NATIONAL AIRSPACE SYSTEM CAPITAL INVESTMENT PLAN

FY2019–2023

Produced by FAA Communications • 2018-AJG-086

Federal Aviation Administration

Administrator's Preface:

The National Airspace System (NAS) Capital Investment Plan (CIP) identifies and describes the program content and plans for FAA's capital programs for a five-year period beginning from the most recent President's Budget submission to Congress. Capital programs are those that receive funding through the Facilities and Equipment (F&E) appropriation. Each year, the FAA updates the five year CIP to match the planned F&E funding targets issued by the Office of Management and Budget (OMB). In consideration of the OMB targets, progress made by each CIP program, current priorities, and other considerations, the agency adjusts planned funding for the programs to ensure the CIP continues to meet both near and long-term objectives for the NAS.

The FAA capital programs are vital to modernization of NAS infrastructure and the development, acquisition, and implementation of new systems, services, and capabilities. For FY 2019-2023, the CIP includes a balanced portfolio for continuing the implementation of the Next Generation Air Transportation System (NextGen) and modernization of the NAS. As new systems and services are developed, they must comply with all FAA reliability and safety requirements before they can become operational in the NAS.

The CIP includes capital programs to improve data collection, analysis, and reporting of daily operations; the management of airport surface traffic; the automation of routine communications between controllers and pilots; and identification of accident risks and causes towards proactively preventing incidents before they occur.

This Overview provides summary level information on FAA's major capital programs included in the FY 2019-2023 CIP. The world-class services provided by the NAS support the continued growth of U.S. aviation and related services that collectively contribute more than five percent annually to the U.S. Gross Domestic Product. As NextGen deployment in the NAS continues, new capabilities will improve efficiency by reducing delays while supporting safety and delivering additional benefits to aviation service providers and their customers. The systems and traffic management capabilities delivered by CIP programs will ensure the FAA is able to meet increasing demand for NAS services while continuing to provide a level of safety that is unmatched in the world today.

Sincerely,

Dan Elwell,
Acting Administrator

Table of Contents

List of Figures and Tables:

Federal Aviation Administration – National Airspace System Capital Investment Plan for Fiscal Years 2019-2023

1 Capital Investment Plan Overview

The Federal Aviation Administration (FAA) National Airspace System (NAS) Capital Investment Plan (CIP) identifies and describes the capital investments required to sustain and modernize the infrastructure, systems, and services required for the safe and efficient operation of the NAS.

Funding for the capital programs in the CIP is constrained to the Facilities and Equipment (F&E) dollars requested in the FY 2019 President's Budget and outyear F&E targets for the following four years. The Office of Management and Budget (OMB) issues new F&E targets annually to the FAA. The table in Section 8 provides estimated funding by Budget Line Item (BLI) as requested in the FY 2019 President's budget. BLI references are provided for programs in the CIP overview so that the source of planned funding can be identified from the table in section 8. Note that BLIs may contain funding for more than one program and requested amounts for individual programs are available after the budget is published.

The FY 2019-2023 CIP includes brief descriptions of the Next Generation Air Transportation System (NextGen) Operational Improvements (OIs) and Current Operations (COs) in Section 4 and all systems and programs that appear on the NAS Enterprise Architecture Roadmaps (EA) in Section 5. The CIP Overview has been reorganized to provide information on key NAS programs and services of interest to the aviation community. The CIP Overview and previous versions of the CIP are available on-line at http://www.faa.gov/air_traffic/publications/cip/.

1.1 Statutory Requirements

The following statutes prescribe the requirements for the annual publication of the CIP.

1. The Consolidated Appropriations Act, 2018 became Public Law 115-141 on March 23, 2018 and provides the appropriation amounts and other direction for the Federal Aviation Administration within DIVISION L—TRANSPORTATION, HOUSING AND URBAN DEVELOPMENT, AND RELATED AGENCIES APPROPRIATIONS ACT, 2018 under Title I—Department of Transportation. For FAA's Facilities and Equipment appropriation, the following direction is provided regarding the Five Year Capital Investment Plan for the National Airspace System for FY 2019-2023: "Provided further, That no later than March 31, the Secretary of Transportation shall transmit to the Congress an investment plan for the Federal Aviation Administration which includes funding for each budget line item for fiscal years 2019 through 2023, 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."

2. 49 U.S. Code, section 44501 Plans and Policy, requires FAA to prepare and publish a national airways system plan that reads: "The Administrator of the Federal Aviation Administration shall review, revise, and publish a national airways system plan, known as the Airway Capital Investment Plan, before the beginning of each fiscal year."
   The plan shall set forth—
   (1) for a 10-year period, the research, engineering, and development programs and the facilities and equipment that the Administrator considers necessary for a system of airways, air traffic services, and navigation aids that will—
      (A) meet the forecasted needs of civil aeronautics;
      (B) meet the requirements that the Secretary of Defense establishes for the support of the national defense; and
      (C) provide the highest degree of safety in air commerce.
      Etc.

In compliance with the requirements of P.L. 115-141 cited above, an Abbreviated CIP consisting of an introduction; planned funding for each CIP program by BLI for FY 2019-2023; and a current status of the major CIP programs was included in the FAA's FY 2019 President's Budget submission to Congress in February of 2018.

The CIP Overview provides a brief summary of each system and program shown on the NAS Enterprise Architecture Roadmaps that provide a 10 or more-year view for each system, or program, as applicable, in compliance with section 44501 of 49 USC referenced above.

The CIP is an integral part of the FAA's near, mid, and long-term planning and budgeting process. Specifically, the most recent CIP program descriptions are used as the basis for the F&E programs formulation request for the following budget year. For example, the program descriptions from the previous FY 2018-2022 CIP became the baseline for requested funding changes in the FY 2019 budget formulation process and in the development of the FY 2019-2023 CIP. This integration ensures the consistency of the capital program information contained in the President's Budget request with that of the associated CIP.

The multi-year view of the CIP also helps to define the expected lead times for program acquisition planning including investment analysis, preparation of required documentation, and a proposed schedule for investment decision briefings to the Joint Resources Council (JRC) as required by FAA's Acquisition Management System (AMS). Some typical JRC investment decision milestones include Concept Requirements Definition Readiness Decision (CRDRD), Investment Analysis Readiness Decision (IARD), Initial Investment Decision (IID), and Final Investment Decision (FID). The resulting planning and investment decisions help interdependent CIP programs to appropriately plan and schedule the approval, acquisition, and deployment of related systems, equipment, or capabilities for the NAS.

The CIP development process also supports updating of the NAS Enterprise Architecture (EA) roadmaps by ensuring that program information shown on the roadmaps in section 5 is consistent with the information in both the President's Budget and the CIP.

1.2 The Joint Resources Council (JRC)

In accordance with the AMS, the JRC is responsible for approval of all acquisition programs. The JRC consists of senior level representatives from FAA's lines of business and provides executive level review, approval, and oversight of the F&E programs included in the CIP. The JRC responsibilities related to the CIP programs include:

- Approval of the FAA investment portfolio each year as part of the F&E budget submission process;
- Annual review and approval of the FAA's Enterprise Architecture Roadmaps;
- Review and approve program requests for investment decisions such as CRDRD, IARD, IID, and FID, and oversees the execution and reporting of acquisition programs;
- Approves and establishes baselines for all required AMS program documents including the program requirements document, acquisition program baseline, business case, and the implementation strategy and planning document;
- Makes acquisition program baseline change decisions that alter program performance, cost, and schedule baselines during solution implementation for investment programs;
- Conducts quarterly acquisition program reviews to manage ongoing investment programs, including operational assets.

1.3 Strategic Priorities and the CIP

In 2014, the former FAA Administrator defined four strategic priorities for the agency and established a "vision" to "transform the aviation system to reflect the highest standards of safety and efficiency and be a model for the world." The CIP continues to utilize these strategic priorities until such time that new long term 'goals' are established. The existing four strategic priorities for the agency are as follow:

- **Make aviation safer and smarter** – There is an imperative to be smarter about how FAA ensures aviation safety because the aviation industry is growing more complex. At the same time, FAA has more safety data than we have ever had before. This provides an opportunity to be more proactive about safety and constantly raise the bar.

- **Deliver benefits through technology and infrastructure** – The NextGen gives FAA the opportunity to redefine the National Airspace System for the future and prove that benefits can be delivered to the users of the system. FAA also needs to safely integrate new types of user technologies into the airspace, as well as rebalance existing services and modernize our infrastructure, which will enable us to reduce our costs and become more efficient in the long run.

- **Enhance global leadership** – Aviation is a global industry. FAA has to continue to be a world leader in aviation and set the safety standard for others to measure against. FAA needs to be at the table to shape international standards to improve aviation safety and efficiency around the world.

- **Empower and innovate with the FAA's people** – The FAA's employees are the ultimate driver behind its success, and FAA needs the best and brightest talent with the appropriate leadership and technical skills to transform the FAA and the aviation system as a whole.

The FAA Strategic Priorities help guide the selection of the capital programs to be included in the CIP that support sustainment and modernization of the NAS to meet these priorities. The FAA Strategic Priorities support the Department of Transportation's (DOT) Strategic Plan.

2 Key Considerations in Capital Planning

Building a balanced portfolio of capital investments to sustain and modernize the NAS requires significant time to develop, plan, and prioritize program outcomes. Proposed capital investments must include a lifecycle cost and schedule in accordance with AMS policy for review and approval by the JRC to request F&E funding through the Congressional budget process. To be successful, program offices require sufficient funding and personnel to fully define their requirements; identify interdependencies with other programs; complete business case development and investment analysis; and manage program risk during execution to deliver planned outcomes on schedule. Before receiving approval to operate in the NAS, new systems must also demonstrate compliance with FAA reliability and safety standards.

Addressing real-time changes in air traffic demand and anticipated future growth may require increases in available NAS capacity, efficiency, predictability, and system flexibility. Additional considerations in capital planning may include: periodic changes in economic conditions; schedules of ongoing capacity expansion projects at major airports; and sustainment needs for mission critical ATC systems, facilities, and other NAS infrastructure. By statute, each year of the CIP must balance to the most recent F&E funding target for that year as issued to FAA by OMB. In the CIP development process, the JRC allocates the F&E targets for each year between capital programs that support the agency's strategic priorities, ongoing development and deployment of NextGen and those that sustain and modernize legacy ATC systems and NAS infrastructure to maintain current NAS performance and safety standards throughout the transition to NextGen.

2.1 Economic Considerations

Access to a reliable worldwide aviation network is essential to the health of the U.S. economy. Both domestic and international commerce rely heavily on ready access to aviation services for carrying passengers and freight to the cities around the world to help sustain economic growth. According to the most recent report on *The Economic Impact of Civil Aviation on the U.S. Economy*[1], published in November 2016 by the Office of Performance Analysis, economic activity attributed to civil aviation-related goods and services during 2014 totaled $1.6 trillion,

[1] Sources: Air Traffic Organization, Office of Performance Analysis, "The Impact of Civil Aviation on the U.S. Economy," November 2016; Matthew Russell, "Economic Productivity in the Air Transportation Industry: Multifactor and Labor Productivity Trends, 1990-2014," *Monthly Labor Review*, March 2017.

generating 10.6 million jobs, and $447 billion in earnings. This biennial report is available at http://www.faa.gov/air_traffic/publications/media/2016-economic-impact-report_FINAL.pdf.

In total, U.S. aviation contributed 5.1 percent to the U.S. Gross Domestic Product (GDP). Other significant aviation related economic activity cited in the November 2016 report includes:

- Air carriers operating in U.S. airspace transported 871.8 million passengers with over 1,230.8 billion Revenue Passenger Miles (RPM).
- In support of commercial activities, more than 64.1 billion revenue ton-miles of freight passed through U.S. airports.
- It is estimated that commercial airline operations enabled $310 billion of visitor expenditures on goods and services.
- Civil aircraft manufacturing, a top U.S. net exporter, had a positive trade balance of $59.9 billion.

New research on air transportation productivity reveals that the industry has an outsized impact on U.S. productivity relative to its size.

2.2 Air Travel Demand

Historically, the demand for air travel is heavily influenced by changes in the economy. Figure 2-1 depicts the total percentage change in RPM and GDP (in constant 2009 dollars) since 1977. Over the last 38 years, passenger demand for air travel (RPM) has grown at a faster rate than the economy (GDP) as shown below.

