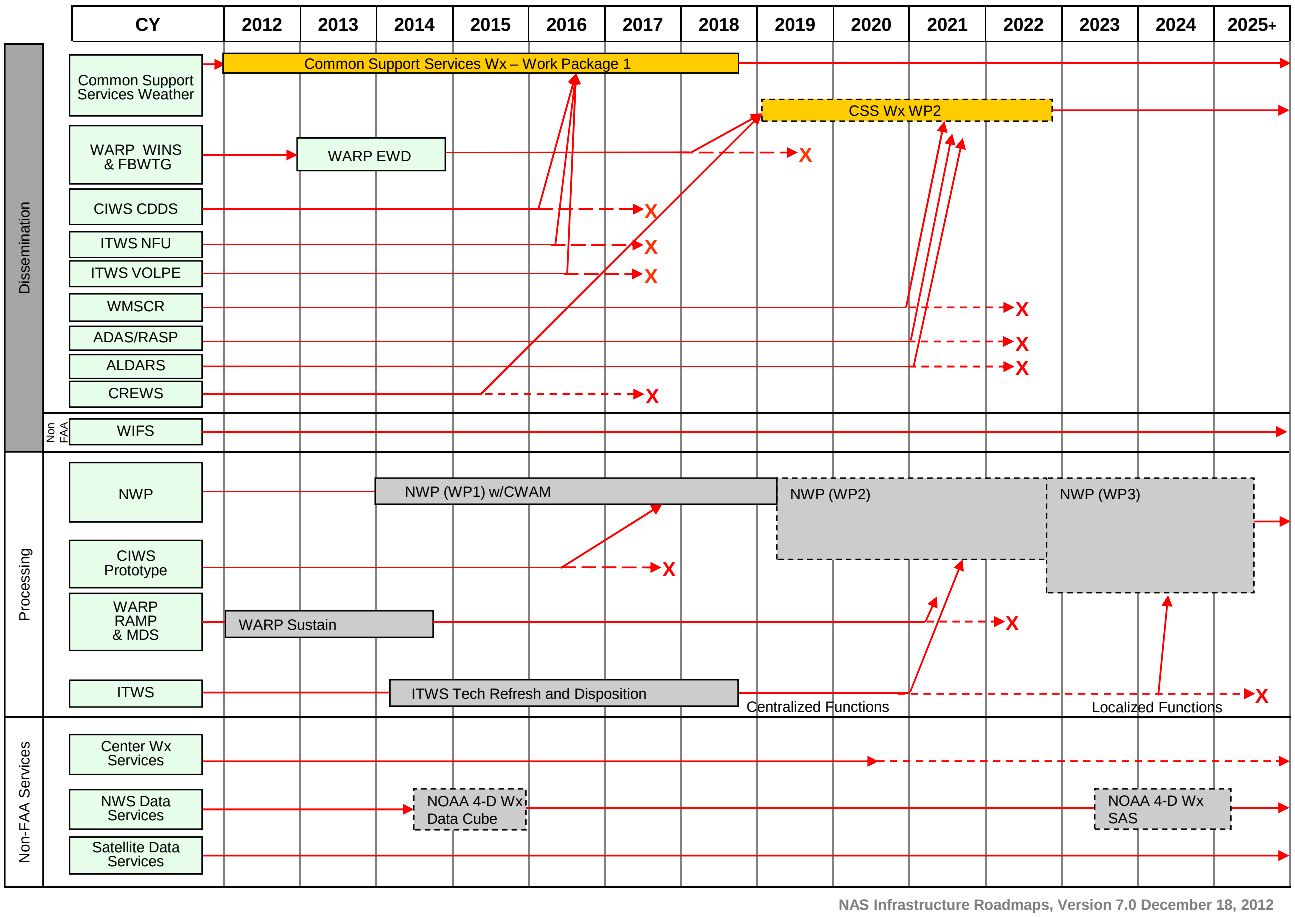

Figure 5-17 Weather Dissemination, Processing, and Display Roadmap

Figure 5-17 shows that NextGen systems will consolidate 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. Common Support Services – Weather (CSS - Wx) which is supported by the SWIM program will be the source for weather information and provide access to all users throughout the NAS. The CCS-Wx program is funded through BLI 2A12C.