Total Percent Growth in RPM and GDP Since 1977

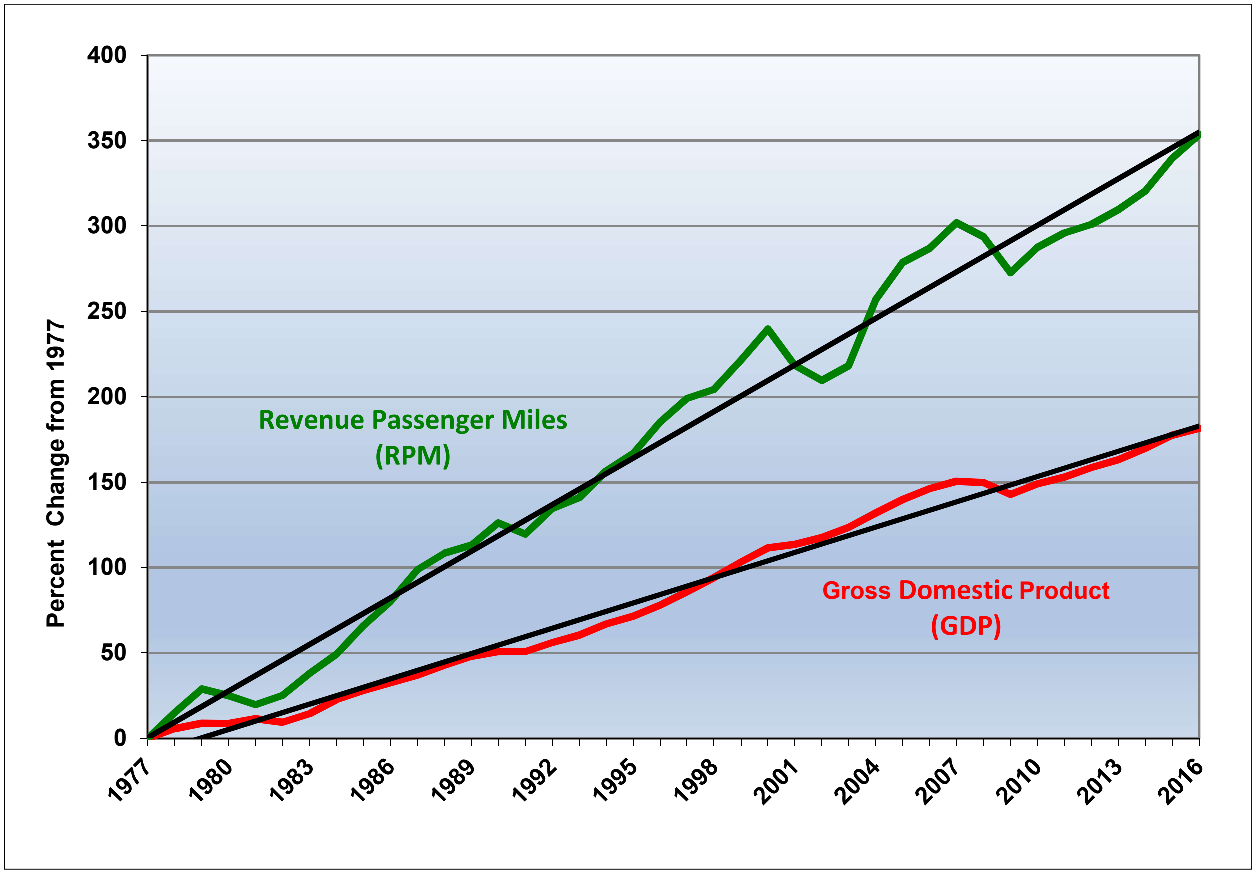

Figure 2-1 Air Travel Demand Relative to GDP[2]

The U.S. inflation-adjusted, i.e., real, economic output long-term growth trend supports the continuing increases in air travel. Recent economic data shows that GDP is continuing to grow and the trend lines in figure 2-1 suggest there continues to be a corresponding increase in the demand for air travel, as measured by RPM.

According to the latest *FAA Aerospace Forecast for Fiscal Years 2017-2037,* available for review at http://www.faa.gov/data_research/aviation/aerospace_forecasts/, overall system RPMs are projected to increase by 2.4 percent a year from fiscal year 2017 to 2037. During this period, U.S. carrier passenger traffic is projected to grow by 1.9 percent a year and commercial operations by 1.5 percent a year. The difference in the forecast increase for U.S. passenger traffic compared to commercial operations will be accommodated through larger aircraft with more seats per aircraft mile and higher load factors.

[2] Sources: U.S. Department of Commerce, Bureau of Economic Analysis and U.S. Department of Transportation, Bureau of Transportation Statistics.

2.3 Airport Expansion Projects

Enhancing capacity and efficiency at large, congested airports is critical to overall NAS performance because delays at the large hub airports often propagate to other airports throughout the system. The 30 large hub airports handle about 73 percent of airline enplanements. The combined total of the 60 large and medium hubs support about 88 percent of all U.S. passenger enplanements.[3] Delays at large and medium hubs affect a significant number of passengers waiting to depart, as well as passengers waiting to board aircraft at the delayed flight's destination.

Additional F&E investments are often required when airport authorities, in coordination with the FAA, build new, extended, or realigned runways to enhance safety, capacity, and/or efficiency. New charted flight procedures are normally needed to achieve full utilization of new runway infrastructure. Approach lights and visibility sensors must be positioned to ensure reliable access during inclement weather conditions to runways that have a precision approach capability. Airspace sectors around the airports may need to be reconfigured to accommodate new approach and departure patterns. Upgraded surveillance systems may be needed to cover the new departure and approach patterns, as well as expanded surface movement areas. Additional controller positions may also be needed to manage reconfigured surface traffic. In some cases, air traffic control facilities, such as control towers, must be relocated to support new or relocated airport infrastructure. The development of new or reconfigured airfield infrastructure may also require additional F&E investments to maintain safe and efficient operations at the airport.

Examples of some recent airport expansion and improvement projects include:

- In 2018, Philadelphia International Airport completed an extension of Runway 9R/27L to 12,000 feet. This will enable the airport to accommodate larger aircraft for long-haul international routes.

- Chicago O'Hare International Airport continues construction of Runway 9C/27C. Part of the airport's overall modernization plan, this will be the airport's sixth parallel runway. The airport expects to commission the runway in 2020.

2.4 Sustaining and Improving Infrastructure and System Performance

The air traffic control system requires reliability and availability to maintain safe separation of aircraft operating in controlled airspace and on the airport surface. To ensure safe separation reliable communication, navigation, and surveillance systems are required. Each system operating in the NAS has a high degree of redundancy to support system reliability and availability to minimize risk of service disruptions. Before these systems reach the end of their service life, planning for their replacement must be well underway to reduce the risk of performance degradation or outages in the event that replacement parts become obsolete or are otherwise difficult to obtain.

[3] Source: FAA Office of Airport Planning and Programming

The air traffic control infrastructure is a complex system made up of several thousand components that control air traffic approaching, landing, and departing from airports. This includes 21 Air Route Traffic Control Centers (ARTCC), over 500 Air Traffic Control Towers (ATCT), and 157 Terminal Radar Approach Control (TRACON) facilities. This daily flow of air traffic is dependent upon several hundred surveillance and weather radars, navigation systems for en route and airport approach guidance, and thousands of radios that allow pilots and air traffic controllers to be in continuous contact during an aircraft's flight.

NextGen will incrementally replace and upgrade much of this equipment as new technologies and procedures are introduced to improve efficiency in air traffic control. Some legacy equipment, such as communication and surveillance systems must remain in operation to supplement or backup NextGen capabilities. Many current buildings that house existing ATC equipment will also be needed for NextGen systems. To sustain the high level of NAS reliability and availability required to ensure the safety and efficiency of flight, continued investment in the sustainment and improvement of these buildings and other legacy infrastructure is required.

As of February 2018, the air traffic control infrastructure had a sustainment backlog estimated at approximately $4.0 billion in unfunded requirements to sustain its facilities. Goals, objectives, strategies, processes, and priorities have been established to address this challenge. Nine systemic issues have been identified across the Air Traffic Organization (ATO) that include Fire Life Safety, Fall Protection, Guyed Towers, Arc Flash, Power Cable, Engine Generators, Fuel Storage Tanks, ARTCC Chiller replacement, and ARTCC Critical Essential Power System replacement. As requested in the FY 2019 President's Budget, the ATC Facilities Sustainment Strategic Plan focuses on the following budget line items for sustaining the NAS infrastructure:

- ARTCC & Combined Control Facility (CCF) Building Improvements, BLI 2A04;
- Air Traffic Control En Route Radar Facilities Improvements, BLI 2A07;
- Terminal Air Traffic Control Facilities – Replace, BLI 2B05;
- ATCT / TRACON Facilities – Improve, BLI 2B06;
- NAS Facilities OSHA and Environmental Standards Compliance, BLI 2B08;
- Fuel Storage Tank Replacement and Management, BLI 2E01;
- Unstaffed Infrastructure Sustainment, BLI 2E02;
- Facilities Decommissioning, BLI 2E06;
- Electrical Power Systems – Sustain/Support, BLI 2E07;
- Energy Management and Compliance (EMC), BLI 2E08;
- Hazardous Materials Management, BLI 3A01;
- Facility Security Risk Management, BLI 3A04; and
- Mobile Assets Management Program, BLI 3A11.

In addition to air traffic control infrastructure, the FAA has several other facilities that support the NAS. The Mike Monroney Aeronautical Center (MMAC) includes facility space used for Air Operations, Engineering, Training (Radar/Navigational Aids (Navaids)), NAS Logistics, Airmen/Aircraft registration, Civil Aeromedical Institute (CAMI), Safety, and Business Services.

The William J. Hughes Technical Center (WJHTC) supports research, test and evaluation of safety systems and new equipment. The infrastructure at these locations requires building system and telecommunications replacement.

Key investments in air traffic control systems that support the current and future operation of the NAS are:

- **En Route Automation –** The En Route Automation Modernization (ERAM) platform requires technology refresh to replace a large subset of system equipment that is near the end of its service life;
- **Terminal Automation –** Older Standard Terminal Automation Replacement Systems (STARS) have reached their end-of-life and key components must be replaced to maintain the operation of the systems;
- **Navigation/Landing –** The Wide Area Augmentation System (WAAS) program will continue to augment the Global Positioning System (GPS) to support the implementation of improved procedures that are dependent on satellite navigation capabilities. Aging Instrument Landing Systems (ILSs) and other Navaids will be replaced if systems become unsupportable due to parts obsolescence; and
- **Surveillance/Weather –** Modernization of en route, and terminal primary and secondary surveillance radars will upgrade or replace older, unsupportable systems. Weather sensing and processing equipment will also be modernized.

More details on these programs and systems are provided in section 5, Enterprise Architecture Infrastructure Roadmaps.

2.5 Planning for the Future through NextGen Investments

NextGen is the ongoing transformation of the NAS to ensure that the FAA will meet future capacity, safety, and environmental requirements and is supported by many capital programs. By combining new technologies for surveillance, navigation, and communications with automation system enhancements, workforce training, procedural changes, and airfield development, NextGen will fundamentally change the way air traffic is managed. These improvements will also facilitate the integration into the NAS of operations involving commercial space and unmanned aircraft systems.

NextGen advances will enable precise monitoring of aircraft both on the ground and in flight; optimize routes for travel between cities; improve decision support to strategically manage traffic flows on busy routes; and leverage precision navigation to improve utilization of existing airspace and runway capacity. More information concerning the vision, benefits, and implementation details and can be found in the *NextGen Implementation Plan* which is available for review at http://www.faa.gov/nextgen/library/.

NextGen is already delivering benefits and with planned funding, will focus on the full delivery of remaining base infrastructure. The addition of new applications will deliver increased capacity and efficiency and provide greater access and flexibility for users to choose route options that best meet their needs. Major initiatives are now focusing on transforming the NAS to Trajectory Based Operations (TBO) and on integrating new entrants, i.e., commercial space and unmanned aircraft systems.

TBO is an Air Traffic Management (ATM) method for strategically planning, managing, and optimizing flights throughout the operation by using time-based management, information exchange between air and ground systems, and the aircraft's ability to fly precise paths in time and space. It leverages significant NextGen investments already made in Performance-Based Navigation (PBN), surveillance, communications, and automation systems for decision support, flight data management, and information sharing. The vision for TBO will be accomplished through improved ATM strategic planning initiatives along with the predominant use of time-based management using precise and repeatable paths defined by PBN procedures and routings.

NextGen programs that will support or deliver future Operational Improvements (OI) are:

- **En Route Automation Modernization (ERAM) –** ERAM Enhancements 2 and 3 include improvements in separation management, trajectory prediction, and human interface capabilities to improve the delivery of air traffic services today and to continue the evolution of NextGen trajectory-based operations (BLI 2A01);
- **System Wide Information Management (SWIM)** – SWIM provides the standards, hardware and software to enable information management and data sharing required to support NextGen and provides for additional infrastructure and capabilities to strengthen the overall NAS information system security posture (BLI 2A11);
- **Automatic Dependent Surveillance – Broadcast (ADS-B) NAS Wide Implementation (ADS-B)** – ADS-B provides more accurate and timely surveillance data needed to allow direct routing and conflict free routes and supports services that provide ADS-B surveillance data for aircraft operating in a large area without access to traditional radar coverage (BLI 2A12);
- **Collaborative Air Traffic Management Technologies (CATMT) –** CATMT Work Package 4 (WP4) and WP5 will improve the demand predictions used by Traffic Flow Management System (TFMS) to determine whether there is sufficient NAS resource capacity, as well as provide controller tools to assist with routing departures given convective weather and traffic volume constraints (BLI 2A13);
- **Time Based Flow Management (TBFM) –** TBFM WP3 focuses on expanding the airspace in which controllers can use the Integrated Departure/Arrival Capability (IDAC) and implementing Terminal Sequencing and Spacing (TSAS) to provide efficient sequencing and runway assignment. TBFM WP4 will deliver additional benefits of time-based metering across the NAS (BLI 2A14);
- **NextGen Weather Processor (NWP) –** This program will establish a common weather processing platform which will provide improved weather products and support more efficient operations and replace the legacy FAA weather processor systems (BLI 2A15);
- **Data Communications in support of NextGen** – Data Comm provides data link communications between controller and pilot to facilitate information transfer, reduce workload, and minimize potential errors in communication of flight plan adjustments (BLI 2A17);
- **National Airspace System Voice System (NVS)** – NVS 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 (BLI 2B12);

- **Terminal Flight Data Manager (TFDM)** – TFDM is the surface management solution for NextGen. TFDM will deliver NextGen decision support capabilities for the airport surface, integrating flight, surface surveillance, and traffic management information in order to improve operational predictability and efficiency at airports (BLI 2B16); and
- **Aeronautical Information Management (AIM) Programs –** AIM provides digital aeronautical information to NAS users. Future AIM Segments will incorporate additional types of aeronautical information in a digital format for machine-to-machine exchange with NAS automation systems (BLI 4A09).

3 Aviation Safety

The Aviation Safety (AVS) organization sets, oversees, and enforces safety standards for all parts of the aviation industry affecting every facet of domestic and international civil aviation safety. AVS is responsible for the certification, production approval, and continued airworthiness of aircraft and avionics as well as the certification of pilots, mechanics, and others in safety-related positions.

Capital investments that support Aviation Safety are:

Regulation and Certification Infrastructure for System Safety (RCISS) provides Information Technology (IT) infrastructure that includes automation hardware, software, and communication components which support AVS safety data and applications. The RCISS Sustainment 3, A17.02-03, program (BLI 3A02) will perform technology refresh on the AVS IT infrastructure, enhance delivery of IT infrastructure services, and invest in Cloud-based solutions to provide the safety workforce with access to data and applications that is secure, reliable, and cost-effective.

The RCISS Sustainment 4, A17.01-04, program (BLI 3A02) will continue the technology refresh of the AVS IT infrastructure and enhance delivery of IT infrastructure services. RCISS Sustainment 4 will maximize AVS safety application flexibility, scalability, and financial efficiency by targeting opportunities and enabling a greater proportion of applications to be hosted in the cloud. The program is working towards a FID.

System Approach for Safety Oversight (SASO) improves, automates, and standardizes the FAA's Flight Standards Service (AFS) safety oversight and inspection processes by implementing the International Civil Aviation Organization (ICAO) Safety Management System (SMS). Within AFS, SMS consists of four primary components; Safety Assurance, Safety Risk Management, Safety Policy, and Safety Promotion. SASO – Phase 3, A25.02-02, program (BLI 3A06) will expand Safety Assurance System (SAS) functionality to oversight of an additional 6,500 certificate holders for a total of over 13,500 certificates across the NAS. It will include SAS development for the following Title 14 Code of Federal Regulations (CFR) Parts: 141 (Pilot Training), 142 (Training Centers), 147 (Aviation Maintenance Technical Schools), and an interface to 183 (Designee Management System).

The SASO – Phase 4, A25.02-03, program (BLI 3A06) will continue the development and expansion of SAS functionality by incorporating additional Title 14 CFR parts into its SMS-based oversight list and will continue to expand and enhance risk profiling models; expand avenues for outreach to the general aviation community; and extend safety policy to bring SMS to the full range of FAA Flight Standards Service oversight activities. The program is working towards a FID.

Aviation Safety Knowledge Management Environment (ASKME) is a suite of functional components designed to support and enable the FAA Aircraft Certification Service (AIR) to more efficiently certify new aircraft and modifications to existing aircraft. The ASKME – Phase 2, A25.01-01, program (BLI 3A07) will provide a comprehensive automated system and a suite of electronic tools for capturing key safety related data resulting from rulemaking and policy development, airworthiness directives, engineering design certification, production/ manufacturing certification, airworthiness certification, and compliance and enforcement.

The ASKME – Enhancement 1, A26.01-02, program (BLI 3A07) will include a Business Process Re-engineering effort to document, update, and streamline business processes, following the planned re-organization of the AIR. Enhancements will also include updates to the underlying technology, integration with non-ASKME systems that will deploy after FY 2019, and end-user-generated requests. The program is working towards a FID.

The Aerospace Medical Equipment Needs (AMEN) Sustainment 3, M53.01-03, program (BLI 3A08) includes the replacement of 65 critical and highly technical pieces of specialized equipment used by Civil Aerospace Medical Institute's (CAMI) scientists, physicians, educators, and engineers. The equipment supports the operations, research, and education performed by four CAMI divisions: Medical Education, Human Factors Research, Aeromedical Research, and Research Support and Occupational Health. The program is working towards a FID.

The Wind & Wave Evacuation and Survival (WiWAVES) Phase 1, M53.02-01, program (BLI 3A08) will provide for the replacement of CAMI's aging Water Survival Research Facility (WSRF), an Aerospace Medical Division laboratory asset, originally installed in 1967 and last renovated in 1983. The program is working towards a FID.

The Aerospace Medicine Safety Information System (AMSIS) – Phase 1, A35.01-01, program (BLI 3A12) will develop a new aerospace medical information network that integrates critical medical information associated with pilots, air traffic controllers, and other aviation related personnel. AMSIS will provide the tools necessary to analyze and verify information to make risk-based policy decisions through an automated method of collecting, reviewing, and analyzing medical information.

BLI #	CIP Title	CIP #
3A02	Regulation and Certification Infrastructure for System Safety (RCISS) – Sustainment 3	A17.01-03
3A02	Regulation and Certification Infrastructure for System Safety (RCISS) – Sustainment 4	A17.01-04
3A06	System Approach for Safety Oversight (SASO) – Phase 3	A25.02-02
3A06	System Approach for Safety Oversight (SASO) – Phase 4	A25.02-03
3A07	Aviation Safety Knowledge Management Environment (ASKME) – Phase 2	A26.01-01
3A07	Aviation Safety Knowledge Management Environment (ASKME) – Enhancement 1	A26.01-02
3A08	Aerospace Medical Equipment Needs (AMEN) – Sustainment 3	M53.01-03
3A08	Wind & Wave Evacuation Survival Facility (WIWAVES) – Phase 1	M53.02-01
3A12	Aerospace Medicine Safety Information System (AMSIS) – Phase 1	A35.01-01

Table 3-1 Aviation Safety Programs

4 NextGen Operational Improvements and Current Operations Supported by Budget Portfolios

Planning the future systems architecture of the air traffic control system requires establishing performance goals for the NAS improvements to be achieved. These goals are defined by the Operational Improvements (OIs) that describe specific operational performance enhancements to be realized through the NextGen investments. OIs in operation are designated as Current Operations (COs). The table that follows lists the NextGen OIs and COs and shows the corresponding NextGen portfolios and Budget Line Items (BLIs) from which these investments will be made. The OIs and COs included in this section are targeted for development and implementation within the FY 2019-2023 timeframe.

The NextGen concept development and implementation work is focused on expanding and realizing NextGen through the development and implementation of NextGen OIs and COs. The OIs and COs will deliver improved services to users by seamlessly integrating data to ensure that the FAA and its stakeholders have a common understanding of the NAS status, both now and in the future, by improving strategic planning, increasing flexibility, and by meeting new challenges such as incorporating new entrants into the NAS and cybersecurity.

4.1 Relationship of Operational Improvements and Current Operations to NextGen Portfolios and Budget Line Items

The table below shows the relationship between each OI, CO, and the corresponding NextGen portfolios and FY 2019 BLIs. The NextGen Portfolios are identified across the top of the table with their FY 2019 BLI number shown in parenthesis. On the left side of the table are the OI and CO numbers and titles. OIs already in operation are designated by (CO) following their title. The check marks to the right of each OI or CO denote the portfolios that the development or implementation work contributes too. A description of each OI and CO is provided in section 4.2 following the table on the next page. In section 4.3, a description of each development portfolio is provided.

For information on the implementation portfolios, Collaborative Air Traffic Management Technologies (CATMT), Time-Based Flow Management (TBFM), and Terminal Flight Data Manager (TFDM), please refer to the Enterprise Architecture Infrastructure Automation Roadmaps in Section 5.1; for CATMT and TBFM, see section 5.1.1 Air Traffic Management and Air Traffic Control; for TFDM, see section 5.1.2 – Air Traffic Support and Oceanic Air Traffic Control.

NextGen Operational Improvements (OIs) by Portfolio & Budget Line Item

OI Number	OI Title	Separation Management (1A04)	Traffic Flow Management (1A05)	On-Demand NAS (A106)	NAS Infrastructure (1A07)	Unmanned Aircraft Systems (1A09)	Enterprise Concept Development, Human Factors, & Demonstrations (1A10)	Collaborative Air Traffic Management Technologies (2A13)	Time-Based Flow Management (2A14)	Terminal Flight Data Manager (2B16)	Performance–Based Navigation & Metroplex (2B19)	System Safety Management (3A09)
101102	Provide Automated Flight Plan Constraint Evaluation with Feedback		✓					✓				
101103	Provide Flight Plan Evaluation and Feedback in all Phases of Flight		✓					✓				
101202	Flight Management with Trajectory			✓	✓	✓						
101203	UAS Flight Information					✓						
102105	Current Oceanic Separation (CO)	✓										
102112	Current En Route Separation (CO)					✓						
102118	Relative Spacing Using Interval Management	✓										
102137	Automation Support for Separation Management	✓					✓					
102138	Enhanced Non-Federal Advisory and Sequencing Services for Class D		✓									
102146	Improved Aircraft Trajectories	✓										
102152	Dynamic, Pair-wise Wake Turbulence Separation	✓										
102154	Wake Re-Categorization	✓										
102157	Improved Parallel Runway Operations with Airborne Applications	✓										
102158	Automated Support for Initial Trajectory Negotiation				✓							
102159	CSPR Paired Departure Wake Mitigation	✓										
102160	Advanced Automation Support for Separation Management	✓										
102161	Improved Parallel Runway Operations Departures	✓										

OI Number	OI Title	Separation Management (1A04)	Traffic Flow Management (1A05)	On-Demand NAS (A106)	NAS Infrastructure (1A07)	Unmanned Aircraft Systems (1A09)	Enterprise Concept Development, Human Factors, & Demonstrations (1A10)	Collaborative Air Traffic Management Technologies (2A13)	Time-Based Flow Management (2A14)	Terminal Flight Data Manager (2B16)	Performance–Based Navigation & Metroplex (2B19)	System Safety Management (3A09)
103119	Initial Integration of Weather Information into NAS Automation and Decision Making				✓							
103123	Full Integration of Weather Information into NAS Automation and Decision Making				✓							
103210	Aircraft Collision Avoidance for New Aircraft Types				✓							
103305	On-Demand NAS Information			✓								
103306	Tailored Delivery of On-Demand NAS Information			✓	✓							
104102	Optimized Oceanic Trajectories via Interactive Planning	✓	✓					✓				
104104	Initial Conflict Probe Improvements	✓										
104115	Current Tactical Management of Flow in En Route for Arrivals and Departures			✓								
104117	Improved Management of Arrival/Surface/Departure Flow Operations		✓						✓	✓		
104120	Point-in-Space Metering		✓					✓				
104122	Integrated Arrival and Departure Airspace Management						✓					
104123	Time-Based Metering Using RNAV and RNP Route Assignments	✓	✓									
104126	Trajectory-Based Management – Gate-to-Gate						✓					
104128	Time-Based Metering in the Terminal Environment		✓						✓	✓		
104206	Full Surface Traffic Management with Conformance Monitoring						✓					
104208	Enhanced Departure Flow Operations		✓									

OI Number	OI Title	Separation Management (1A04)	Traffic Flow Management (1A05)	On-Demand NAS (A106)	NAS Infrastructure (1A07)	Unmanned Aircraft Systems (1A09)	Enterprise Concept Development, Human Factors, & Demonstrations (1A10)	Collaborative Air Traffic Management Technologies (2A13)	Time-Based Flow Management (2A14)	Terminal Flight Data Manager (2B16)	Performance–Based Navigation & Metroplex (2B19)	System Safety Management (3A09)
104211	Surface Traffic Management		✓							✓		
105207	Full Collaborative Decision Making		✓	✓			✓	✓				
105208	Traffic Management Initiatives with Flight-Specific Trajectories		✓				✓	✓				
105303	Advanced Flight Day Evaluation		✓					✓				
107120	Resilient PBN Operations	✓									✓	
108206	Flexible Airspace Management			✓								
108207	Manage Airspace To Flow			✓								
108209	Increase Capacity and Efficiency Using Area Navigation (RNAV) and Required Navigation Performance (RNP)										✓	
108212	Improved Management of Special Activity Airspace (SAA)		✓	✓	✓			✓				
108214	UAS Airspace Access					✓						
108215	Increase Capacity and Efficiency Using Streamlined PBN Services						✓				✓	
601103	Safety Information Sharing and Emergent Trend Detection											✓
601104	Automated Safety Information Sharing and Analysis											✓
601202	Integrated Safety Analysis and Modeling											✓
601302	Increase International Cooperation for Aviation Safety											✓

Table 4-1 NextGen Operational Improvements (OIs) by Portfolio & Budget Line Item

4.2 NextGen Operational Improvement and Current Operation Descriptions

A short description of each of the OIs and COs in table 4.1 are included in this section. Each of the portfolios contributes unique elements to the research, development, and implementation activities required to deliver the operational change. Each OI has a unique six-digit identifier that is included as a reference.

Provide Automated Flight Plan Constraint Evaluation with Feedback, OI: 101102

Timely and accurate NAS information enables users to plan and fly routings that meet their objectives. Constraint information that impacts the proposed route of flight is incorporated into automation and is available to users. Examples of constraint information include special use airspace status, significant meteorological information (SIGMETS), infrastructure outages, and significant congestion event.

Provide Flight Plan Evaluation and Feedback in all Phases of Flight, OI: 101103

Flight planning activities are accomplished from the flight deck as readily as at any other location. Airborne and ground automation provide the capability to exchange flight planning information and negotiate flight trajectory agreement amendments in near real-time.