Currently, the Weather and Radar Processor Weather Information Network Server (WARP WINS) processes and stores data from multiple NEXRAD radars for en route control facilities to use. 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 WARP FBWTG (FAA Bulk Weather Communications Gateway) provides National Weather service data to the center weather service units to aid in their forecast of weather conditions in the center's airspace. The roadmap shows that WARP will be upgraded with an Enhanced WINS distribution (WARP EWD) before the

WARP functions are incorporated in CSS – Wx. The WARP upgrade program is funded through BLI 2A15.

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 Data Distribution System (CDDS) program enabled the existing CIWS system to distribute data to external NAS users so traffic management participants have the same information for daily route planning.

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. ITWS has been installed at 23 airports. 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. The ITWS will have two enhancements. The National Weather Service Filter Unit (ITWS NFU) will send data collected by FAA to the National Weather Service to use for weather forecasting. The ITWS Volpe will web enable the ITWS weather data for external users.

ITWS will receive technology refresh in the near term, and we will incorporate its weather inputs and processing power into the NextGen Weather Processor by 2018. ITWS is funded through BLI 2B21.

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 FAA will migrate WMSCR functionality into the SWIM Common Support Services for weather information distribution.

The Automated Weather Observation System Data Acquisition System/Regional ADAS Service Processor (ADAS/RASP) 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 Automated Lightning Detection and Reporting System (ALDARS) will become part of the NextGen weather processor after 2018 and its information will be consolidated with other weather inputs.

The Center/TRACON Remote Weather System (CREWS) collects data to help center and terminal facility controllers coordinate the flows of air traffic into busy terminal facilities.

World Area Forecast System (WAFS) Internet File Service (WIFS) is a commercial service that provides the information to support global flight operations.

The NextGen Weather Processor (NWP) 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. The NWP program will enhance the display of weather information by using new algorithms to portray icing conditions, turbulence, and other hazards and ITWS capabilities. Further upgrades of weather-predicting algorithms will also be added to include Wind Shear/Microburst and Wake Vortex Detection and prediction advisories. The WARP RAMP (Radar and mosaic Processor) and MDS (Meteorological Data Server) components which process weather data will remain in service until their functions are incorporated in NWP. The NWP program is funded through BLI 2A20.

The NOAA 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 hosted by the National Weather Service, and FAA will access it as the Single Authoritative Weather Source for all users of the NAS. The Single Authoritative Source (4-D Wx SAS) 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. Integration of the 4-D Weather Cube into the NAS is funded through the CSS-Wx program in BLI 2A12C.

The non-FAA services provide data from the National Weather Service (NWS) ground and satellite sensors to FAA for use by the NWS meteorologist who interpret and forecast weather at the FAA en route centers.

Figure 5-18 shows the future capital investments for weather sensors and weather dissemination and processing systems. Funding amounts are in Millions of Dollars.

BLI Number	Program Name	FY 2014 Budget	FY 2015	FY 2016	FY 2017	FY 2018
	Weather Functional Area	**$46.4**	**$67.3**	**$57.1**	**$61.2**	**$70.4**
2A04	Next Generation Weather Radar (NEXRAD)	$4.1	$7.1	$6.5	$6.3	$5.5
2A15	Weather and Radar Processor (WARP)	$0.7	$0.0	$0.0	$0.0	$0.0
2B02	Terminal Doppler Weather Radar (TDWR) – Provide	$3.6	$0.0	$0.0	$0.0	$0.0
2B21	Integrated Terminal Weather System (ITWS)	$1.3	$4.4	$5.4	$5.0	$3.8
2A14	Windshear Detection Service (WDS)	$2.0	$4.3	$5.2	$4.5	$1.0
2A20	Next Generation Weather Processor (NWP)*	$23.5	$43.3	$30.8	$32.3	$46.6
2C01	Aviation Surface Weather Observation System	$10.0	$8.0	$8.0	$10.0	$10.0
2C04	Weather Camera Program	$1.2	$0.2	$1.1	$3.2	$3.5

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Note: BLI numbers with X represent outyear programs not requested in the FY 2014 President's Budget.