Flight Management with Trajectory, OI: 101202

Develops and maintains all information about a flight and makes that information available to all decision support tools to improve strategic flight planning and tactical flight management. Flight planning data elements will be updated to incorporate unique flight characteristics for UAS. As reroutes are selected, user preferences assessed, and approved, the trajectory flight data will continue to be updated and made available to subscribers so that both tactical and strategic plans can be developed with the most up to date 4D trajectory of the flight.

UAS Flight Information, OI: 101203

UAS operators provide their intended flight information in the form of a notification or authorization request, depending on their intended flight path. The FAA uses this information to generate advisories regarding where UAS are operating for use by ATC when warranted. The UAS flight information service provides a means to conduct safety oversight such as conduct conformance monitoring that UAS are operating with the constructs of the certificate and investigations into incidents with UAS.

Current Oceanic Separation, CO: 102105

Advanced Surveillance and Enhanced Procedural Separation for the Ocean should allow reduced separation standards in oceanic areas leading to enhanced safety and efficiency benefits. Improvements in oceanic surveillance information through satellite links will enable more frequent position reports in oceanic areas where ground infrastructure is difficult or cost-prohibitive to install.

Current En Route Separation, CO: 102112

Addressing unique requirements for Unmanned Aircraft Systems (UAS) separation will allow for their better integration into the NAS. The seamless integration of communications between pilots-in-command of UAS and air traffic controllers will improve the response time between ATC instructions and UAS pilots. UAS will be able to detect and avoid other aircraft in order to remain well clear which will enable UAS aircraft to operate under flight rules that are similar to visual flight rules for manned aircraft.

Relative Spacing Using Interval Management, OI: 102118

Improved inter-aircraft spacing precision is achieved using new aircraft capabilities, which should increase efficiency and throughput in capacity-constrained airspace without negatively impacting controller workload and task complexity. This will improve overall traffic flow and help avoid some costly, low-altitude maneuvering. This will be used in locations that do not have or are not currently conducting time based flow management.

Automation Support for Separation Management, OI: 102137

Air Navigation Service Provider (ANSP) automation provides the controller with tools to manage aircraft separation in a mixed navigation and wake performance environment. Advances in Performance Based Navigation (PBN) and additional wake separation categories leads to the use of more sophisticated separation rules between aircraft and the need for advisory support to the controller.

Enhanced Non-Federal Advisory and Sequencing Services for Class D Airport Operations, OI: 102138

Improved surveillance, communications, and decision support capabilities used by personnel located in a remote ground level facility may provide a more cost effective solution for providing advisory and sequencing services in class D airspace. This will enable faster confirmation the runway is clear thereby enabling more consistent airport services and additional operations, especially during Instrument Meteorological Conditions (IMC) and enable these services to be provided for more airports across the NAS.

Improved Aircraft Trajectories, OI: 102146

Increased system precision and enhanced automation supports the efficient use of flight levels so that aircraft can more closely fly routes that maximize the airlines' goals of fuel efficiency, aircraft operations, and schedule. Aircraft provide state and intent data that will lead to fewer predicted problems, and as a result, fewer diversions from the preferred routing.

Dynamic, Pair-wise Wake Turbulence Separation, OI: 102152

Wake turbulence separation procedures and applications supporting en route and terminal operations are integrated into air traffic automation to provide dynamic, pairwise, lateral, longitudinal, and vertical wake separation requirements for trajectory management based on aircraft and weather conditions, in real time.

Wake Re-Categorization, OI: 102154

The current set of pairwise wake separation requirements have been updated and expanded based on analysis of wake generation, wake decay and encounter effects for the current fleet of aircraft. These new separation standards are programmed into the automation systems to allow the controllers to use more accurate aircraft separation standards to increase both flight efficiency and runway capacity utilization.

Improved Parallel Runway Operations with Airborne Applications, OI: 102157

Improved flight deck capabilities allow for increased arrival capacity for parallel runway operations in Instrument Meteorological Conditions. Reduced separation for dependent approaches of Closely Spaced Parallel Runways (CSPR) will be enhanced using aircraft avionics that assist pilots in maintaining the required interval from other aircraft. Ground automation identifies opportunities to the controller who can provide a clearance to the flight crew for specific lateral and longitudinal separation distance from other aircraft.

Automated Support for Initial Trajectory Negotiation, OI: 102158

En Route sector capacity and throughput are increased through the ability to send route changes and instructions to the cockpit over data communications. Trajectory management is enhanced by automated assistance to negotiate pilot trajectory change requests with properly equipped aircraft operators.

CSPR Paired Departure Wake Mitigation, OI: 102159

Changes in procedures and standards, and the implementation of new technology, will safely reduce the impact of wake separation standards on airport operations. Changes to wake separation minima implemented at airports with CSPR complexes will increase throughput during departure operations during periods with favorable winds.

Advanced Automation Support for Separation Management, OI: 102160

ANSP automation provides the controller with tools to manage aircraft separation with more advanced wake separation standards and PBN capabilities. Controllers will use ANSP automation enhancements to obtain additional situational awareness to decrease the cognitive workload and increase the operational benefit afforded by more closely spaced routes.

Improved Parallel Runway Operations for Departures, OI: 102161

The improvement will recover lost capacity through reduced separation standards and increased applications of dependent and independent operations for CSPR departure operations. Improvements will be focused on finding ways to recover lost departure capacity using proven methods that increase Closely Spaced Parallel Operations (CSPO) arrival capacity.

Initial Integration of Weather Information into NAS Automation and Decision Making, OI: 103119

Advances in weather information content and dissemination provide users and/or their decision support tools with the ability to identify specific weather impacts on operations (e.g., trajectory management and impacts on specific airframes, arrival/departure planning) to ensure continued safe and efficient flight.

Full Integration of Weather Information into NAS Automation and Decision Making, OI: 103123

Weather information will be translated into constraint information to be fully integrated into decision-support technologies. Advanced impact assessment tools improve ANSP and flight operator tactical and strategic planning by providing consolidated weather processing of observational and forecast capabilities to produce consistent weather information for improved Air Traffic Management (ATM) decision-making for meeting capacity, efficiency, and safety objectives.

Aircraft Collision Avoidance for New Aircraft Types, OI: 103210

New technologies will benefit aircraft-based Collision Avoidance (CA) avionics as they are extended to accommodate Unmanned Aircraft Systems. The CA technologies will process non-cooperative surveillance targets in order to sense/detect and avoid other aircraft. In addition, the logic will also account for the variety of aircraft sizes and dynamic capabilities of the aircraft.

On-Demand NAS Information, OI: 103305

NAS and aeronautical information will be available to users on demand. This information is consistent across applications and locations that are available to authorized subscribers and equipped aircraft. Proprietary and security-sensitive information is not shared with unauthorized agencies or individuals.

Tailored Delivery of On-Demand NAS Information, OI: 103306

The delivery of selected NAS and aeronautical information data elements will be available to users and tailored based on the information that pertains to their flight trajectory. An integrated set of weather information will be available to users on demand and tailored based on their flight trajectory. This information is consistent across applications and locations that are available to authorized subscribers and equipped aircraft.

Optimized Oceanic Trajectories via Interactive Planning, OI: 104102

Interactive planning between the oceanic airspace user and FAA automation both before and after departure enhances the ability of the flight to fly closer to the user's preferred 4D trajectory. Users can receive feedback on their intended Oceanic trajectory and adjust plans if desired. Given the long duration of oceanic flights, there are often changes to wind and weather conditions while the flight progresses which change the flight's progress along the route. The exchange of the route information from the aircraft provides the FAA with more up to date location information. Automation improvements allow the user to more easily request trajectory changes that better fit the new conditions.

Initial Conflict Probe Improvements, OI: 104104

Automation enables the ANSP to better accommodate pilot requests for trajectory changes by providing conflict detection, trial flight planning, and development of resolutions that take into account aircraft capabilities, airspace status, and pilot and ANSP preferences.

Current Tactical Management of Flow in En Route for Arrivals and Departures, OI: 104115

Automation will assist with minimizing the capacity and efficiency impacts of special activity airspace closures using integrated tools based on mature Aeronautical Information Exchange models.

Improved Management of Arrival/Surface/Departure Flow Operations, OI: 104117

This improvement integrates advanced arrival/departure flow management with advanced surface operation techniques to improve overall airport capacity and efficiency.

Point-in-Space Metering, OI: 104120

The ANSP uses scheduling tools and trajectory-based operations to assure smooth flow of traffic and increase the efficient use of airspace. Point-in-space metering can be associated with a departure fix, arrival fix, or any other point-in-space, such as airspace boundaries or other flow converging points. Decision support tools will allow traffic managers to develop scheduled arrival times for constrained resources and allow controllers to manage aircraft trajectories to meet the scheduled meter times.

Integrated Arrival and Departure Airspace Management, OI: 104122

New airspace design takes advantage of expanded use of terminal procedures and separation standards. This is particularly applicable in major metropolitan areas supporting multiple high-volume airports. This increases aircraft flow and introduces additional routes and flexibility to reduce delays.

Time-Based Metering Using RNAV and RNP Route Assignments, OI: 104123

RNAV, RNP and time-based metering provide efficient use of runways and airspace in high-density airport environments. RNAV and RNP provide users with more efficient and consistent arrival and departure routings and fuel-efficient operations. Metering automation will be augmented to provide additional options to manage the flow of aircraft to meter fixes, thus permitting more efficient use of runways and airspace. Decision support tool functions will be implemented in traffic management tools and procedures to assist ATM in selecting route configurations that optimize airspace in the Metroplex environment.

Trajectory-Based Management – Gate-to-Gate, OI: 104126

All aircraft operating in high-density airspace are managed by Four Dimensional Trajectories (4DT) to dramatically reduce the uncertainty of an aircraft's future flight path. Integration of these improved time estimates into separation assurance and traffic management tools results in more efficient tactical adjustment of individual aircraft trajectories and increased capacity and throughput. Trajectory exchange through data communications will significantly contribute to this improvement.

Time-Based Metering in the Terminal Environment, OI: 104128

This improvement extends current metering capabilities into the terminal environment and furthers the pursuit of 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 solidifies the foundation for future advanced airborne-based applications that will depend upon ground-based automation to maintain the complete sequence of aircraft into and out of high-density terminal locations.

Full Surface Traffic Management with Conformance Monitoring, OI: 104206

Efficiency and safety of surface traffic management is increased using improved automation support for taxi route planning, data link of taxi instructions, and automated conformance monitoring of the aircraft to the approved taxi clearance.

Enhanced Departure Flow Operations, OI: 104208

Efficient departure operations are achieved through the improved ability to quickly revise departure clearances in the event that changing weather, winds or system constraints requires amendments to the pre-departure clearance. Traffic managers create route amendments and send the updated flight data to air traffic controllers for delivery to affected flights. Revised departure clearances are issued electronically to equipped aircraft.

Surface Traffic Management, OI: 104211

Departures are sequenced and staged to maintain throughput. Automation generates predicted airport and runway schedules for arrivals and departures providing better demand/capacity balancing. ANSP uses automation to integrate surface movement operations with departure sequencing to ensure departing aircraft meet departure schedule times while optimizing the physical queue in the movement area. The use of virtual departure queues into the movement area will save fuel and reduce emissions.

Full Collaborative Decision Making, OI: 105207

Timely, effective, and informed decision-making based on shared situational awareness is achieved through advanced communication and information sharing systems. Stakeholder decisions are supported through access to an information exchange environment and a transformed collaborative decision making process that allows wide access to information by all parties (whether airborne or on the ground), while recognizing privacy and security constraints.

Traffic Management Initiatives with Flight-Specific Trajectories, OI: 105208

This capability will increase the agility of the NAS in adjusting and responding to dynamically changing conditions such as severe weather, congestion and system outages through the automated identification, generation and dissemination of route changes.

Advanced Flight Day Evaluation, OI: 105303

Continuous flight day evaluation is improved through advanced predictions of airport capacity, improved integration of ANSP automation systems, and improved algorithms to estimate demand and capacity imbalances. ANSP and users use (real-time) constraint information and integrated Traffic Management Initiative (TMI) mitigation strategies to increase operational predictability and throughput.

Resilient PBN Operations, OI: 107120

The ability to conduct PBN operations in the event of Global Navigation Satellite Service (GNSS) outages will be assured through the use of multiple mitigation strategies. These strategies will enable aircraft to continue to navigate using PBN en route and at our most economically important locations. The ability to assure that PBN operations will continue during GNSS outages or interference events will result in a more resilient NAS.

Flexible Airspace Management, OI: 108206

ANSP automation supports reallocation of trajectory information, surveillance, communications, and display information to different positions or different facilities. The ANSP moves controller capacity to meet demand. Automation enhancements enable increased flexibility to change sector boundaries and airspace volume definitions in accordance with pre-defined configurations.

Manage Airspace to Flow, OI 108207

This capability provides resources that allow the ANSP or Front Line Supervisor to dynamically reconfigure airspace boundaries and/or altitude stratums to accommodate changes in demand, flow, weather constraints, and staffing. This enables users and control authorities to adjust boundaries, Special Activity Airspace (SAA) times and volumes, to optimize usable airspace within specified time windows.

Increase Capacity and Efficiency Using Area Navigation (RNAV) and Required Navigation Performance (RNP), OI: 108209

This improvement will allow use of RNAV and RNP to enable more efficient aircraft trajectories. Combined with airspace changes, RNAV and RNP increase airspace efficiency and capacity. Further efficiencies will be gained through the development and implementation of advanced criteria. RNAV and RNP will permit the flexibility of point-to-point operations and allow for the development of routes, procedures, and approaches.

Improved Management of Special Activity Airspace (SAA), OI: 108212

Special Activity Airspace availability is optimized and managed in real-time, based on actual flight profiles and real-time operational use parameters. Assignments, schedules, coordination, and changes to all types of SAAs are made readily available for operators and ANSPs using automation systems, and are used to assess airspace status and route availability.

UAS Airspace Access, OI: 108214

UAS access to designated airspace volumes is determined based on airspace classes and the performance level of the UAS. Airspace management provides the availability status for airspace volumes as needed to prevent UAS from flying in the vicinity of manned aircraft or to segregate airspace for first responders.

Increase Capacity and Efficiency Using Streamlined PBN Services, OI: 108215

Leveraging lessons learned from community outreach, airspace efficiencies will be gained through the development and implementation of additional and advanced PBN services that provide more efficient aircraft trajectories and increase airspace capacity. PBN procedures will also be redesigned to streamline services in order to enable more optimal descents with time-based terminal sequencing and spacing tools.

Safety Information Sharing and Emergent Trend Detection, OI: 601103

Information analysis and sharing directly supports safety promotion and safety assurance initiatives. It supports analytical efforts such as the comparison of baseline information and trends. It also indirectly supports safety risk management through issue identification, information and tools for analysis of hazards.

Automated Safety Information Sharing and Analysis, OI: 601104

Aviation operational safety will be enhanced and risk reduced by automating risk identification and notification processes. Improvements in the analytical techniques and tools used to extract information from additional data sources will continuously improve the understanding of the data and its implications for safety.

Integrated Safety Analysis and Modeling, OI: 601202

This OI mitigates safety risk associated with the design, evolution and implementation of NextGen by providing enhanced integrated safety methods. It will provide advanced capabilities for integrated, predictive safety baseline risk assessment; advanced capabilities for integrated risk analysis; improved validation and verification processes supporting certification; simulation protocols that provide enhanced evaluation frameworks for safe operational procedures; and enhanced training requirements analysis for safe system operation.

Increase International Cooperation for Aviation Safety, OI: 601302

This OI promotes worldwide aviation safety enhancements for the traveling public through international participation in the development and implementation of safer practices and systems. It also contributes to the continued viability of the U.S. Aviation industry by supporting the required harmonization of international standards for an interoperable Safety Management System (SMS).

4.3 NextGen Portfolio Descriptions and their supporting Capital Programs

The portfolios define the research, engineering, and acquisition activities needed to achieve additional functionality in base and new systems along with any complementary development of standards, guidance, and procedures that may be required. Each of the portfolio descriptions in this section are followed by a list of the capital programs that support the portfolio. The OIs and COs linked to each portfolio and the corresponding descriptions were discussed previously in sections 4.1 and 4.2, respectively.

For information on the implementation portfolios, Collaborative Air Traffic Management Technologies (CATMT), Time-Based Flow Management (TBFM), and Terminal Flight Data Manager (TFDM), please refer to the Enterprise Architecture Infrastructure Automation Roadmaps in Section 5.1. For CATMT and TBFM, see section 5.1.1 Air Traffic Management and Air Traffic Control. For TFDM, see section 5.1.2 Air Traffic Support and Oceanic Air Traffic Control.

For more information on NextGen accomplishments, please visit Performance Snapshots at http://www.faa.gov/nextgen/snapshots/.

4.3.1 Separation Management Portfolio

This portfolio provides controllers and pilots with the necessary tools and procedures to perform separation management in all airspace and airports within the NAS. The aircraft separation assurance service is the cornerstone of ATC operations. The investments in this portfolio provide the tools, procedures, standards, and guidance to improve the management of aircraft in a mixed environment with varying navigation equipment and wake performance capabilities.

Capital investments that support the Separation Management Portfolio are listed below.

BLI #	CIP Title	CIP #
1A04	Automatic Dependent Surveillance-Broadcast (ADS-B) In Applications – Flight Interval Management	G01S.02-01
1A04	Separation Automation System Engineering	G01A.01-06
1A04	Closely Spaced Parallel Runway Operations	G06N.01-02
1A04	Concept Development for Integrated NAS Design & Procedures Planning	G05A.02-04
1A04	Space Integration Enhancements 1	G01M.03-01
1A04	NextGen Oceanic Capabilities	G01A.01-07
1A04	Wake Turbulence Re-Categorization	G06M.02-02
1A04	Common Trajectory Models	G01A.06-01
1A04	Applications in Support of Air Traffic Control	G01A.07-01

Table 4-2 Separation Management Programs

4.3.2 Traffic Flow Management (TFM) Portfolio

This portfolio will improve overall access, efficiency, and flexibility of the NAS by making the best use of available airspace and airport capacity through improved planning and coordination. Advanced traffic management automation tools will be used to improve flight and flow decision making to optimize airspace and airport capacity. These tools will also assist with improved collaborative decision making with the user community to meet their business objectives. The capabilities in the portfolio address the exchange of information between controllers, pilots, and air traffic managers throughout all phases of flight and the development of automation capabilities that increase airspace and airport access and optimize available capacity by improving the flow of flights through integrated planning of departure, en route, arrival, and airport surface operations.

Capital investments that support the Traffic Flow Management Portfolio are listed below.

BLI #	CIP Title	CIP #
1A05	Surface Tactical Flow	G02A.01-01
1A05	Time Based Flow Management (TBFM) Work Package 4	G02A.01-08
1A05	Strategic Flow Management Application	G05A.01-01
1A05	Strategic Flow Management Engineering Enhancement (SFMEE)	G05A.01-02
1A05	Advanced Methods	G05A.02-02

Table 4-3 Traffic Flow Management Programs

4.3.3 On-Demand NAS Portfolio

On-Demand NAS Portfolio will provide flight planners, air traffic controllers and traffic managers, and flight crews with consistent and complete information related to changes in various areas of the NAS, such as temporary flight restrictions, temporary availability of special activity airspace, equipment outages, and runway closures. This portfolio ensures that NAS and other aeronautical information is consistently provided across all NAS applications and locations using common net enabled access to aeronautical and flight information utilizing global standards – Aeronautical Information Exchange Model (AIXM) and Flight Information Exchange Model (FIXM).

Capital investments that support the On-Demand NAS Portfolio are listed below.

BLI #	CIP Title	CIP #
1A06	Flight Object	G05A.02-03
1A06	Common Status & Structure Data	G05A.02-01
1A06	Flight Object Exchange Services (FOXS)	G05A.02-08
1A06	Dynamic Airspace	G05A.04-01
1A06	Flight Deck Collaborative Decision Making	G05A.02-11
1A06	Enterprise Information Management (EIM)	G05M.04-01

Table 4-4 On-Demand NAS Programs

4.3.4 NAS Infrastructure Portfolio

The NAS Infrastructure Portfolio includes capabilities that address aviation weather issues, which supports the need to improve Air Traffic Management (ATM) decision making during adverse weather conditions, improves the use of weather forecast information in the NAS and evolves the existing aviation weather infrastructure, i.e., dissemination, processor, and sensor systems, to standardize weather information and interfaces, and reduce operational costs. This work also includes new air traffic control management procedures, separation standards, and flexible airspace categories to increase throughput.

Capital investments that support the NAS Infrastructure Portfolio are listed below.

BLI #	CIP Title	CIP #
1A07	Weather Observation Improvements	G04W.02-01
1A07	Weather Forecast Improvements – Work Package 1	G04W.03-01
1A07	NextGen Navigation Engineering	G06N.01-03
1A07	New Air Traffic Management (ATM) Requirements	G01M.02-02
1A07	Information Management	G05M.03-01
1A07	Data Communications – ATN Gateway Internet Protocol	G01C.02-01

Table 4-5 NAS Infrastructure Programs

4.3.5 Support Portfolio

This portfolio explores new technologies at the NextGen laboratories by providing the NAS environments required to validate the broad framework of NextGen concepts, technologies, and systems and to test the integration, development, and operations functions before they are introduced into the NAS. Operational Analysis supports the transition to NextGen by providing a comprehensive evaluation of fielded improvements and reporting of post-implementation performance information.

BLI #	CIP Title	CIP #
1A08	NextGen Laboratories	G03M.02-01

Table 4-6 Support Portfolio Program

4.3.6 Unmanned Aircraft Systems (UAS)

NextGen Unmanned Aircraft Systems is essential for ensuring safe and efficient integration of UAS into the NAS. These investments play a critical role in providing NAS access to UAS operations without impacting manned aircraft operations and creating disruptions or delays.

Capital investments that support Unmanned Aircraft Systems are listed below.

BLI #	CIP Title	CIP #
1A09	Unmanned Aircraft Systems (UAS) Concept Validation and Requirements Development	G01A.05-02
1A09	Unmanned Aircraft Systems (UAS) Flight Information Management	G01A.05-01

Table 4-7 Unmanned Aircraft Systems (UAS) Programs

4.3.7 Enterprise, Concept Development, Human Factors, & Demonstrations Portfolio

This portfolio will conduct the research needed to determine the viability and benefits of future NAS concepts. It conducts enterprise level activities, including development of concepts across the NAS, human factors analysis of the NextGen operational environment, and demonstrations of proposed NextGen system improvements to ensure operational feasibility and viability with the NAS. Concepts will be researched and assessed to identify research issues, evaluate benefits, reduce risk, and develop preliminary operational requirements and procedures to enhance safety, increase operational efficiency, increase airspace capacity, and expand current capabilities throughout the NAS.

Capital investments that support the Enterprise, Concept Development, Human Factors, & Demonstrations Portfolio are listed below.

BLI #	CIP Title	CIP #
1A10	Enterprise Concept Development	G05A.02-10
1A10	Enterprise Human Factor Development	G01M.02-05
1A10	Stakeholder Demonstrations	G08M.01-04

Table 4-8 Enterprise, Concept Development, Human Factors, & Demonstrations Programs

4.3.8 Performance-Based Navigation & Metroplex Portfolio

PBN uses RNAV and Required Navigation Performance (RNP) to improve access and flexibility in the NAS with the goal of providing the most efficient aircraft routes from departure runway to arrival runway with greater precision and accuracy. Progressive stages of PBN capabilities include the safe implementation of more closely spaced flight paths for departure, arrival, and approach and improves the operational efficiency for airports located in Metroplexes.

Capital investments that support the Performance Based Navigation & Metroplex Portfolio are listed below.

BLI #	CIP Title	CIP #
2B19	NextGen Performance Based Navigation (PBN) – Metroplex Area Navigation (RNAV)/Required Navigation Performance (RNP)	G05N.01-01
2B19	NextGen Distance Measuring Equipment (DME) Support For Performance Based Navigation (PBN) Strategy	G01N.01-02

Table 4-9 Performance Based Navigation & Metroplex Programs

4.3.9 System Safety Management Portfolio

System Safety Management is developing data acquisition, storage, analysis, and modeling capabilities to meet the safety analysis needs of NextGen designers, implementers, and safety professionals. These resources will be used to ensure that new capabilities either improve or maintain current safety levels while improving capacity and efficiency in the NAS.

Capital investments that support the System Safety Management Portfolio are listed below.

BLI #	CIP Title	CIP #
3A09	Aviation Safety Information Analysis and Sharing (ASIAS)	G07A.02-01

Table 4-10 System Safety Management Programs

4.3.10 Cross Agency NextGen Management

Delivering NextGen is a high priority for the Administration, the Department of Transportation and the FAA. Its complexity and interdependencies make it the most challenging FAA undertaking to date requiring evaluation of internal processes and internal structures to meet the demands of modernizing the NAS. The Cross Agency NextGen Management Program integrates NextGen multi-agency research and development requirements and facilitates the transfer of research between its partner agencies.

The capital investment that supports Cross Agency NextGen Management is listed below.

BLI #	CIP Title	CIP #
4A10	Cross Agency NextGen Management	G08M.04-01

Table 4-11 Cross Agency NextGen Management

5 Enterprise Architecture Infrastructure Roadmaps

The detailed infrastructure roadmaps in the following subsections are an integral part of the NAS Enterprise Architecture (EA) and show the existing systems and services in the NAS and the planned capital programs for both legacy and NextGen systems. The EA roadmaps extend beyond the 5-year CIP horizon and show timelines for planned or proposed NAS modernization programs envisioned for the future. The roadmaps are updated annually to reflect the results of studies, demonstration projects, and economic analyses related to the programs but are generally stable from year-to-year. Upgrading the sophisticated systems used for air traffic control requires significant engineering development efforts and long range planning to ensure the continued safety and efficiency of the NAS.

The EA roadmaps provide an executive level view of the NAS systems and programs and are not intended to show all of the detailed planning behind them. The roadmaps show the length of time that systems remain in service, programs to sustain systems, and programs to replace systems or consolidate functions.

Some new systems or services shown in the roadmaps may require aviation users to add equipment to their aircraft and/or adopt new procedures. This can alert users to potential changes that could affect their equipment and require additional training.

The infrastructure roadmaps in this section organize the NAS architecture by functional area. Existing FAA systems/services are shown in light blue on the left side of the roadmaps. Funding to maintain and operate these in-service systems is provided by the Operations appropriation. Capital investment programs to upgrade or replace these systems are shown as boxes within the roadmap timeline and are funded by the F&E appropriation. The length of each box on a roadmap represents the projected schedule in calendar years that a program has, or is expected to receive, funding. NAS programs are shown as gray bars; NextGen programs are depicted using orange bars. A dotted box means that a program is planned but has not yet received formal approval for funding within the CIP financial baseline.