Note: FY 2015-2018 outyear funding amounts are estimates.

Figure 5-18 Funding amounts in the Weather Functional Area

5.6 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 arrival and departure traffic to and from airports.

There are more than 16,000 unstaffed facilities—many in very remote locations—sheltering communications, navigation, surveillance equipment and weather sensors. Much of this equipment is housed in buildings that have exceeded service live 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 hazardous locations near the ocean or on mountaintops. Replacing roofing, electric power generators, heating/cooling, and structural and security components of these structures is essential to successful operation of the NAS. Modernization of unstaffed facilities is funded through BLI 2E02.

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 2014 and beyond to upgrade buildings and supporting infrastructure, such as roads. Annual funding is provided to reconfigure the research laboratories to accommodate acceptance testing for new equipment and to test modifications to existing equipment. The WJHTC is funded through BLI 1A02, 1A03 and 1A04. The MMAC is funded through BLI 3B01 and 4A04.

The Terminal Air Traffic Control Facilities – Replace program includes funding for replacement of exiting airport traffic control towers (ATCT) and TRACON facilities. Projects are funded in five segments and are scheduled based on Agency's priorities. A project typically spans a period of 5-10 years from inception to completion depending on the size of the project. Each segment of a project is fully funded in the year requested but it may take more than one year to complete that segment and costs for that segment may exceed the original estimate. Funding is allocated to the segments based on Agency priorities while maintaining the overall 5 year funding estimates for the program. ATCT/TRACON replace program is funded through BLI 2B06.

The Terminal Air Traffic Control Facilities – Modernize program 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. ATCT/TRACON modernization program is funded through BLI 2B07.

The FAA upgrades and improves Air Route Traffic Control Center (ARTCC) facilities by replacing heating and cooling systems, upgrading electrical power distribution systems, and providing other facility needs to meet mission requirements. ARTCC modernization program is funded through BLI 2A05.

Figure 5-19 shows the future capital investments for facilities programs for the air traffic control system. Funding amounts are in Millions of Dollars.

BLI Number	Program Name	FY 2014 Budget	FY 2015	FY 2016	FY 2017	FY 2018
	Facilities Functional Area	**$472.4**	**$516.9**	**$575.8**	**$594.3**	**$604.2**
1A02	NAS Improvement of System Support Laboratory	$1.0	$1.0	$1.0	$1.0	$1.0
1A03	William J. Hughes Technical Center Facilities	$12.0	$12.0	$12.0	$12.0	$12.0
1A04	William J. Hughes Technical Center Infrastructure Sustainment	$6.0	$8.1	$9.2	$10.3	$10.0
1A13	Next Generation Air Transportation System (NextGen) – System Networked Facilities*	$9.0	$9.0	$10.8	$11.0	$12.0
1A14	Next Generation Air Transportation System (NextGen) – Future Facilities* **	$10.0	$24.7	$61.0	$67.0	$30.0
2A05	ARTCC Building Improvements/Plant Improvements	$53.0	$53.0	$61.0	$63.0	$63.5
2B06	Terminal Air Traffic Control Facilities - Replace	$72.0	$100.0	$100.0	$110.0	$110.0
2B07	ATCT/Terminal Radar Approach Control (TRACON) Facilities - Improve	$53.2	$52.7	$52.7	$53.1	$53.1
2B09	NAS Facilities OSHA and Environmental Standards Compliance	$26.0	$26.0	$26.0	$26.0	$29.0
2C03	Alaska Flight Service Facility Modernization (AFSFM)	$2.9	$2.9	$2.0	$2.0	$2.0
2E01	Fuel Storage Tank Replacement and Monitoring	$8.7	$6.8	$14.0	$14.0	$16.0
2E02	Unstaffed Infrastructure Sustainment	$33.0	$33.0	$33.3	$34.4	$44.4
2E03	Aircraft Related Equipment Program	$10.4	$9.0	$11.4	$9.0	$9.0
2E06	Facilities Decommissioning	$6.5	$5.0	$6.0	$6.0	$10.0
2E07	Electrical Power Systems – Sustain/Support	$85.0	$100.0	$100.0	$100.0	$125.0
2E08	FAA Employee Housing and Life Safety Shelter System Service	$2.5	$0.0	$0.0	$0.0	$0.0
3A01	Hazardous Materials Management	$20.0	$20.0	$20.0	$20.0	$20.0
3A03	Logistics Support Systems and Facilities (LSSF)	$10.0	$1.0	$1.5	$1.1	$1.4
3A05	Facility Security Risk Management	$15.0	$15.1	$15.0	$15.1	$15.1
3A12	National Test Equipment Program	$3.0	$2.0	$4.0	$4.0	$4.0
3A13	Mobile Assets Management Program	$3.0	$4.0	$2.0	$2.0	$3.0
3B01	Aeronautical Center Infrastructure Modernization	$12.3	$13.2	$14.1	$14.0	$14.0
4A04	Mike Monroney Aeronautical Center Leases	$17.9	$18.4	$18.8	$19.3	$19.7