Below each roadmap a brief description is provided for each system/service shown in a blue box along the left side. For each CIP program requesting funds between FY 2019-2023, a brief summary is provided that includes the purpose of the program, the associated Budget Line Item (BLI) number, and the CIP program title and number. The BLI is used to associate a CIP program shown on the FAA Enterprise Architecture Roadmaps with the planned funding identified in Section 8, Estimated Funding by BLI. Note that some BLIs may fund multiple CIP programs.

For system or program boxes shown as ending in either 2017 or 2018, please see the previously published CIP for a description of the system or program for those years.

Figure 5-1 shows and defines the symbols used in the infrastructure roadmaps. The solid red lines indicate the time that systems, or their replacements will remain in operation. The dashed lines indicate that a system is scheduled to be replaced or taken out of service. The end date of operation is indicated with an X. The boxes with names identify programs, functions or systems, which are either described in the text below each roadmap or are defined in the Acronyms and Abbreviations section of this document.

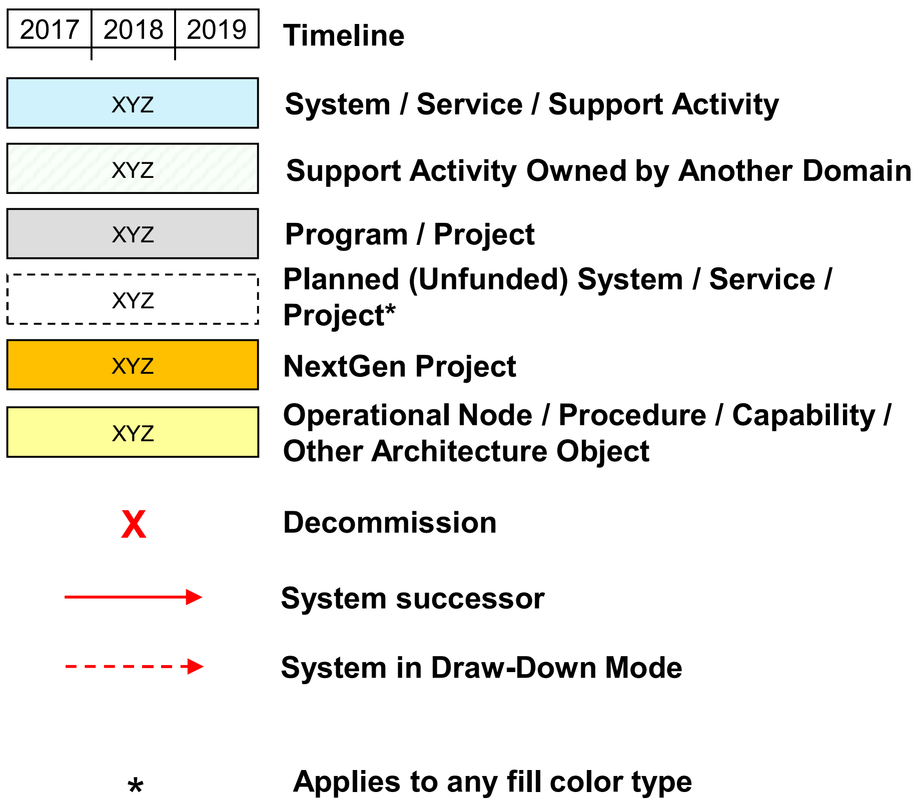

Figure 5-1 Infrastructure Roadmap Legend

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 speed, altitude, and direction for approximately 60,000 flights that they track and keep safely separated each day. Automation provides controllers with continuously updated displays of aircraft identification, position, and whether the aircraft is level, climbing, or descending. Existing or upgraded automation systems will also host software enhancements developed by NextGen programs to support operational improvements (OIs) and Current Operations (COs).

The Traffic Flow Management System (TFMS) supports the FAA's Air Traffic Management (ATM) personnel in providing efficiency-critical NAS services. The system compares the projected traffic with the capacity of destination airports to determine if steps need to be taken to manage the flow and prevent delays. Throughout each day, Traffic Managers use the TFMS to maintain near real-time situational awareness and predict areas which may experience congestion due to capacity reductions or an unusual increase in demand. The TFMS is used to facilitate planning teleconferences every two hours to proactively plan impact mitigation strategies between the Air Traffic Control System Command Center (ATCSCC), Traffic Management Units (TMU) at all major ATC facilities (80 sites), and flight operators. TFMS remote sites are also located at other FAA and Government offices (39).

Automation implementation, including the plans to sustain, upgrade, replace, or decommission current systems from 2017 through 2031 are shown in the following NAS EA roadmaps:

1. Roadmap 1 (figure 5-2) - Air Traffic Management and Air Traffic Control
2. Roadmap 2 (figure 5-3) - Air Traffic Support and Oceanic Air Traffic Control
3. Roadmap 3 (figure 5-4) - Flight Services, Aeronautical, and Information Support

5.1.1 Air Traffic Management and Air Traffic Control

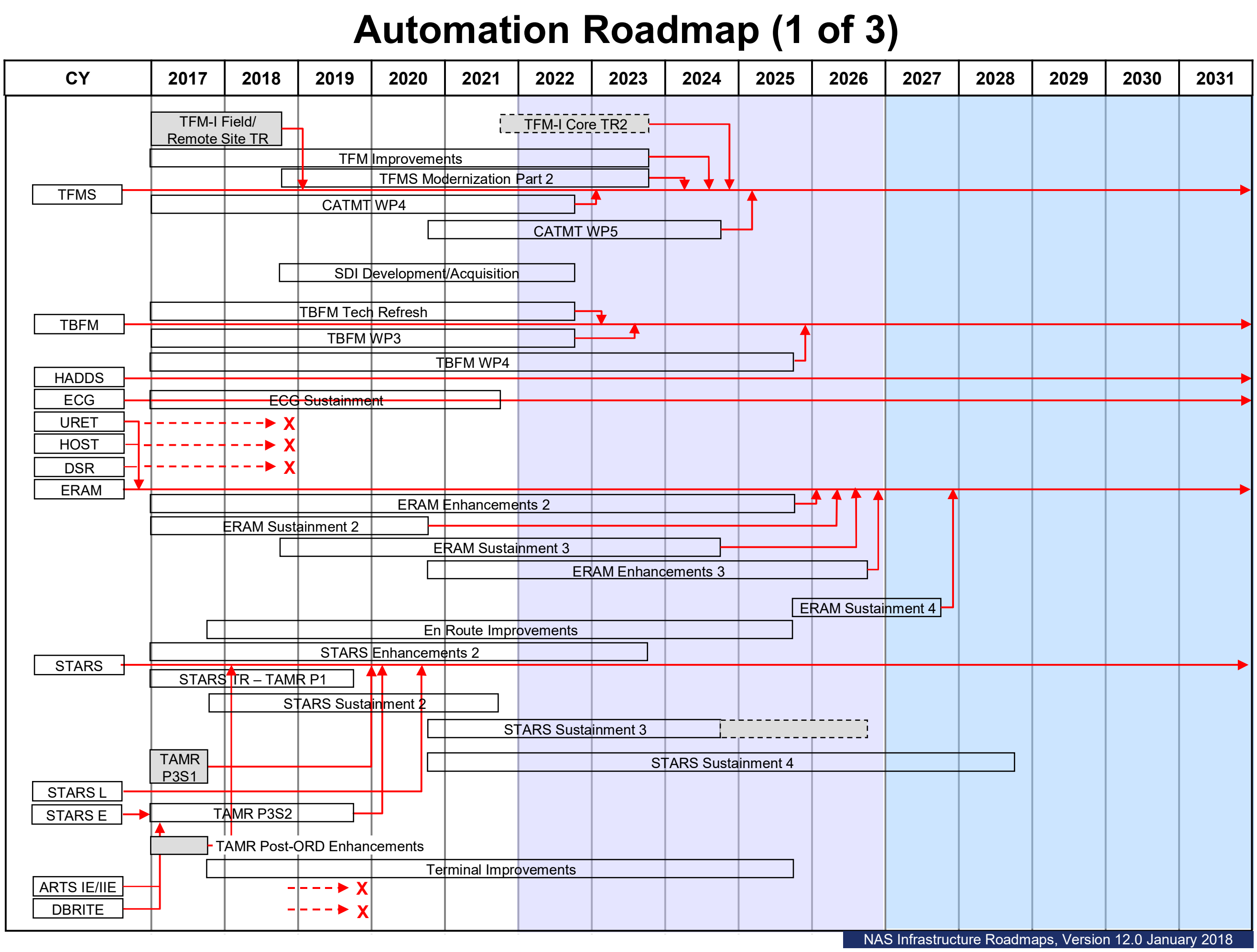

Figure 5-2 Air Traffic Management and Air Traffic Control Roadmap

TFMS, shown at the top left of figure 5-2, supports the FAA's Traffic Management personnel in providing efficiency-critical NAS services. TFMS becomes especially important when external factors such as adverse weather reduce NAS capacity and require proactive planning, coordination, and adjustments to mitigate impacts.

The FAA will continue to implement the TFM Infrastructure Field/Remote Site Technology Refresh program and complete the replacement of TFMS equipment at field sites in FY 2020.

The TFM Infrastructure – TFM Improvements, A05.01-14, program (BLI 2A05) will upgrade decision support tools to help traffic managers implement more efficient Traffic Management Initiatives (TMI). The program will conduct operational analysis, engineering analysis, solution development, and solution implementation activities designed to improve the delivery of TFM services.

The TFMS Modernization Part 2, A05.01-15, program (2A05) will modernize TFMS legacy front-end software applications and will increase integration and interoperability by establishing a fully robust, commercially-available and standards-compliant system. It will also provide a replace-in-kind technology refresh of the hardware providing the central data processing capability for the TFMS. The program is working towards a FID.

If approved, the TFM-Improvements (TFM-I) Core Technology Refresh 2 (TR2) program will modernize TFMS components that have reached their end-of-life.

Collaborative Air Traffic Management Technologies (CATMT) – Work Package 4 (WP4), G05A.05-03, program (BLI 2A13) provides NextGen Midterm TFM/CATM capabilities between FY 2017 and FY 2022. These include: Improved Demand Predictions (IDP) – a set of several enhancements aimed at improving the TFMS predictions of demand for NAS resources; Integrated Departure Route Planning (IDRP) – a tool that provides strategic/tactical forecast of departure route and fix status due to convective weather and traffic volume for specific terminals; and TFMS Ingestion of Weather Data – will replace the legacy Corridor Integrated Weather System Data Distribution System prototype with the new System Wide Information System Common Support Services – Weather (CSS-Wx) service. The NextGen Operational Improvements that this NextGen program supports can be found in Section 4.1.

CATMT – Work Package 5 (WP5), G05A.05-04, program (BLI 2A13) will provide NextGen Midterm TFM/CATM capabilities between FY 2021 and FY 2025. Investment analysis and concept engineering work of candidate capabilities for WP5 are being performed by the Strategic Flow Management Engineering Enhancement (SFMEE), G05A.01-02, program (BLI 1A05). The SFMEE program is working toward a FID. The NextGen Operational Improvements that this NextGen program supports can be found in Section 4.1.

The Space Data Integrator (SDI) Prototype Sustain, M55.01-01, program (BLI 2A20) demonstrated the automation of the FAA's current manual process with the ability to enable existing NAS automation and decision support tools to share information during launch and reentry operations and will support the validation of future commercial space and air traffic requirements in the TFM, En Route, and Terminal environments.

The Space Data Integrator (SDI) Development/Acquisition, M55.01-02, program (BLI 2A20) will provide a data integration capability to process real-time vehicle and ingest aircraft hazard area data, and then provide the information to the Joint Space Operations Group and the TFMS at the ATCSCC and other affected facilities. The program is working towards a FID.

The Time Based Flow Management (TBFM) system uses time-based metering to better utilize NAS capacity by improving traffic flow management of aircraft approaching and departing congested airspace and airports. Aircraft using this technique can arrive properly sequenced and spaced to maximize capacity at the nation's busiest airports. TBFM is operational at 20 ARTCCs and adapted for most major airports served by these centers. Time-based metering through TBFM has provided an average 3-5% increase in throughput at the airports where it is installed.

TBFM Technology Refresh, G02A.01-07, program (BLI 2A14) will replace the existing hardware that was deployed in 2012 and 2013 with new hardware in the FY 2021-2022 timeframe. The program is working toward a FID.

TBFM Work Package 3, G02A.01-06, program (BLI 2A14) will implement additional NextGen concepts, such as optimized descent during time-based metering; Terminal Sequencing and Spacing to provide efficient sequencing and runway assignment; and includes expansion of the Integrated Departure /Arrival Capability to additional locations. The NextGen Operational Improvements that this NextGen program supports can be found in Section 4.1.

TBFM Work Package 4, G02A.01-08, program (BLI 1A05) will build upon existing core TBFM capabilities to increase benefits from time-based metering and enable the expansion of Performance Based Navigation (PBN) operations across the NAS. The program is working towards a FID. The NextGen Operational Improvements that this NextGen programs supports can be found in Section 4.1.

The Host ATM Data Distribution System (HADDS) supplies data to the TFMS, discussed above, and will remain in operation through the timeframe of the current roadmap (2017-2031).

The En Route Communications Gateway (ECG) system is a computer system that formats and conveys critical air traffic data to the En Route Automation Modernization (ERAM) and the Enhanced Backup Surveillance System at the ARTCCs. The ECG Sustainment, A01.12-02, program (BLI 2A02) plans, procures, and deploys ECG hardware or software components to maintain a high level of system availability.

The ERAM program incorporated three of the en route system component pieces: User request Evaluation Tool (URET); Host Computer; and Display System Replacement (DSR). DSRs are the ATC displays at the en route centers. URET is a conflict-detection tool that automatically detects and advises air traffic controllers of potential conflicts between aircraft or between aircraft and special activity airspace. The ERAM system replaced the Host Computer, processes flight and surveillance data, and generates display data for en route air traffic controllers.

The ERAM Sustainment 2, G01A.01-10, and ERAM Sustainment 3, G01A.01-11, programs (BLI 2A01) will sustain the ability for en route controllers to collectively track up to 1,900 aircraft at a time by updating a subset of ERAM equipment that is in critical need of replacement at the 20 ARTCCs. The ERAM Sustainment 3 program is working towards a FID.

The ERAM Enhancements 2, G01A.01-08, and ERAM Enhancements 3, G01A.01-12, programs (BLI 2A01) will improve the efficiency and effectiveness of en route sector operations by enabling the implementation of NextGen capabilities to support increased efficiency and capacity benefits. The ERAM Enhancements 2 program provides software enhancements for the en route sector controller team. These include enhancements to improve trajectory modeling, conflict probe, and flight plan processing, and other improvements. The ERAM Enhancements 3 program will provide separation management automation enhancements to assist en route controllers in managing safe aircraft separation in a mixed environment of varying navigation equipment and wake performance capabilities. It will enhance trajectory management, upgrade flight data management, and optimize use of aircraft PBN data. The ERAM Enhancements 3 program is working toward FID.

The En Route Improvements, A01.16-01, program (BLI 2A19) will improve the presentation, access, and use of ERAM and other systems data by air traffic controllers and managers, resulting in more efficient, safer, and cost-effective delivery of en route services. It will conduct operational analysis, engineering analysis, solution development, and solution implementation activities designed to improve the delivery of en route domain services.

The last five systems in figure 5-2 provide ATC automation for terminal airspace. They include the Standard Terminal Automation Replacement System (STARS); The STARS Enhanced Local Integrated Tower Equipment (ELITE or E)/ STARS Local Integrated Tower Equipment (LITE or L) (STARS E/L); The Automated Radar Terminal System (ARTS) model 1E/IIE; and Digital Bright Radar Indicator Tower Equipment (DBRITE). STARS and ARTS systems allow TRACON controllers to track aircraft as they transition from en route control to terminal airspace, normally within 60 miles of the destination airport. DBRITE is a tower display that allows tower cab controllers to determine the location of approaching traffic before it becomes visible to them.

STARS – Technology Refresh (TAMR Phase 1), A04.01-01, program (BLI 2B02) is the technology refresh of the STARS automated radar processing and display systems at 48 Terminal Radar Approach Control (TRACON) facilities and their associated Air Traffic Control Towers (ATCTs). The TAMR Phase 1 program will provide hardware updates including new high-resolution Liquid Crystal Display color displays, processors, storage devices, and enhanced memory; a software update to support NextGen initiatives, and to maintain, correct, or improve system performance, efficiency, safety, and security vulnerabilities.

The STARS Technology Refresh/Sustainment 2, A04.01-03 program (BLI 2B02) will enable the FAA to design and replace key elements of STARS that have reached their end-of-life (EOL) and are no longer compatible with current commercial offerings. The program will replace five STARS Generation 1/2 (G1/G2) Local Integrated Tower Equipment (LITE) systems with new STARS G4 remote tower equipment.

The STARS Technology Refresh/Sustainment 3, A04.01-05, program (BLI 2B02) will deploy a new Operating System, digital video to all Terminal Control Workstations (TCW) and Tower Display Workstation (TDW) at all Generation 4 sites and TDWs at all G4 Enhanced Local Integrated Tower Equipment (ELITE) sites. The program is working towards a FID.

The STARS Technology Refresh/Sustainment 4, A04.01-06, program (BLI 2B02) will engineer and deploy additional key elements of STARS that have reached their EOL and address the G5 next generation platform replacement and the Main Display Monitor. The program is working towards a FID.

The Terminal Automation Modernization – Replacement (TAMR) – Phase 3, Segment 2, A04.07-02, program (BLI 2B03) will replace 91 Automated Radar Terminal System (ARTS) IIE systems at TRACONs and their associated ATCTs, and six ARTS IE systems (stand-alone ATCT display systems) with STARS hardware, software, and displays. This Segment will deploy a scaled STARS system, known as STARS Enhanced Local Integrated Tower Equipment (ELITE) to the ARTS IIE facilities and STARS Remote Towers to the ARTS IE facilities.

The Terminal Automation Modernization – Replacement (TAMR) – Post Operational Readiness Demonstration (ORD) Enhancements program considered requests for operational needs and capabilities that existed in ARTS at the time of transition to STARS at Phase 1 and Phase 3 sites.

The Terminal Improvements, A.04.09-02, program (BLI 2B04) will support operational analysis, engineering analysis, solution development, and solution implementation activities designed to improve the delivery of terminal services. The scope of these NAS improvements is limited to operational changes that do not require significant capital investments, a formal investment decision, or involve significant systems complexity, interdependencies, or NAS operational changes.

The STARS Enhancements 2, A04.08-01, program (BLI 2B04) is the next useful segment for the STARS platform and will consolidate terminal automation onto a single platform. As envisioned by NextGen, it will implement the capabilities necessary to enable Trajectory-Based Operations (TBO) in the terminal environment, and identify and address outstanding operational needs. The program is working towards a FID.

5.1.2 Air Traffic Support and Oceanic Air Traffic Control

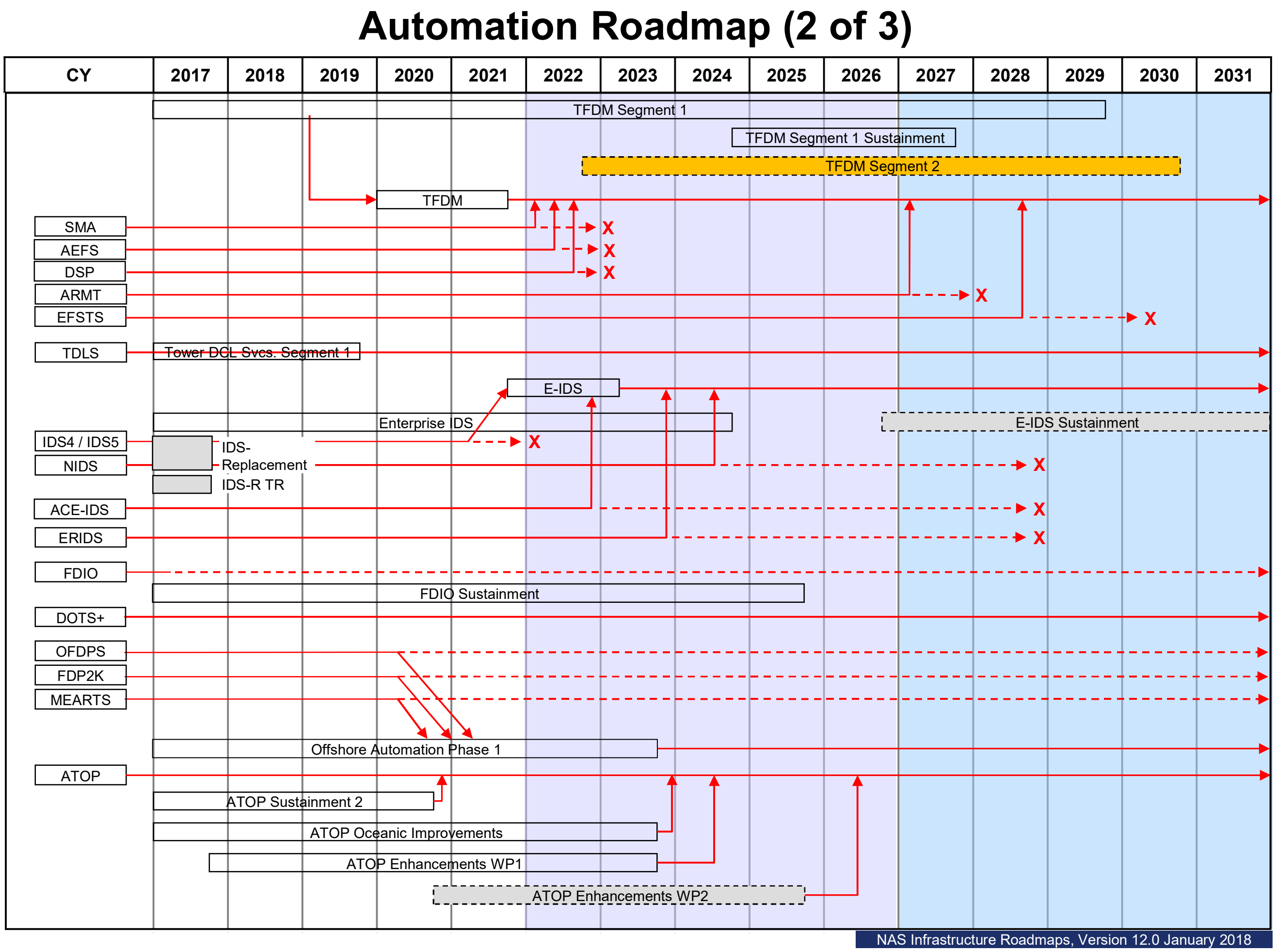

Figure 5-3 Air Traffic Support and Oceanic Air Traffic Control Roadmap

The first system on the top left of figure 5-3 is the Surface Movement Advisor (SMA) and it provides the status of aircraft moving from the gates to the runways and improves taxiing efficiency. The Advanced Electronic Flight Strips (AEFS) prototype system replaced paper flight strips with an electronic touchscreen system that provides ATCs with the ability to create, amend, and transfer flight strips electronically from one tower position to another tower position or to the TRACON. The Departure Spacing Program (DSP) is used by tower controllers to optimize taxi and takeoff clearances to more efficiently use available runway and airspace capacity. The Airport Resource Management Tool (ARMT) provides an assessment of available airport capacity. The Electronic Flight Strip Transfer System (EFSTS) is a system to transfer flight information to towers and TRACONs electronically rather than by paper.

At the top of Figure 5-3 is TFDM – Segment 1, G06A.03-01, program (BLI 2B16). TFDM will deliver to tower air traffic controllers and FAA traffic managers NextGen decision support capabilities that integrate flight, surveillance, and traffic management information to improve air traffic control coordination and decision-making. The use of Electronic Flight Data and Strips will allow tower controllers to maintain an integrated view of the air traffic environment, improving their situational awareness of airport operations. The implementation plan is based on a two software build approach and deployment of TFDM to 89 airports from FY 2020 to FY2028. TFDM will replace SMA, AEFS, DSP, ARMT, and EFSTS. The NextGen Operational Improvements that this NextGen program supports can be found in Section 4.1.

If approved, the TFDM – Segment 2 program will support the implementation of additional system enhancements and future sites for the TFDM capability.

The Tower Data Link Services (TDLS) provides data link of the as-filed flight plan, called Pre-Departure Clearance (PDC), through Airline operators to pilots preparing to depart an airport. See Communication Roadmap 5, section 5.2, for a description of the Data Communications Segment 1 Phase 1 program.

The Integrated Display Systems model 4 (IDS-4), IDS model 5 (IDS-5), and NAS IDS (NIDS) provide rapid retrieval and display of a wide range of weather, operational support, and administrative information for air traffic controllers and other users in the terminal environment.

The Integrated Display Systems (IDS) Replacement program replaced the IDS-4 with a state-of-the-art system comprised mainly of Commercial-Off-The-Shelf (COTS) components. The IDS Replacement Technology Refresh (TR) program completed a system analysis to identify obsolete IDS components needing replacement. The results of this analysis lead to the development of the Enterprise Information Display System (E-IDS) program.

The Automated Surface Observing System (ASOS) Controller Equipment-Information Display System (ACE-IDS) displays weather information collected by ASOS to tower controllers.

The En Route Information Display System (ERIDS) is an information display system that provides access to aeronautical data including weather, airspace charts, ATC procedures, Notices to Airmen (NOTAM), and pilot reports (PIREPS).

The Enterprise Information Display System (E-IDS), A03.05-03, program (BLI 2B13) will provide an enterprise-level platform that replaces multiple types of IDS in the En Route, Terminal, Traffic Flow, Oceanic, and Offshore domains with standard functionality and common hardware/software. E-IDS will replace IDS-4, IDS-5, ACE-IDS, and ERIDS. The program is working towards a FID.

The Flight Data Input/Output (FDIO) system interfaces to several En Route automation systems and provides standardized flight plan data, weather information, safety related data, and Wake Re-categorization to Air Traffic Controllers located at approximately 690 remote sites.

The FDIO – Sustainment, A01.11-01, program (BLI 2B04) replaces end-of-life/obsolete FDIO equipment with fully compatible COTS and modified COTS equipment. To maintain system availability, the program replaces individual components as they reach the end of their service life based upon a 5-year replacement cycle.

The Dynamic Ocean Tracking System plus (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 three oceanic automation systems, Offshore Flight Data Processing System (OFDPS), Flight Data Processing 2000 (FDP2K), and the Microprocessor En route Automated Radar Tracking System (Micro-EARTS), process flight data regarding the position of aircraft on oceanic and offshore flights to aid controllers in separating flights in FAA controlled airspace.