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Note: FY 2015-2018 outyear funding amounts are estimates.

Figure 5-19 Funding amounts in the Facilities Functional Area

6 Conclusion

The capital investment plan shows FAA's commitment to balancing the needs of maintaining legacy facilities and equipment, enhancing redundancy to ensure safety, and investing in the future capabilities of NextGen. Operational improvements that rely on capital investment often take several years after the appropriation of funding to be routinely used, because the complex equipment necessary to support changes needed for operational improvements takes time to develop, build, install, test and then train controllers in its use.

FAA has taken positive steps in implementing NextGen capabilities. The delivery of ADS-B services throughout much the United States is already providing safety and efficiency benefits to operators in, for example, the Gulf of Mexico. The ability to share airport surface information with the airline operators using SWIM has improved the FAA and carriers joint ability to plan for surface operations at congested airports, especially in inclement weather where there are large surface delays and operationally complexity. The expansion of the Time Based Flow Management Capability to more airports and across greater distance assure that the airport capacity is fully utilized with minimum delay cost for the users. The focus on providing a Metroplex approach to the addition of RNP procedures for terminal approach paths coupled with ongoing development of advanced decision tools show both the viability and commitment to the delivery of NextGen concepts. These successes demonstrate that efficiency can be improved with more advanced equipment and procedures. As time progresses, the use of delivery of enhanced procedures coupled with advanced tools will grow and NextGen goals will continue to be met.

In addition to future capacity, efficiency and environmental demand considerations, equipment, facilities and IT systems suffer from normal obsolescence. The computer systems and other technology that FAA uses for air traffic control have an estimated life of 10 to 20 years. Regardless of whether there is growth or decline in air travel, FAA will have to upgrade or replace several system components in the next 5 years. FAA is and will continue to be committed to modernizing the existing air traffic control system and supporting its infrastructure.

7 Appendices

The CIP contains five appendices.

Appendix A

- Lists FAA strategic goals, outcomes, and performance metrics.
- Associates CIP programs with strategic outcomes and performance metrics.

Appendix B

- Provides CIP program descriptions and the alignment of programs to strategic goals.
- Describes the programs contribution to meeting the performance metric.
- Lists performance output goals for FY 2014–2018.
- Shows system implementation schedules.

Appendix C

- Provides funding amounts from FY 2014 through FY 2018 by Budget Line Item (BLI). Funding amounts are in Millions of Dollars.

Appendix D

- Response to GAO Report 08-42 - Identifies major programs with cost and schedule changes from the original baseline and explains the causes of those changes.

Appendix E

- Defines acronyms and abbreviations.