The Offshore Automation – Phase 1, A38.01-01, program (BLI 2A18) will replace the air traffic systems at the FAA's four offshore facilities; Anchorage Air Route Traffic Control Center, Honolulu Combined Control Facility (CCF), Guam CCF, and San Juan CCF. Replacing the existing legacy automation and flight data processing systems with common en route and terminal automation systems at the four offshore facilities will improve NAS interoperability and reduce costs by standardizing platform training, maintenance, and development efforts for all locations. The program is working towards a FID.

The Advanced Technologies and Oceanic Procedures (ATOP) program updated procedures and modernized the oceanic automation systems located at the Oakland, New York, and Anchorage ARTCCs. ATOP fully integrates flight and radar data processing, detects conflicts between aircraft, provides data link and surveillance capabilities, and automates previously manual processes for oceanic air traffic control.

The ATOP – Sustainment 2, A10.03-01, program (BLI 2A09) will replace the hardware and operating system, and integrate the new technology with the baseline ATOP applications. The ATOP program reduces maintenance and logistics costs and supports incorporation of software changes and new capabilities to support future NextGen, Surveillance and Broadcast Services, and other NAS improvements.

The ATOP – Oceanic Improvements, A10.03-03, program (BLI 2A09) will support operational analysis, engineering analysis, solution development, and solution implementation activities designed to improve the delivery of oceanic domain services. This will improve the flexibility, reliability, and efficiency of oceanic air traffic control by providing enhancements to more frequently accommodate user preferred flight trajectories and altitude changes to increase the likelihood of on-time arrivals.

The ATOP – Enhancements (Work Package 1), A10.03-02, program (BLI 2A09) is addressing the operational shortfalls of the current oceanic system as the FAA moves forward with NextGen and other NAS upgrades. The program is working towards a FID.

If approved, the ATOP Enhancements (Work Package 2) program will continue to address operational shortfall of the oceanic systems.

5.1.3 Flight Services, Aeronautical and Information Support

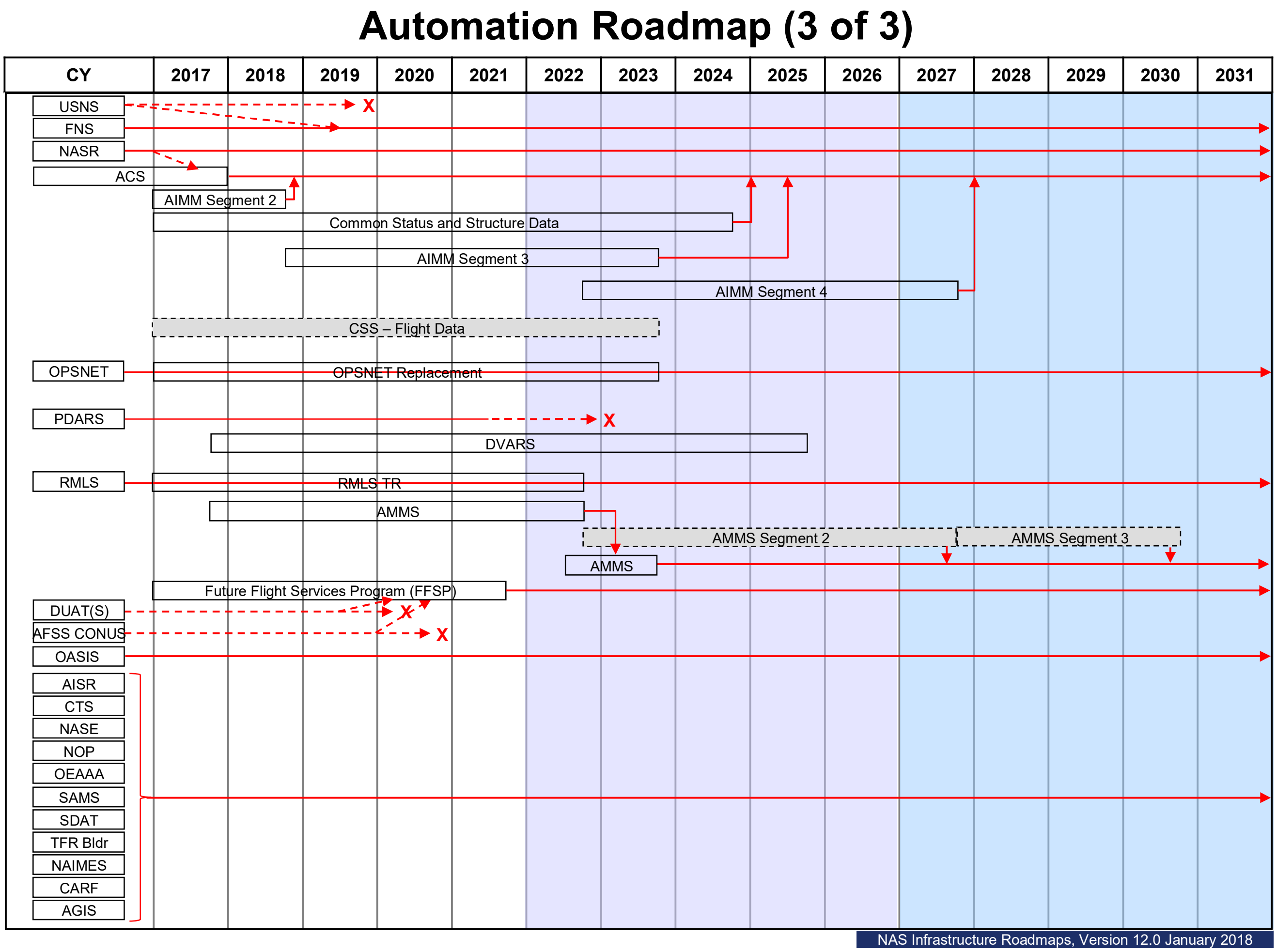

Figure 5-4 Flight Services, Aeronautical and Information Support Roadmap

At the top left of figure 5-4 is the United States NOTAM (Notice to Airmen) System (USNS) which is an automated system used to process, store, and distribute NOTAM information.

The Federal NOTAM System (FNS) will replace USNS in the future and will remain in operation throughout the roadmap timeframe. This centralized system collects and distributes NOTAMs to alert pilots to outages of any Navaids, closed runways, or other factors that may affect their flight.

The National Airspace System Resources (NASR) contains information pertaining to Instrument Approach Procedures, Departure Procedures, Standard Terminal Arrival Routes, and Military Training Routes.

Aeronautical Common Services (ACS) publishes information about airports, navigational aids, and other aeronautical data.

The Aeronautical Information Management (AIM) Modernization Segment 2 program will provide aviation users with digital aeronautical information that conforms to international standards and supports NextGen objectives. The program will be completed in FY 2018.

The Common Status & Structure Data (CSSD), G05A.02-01, program (BLI 1A06) will establish the requirements and information flows for the collection, management, and maintenance of aeronautical information in a digital format for machine-to-machine exchange. The common data and information services and integration activities enable improved flight planning and pilot briefing services; increased on-demand NAS operational performance information; and better airspace management using timely schedule information and a common awareness of Special Activity Airspace (SAA) status across the NAS. To support NextGen capabilities, this program enables the FAA to improve situational awareness through better access to aeronautical information and a common language.

The Aeronautical Information Management (AIM) Modernization Segment 3, G05A.02-06, program (BLI 4A09) will modernize and expand on the ACS enterprise service and initial SAA and Geographic Information Service (GIS) capabilities developed by AIM Modernization Segment 2. Segment 3 will add performance capability by increasing integration with NAS automation to integrate or fuse the static aeronautical information with operational data feeds that provide updates on the activation status of SAA and active runway/airport configuration data from the authoritative source. The CSSD program is working towards a FID for AIMM Segment 3.

AIM Modernization Segment 4, G05A.02-07, program (BLI 4A09) will build on the infrastructure and capabilities established in AIM Modernization Segments 2 and 3. Key elements of AIMM S4 include expanding Authoritative Sources for Unmanned Aircraft Systems and Commercial Space Integration and expanding ATM System Integration with ACS/ System Wide Information Management (SWIM) Services. The CSSD program is working towards a FID for AIMM Segment 4.

The Common Support Services – Flight Data (CSS-FD) will provide single operator interface to NAS for flight planning and filing and improve the exchange of early intent, i.e. pre-departure data, NAS constraint checking, and flight plan submission. This will allow the airspace users to more effectively plan their flight operations. This work is being conducted under the Flight Object Exchange Services, G05A.02-08, program (BLI 1A06).

The Operations Network (OPSNET) is the official FAA system for collecting and reporting flight operations count and delay metrics. The OPSNET system measures the number of delays attributable by cause including weather, air traffic volume, equipment status, and runway conditions. The OPSNET Replacement, A37.01-01, program (BLI 1A01) will expand the collection and recording of delay causes to improve reporting and provide a system that limits manual data entry and automates compilation of operational data received from FAA automation systems. The program is working towards a FID.

The Performance Data Analysis and Reporting System (PDARS) provides data, tools, and analysis to operational facilities to support modeling, measurement, and analyses of new runways, airfield improvements, air traffic procedures, and other technological implementations to improve airport capacity and system efficiency.

The Data, Visualization, Analysis and Reporting System (DVARS), M08.28-05, program (BLI 2E11) will serve as a replacement to PDARS utilizing a modernized platform. DVARS will provide the same capabilities as PDARS through integrated visualization and reporting tools that allow users to access quality NAS data and perform modeling, analysis, and trending.
The program is working toward a FID.

The Remote Maintenance Logging System (RMLS) allows systems maintenance staff to monitor equipment performance electronically from a central location and enables generating, quantifying, analyzing, measuring, and reporting the maintenance information. RMLS improves the effectiveness of Tech Ops maintenance processes and practices and oversees the entire event management life cycle, from generation of the initial event through assignment, updates, and event closure.

The RMLS Technology Refresh, M07.04-02, program (BLI 2B14) will extend the service life of RMLS hardware and software located at the National Operations Control Center, Atlantic Operations Control Center, Mid-States Operations Control Center, Pacific Operations Control Center, Southern California TRACON, the William J. Hughes Technical Center (WJHTC), ARTCCs, and the Combined Control Facility (CCF) in Hawaii.

The Automated Maintenance Management System (AMMS), M07.05-01, program (BLI 2B14) will allow for the interfacing of maintenance systems through a Service-Oriented Architecture environment utilizing SWIM to create an enterprise infrastructure for sharing data between dispersed maintenance systems. AMMS will develop common enterprise data services for maintenance data; implement data standards for the exchange of data between services, systems, and equipment; and deliver advanced automated maintenance tools to improve data integrity and increased situational awareness to support predictive rather than periodic maintenance. The program is working towards a FID.

If approved, the AMMS Segment 2 program will continue to improve upon the enterprise infrastructure philosophy of sharing data between dispersed maintenance systems. Enhancements within the enterprise data services and data standard will allow for the exchange of data between logistics and configuration management systems and services. The maintenance automation tool will evolve to provide for improved situational awareness towards the portfolio of NAS lifecycle management systems and services.

If approved, the AMMS Segment 3 program will expand upon the system-to-system interfaces and provide for data exchanges with human resources, weather, and Air Traffic systems and services. This will allow for continued improvements of maintenance scheduling/coordination and lifecycle management of the NAS.

The Automated Flight Service Station Continental United States (AFSS CONUS), Direct User Access Terminal System (DUATS), and Operational and Supportability Implementation System (OASIS) provide aeronautical and weather data to support flight services. Flight services include flight planning and pilot weather briefings primarily used by General Aviation (GA) pilots. Contractor flight service personnel using the AFSS CONUS provide flight services in the lower 48 States, Hawaii and Puerto Rico. The 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 GA pilots.

The Future Flight Service Program (FFSP), A34.01-01, (BLI 2C02) will subsume AFSS and DUATS scope, seeking to enhance GA and NAS users' safety awareness by providing more accurate and efficient updates to changing weather conditions and allowing pilots to make better decisions on avoiding hazardous weather. FFSP expands the web portion of flight services and seeks to reduce or eliminate obsolete or redundant services and activities provided by other FAA service organizations to increase efficiency and reduce the overall cost of delivering flight services. The program is working towards a FID.

The last 11 systems shown on Figure 5-4 are expected to continue in operation through the timeframe of the current roadmap. A brief description of the service or capability provided by each of these systems 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) provides the official source of time that synchronizes the information flows in the air traffic control equipment.

NAS Adaptation Services Environment (NASE) contains detailed information about the airspace, geography, equipment, and procedures required to make each ATC system work properly.

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) contains data about obstructions around airports that present a hazard for aircraft taking off and landing.

Special Use Airspace Management System (SAMS) informs controllers when airspace ordinarily reserved for military use is available for civilian use.

Sector Design and Analysis Tool (SDAT) is a visualization and analysis tool used to evaluate the impact on controller workload when sector and route changes are being considered during major airspace redesign efforts.

Temporary Flight Restriction Builder (TFR Bldr) is 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.

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) is a system used by military and civilian pilots to reserve altitudes for their planned flights.

Airport Geographic Information System (AGIS) collects, stores, and disseminates geospatial features and attributes associated with the physical infrastructure of the airport. The survey data and AGIS system are necessary for maintaining existing and developing new approach and departure procedures.

5.2 Communication Roadmaps

Communication between pilots and controllers is an essential element of air traffic control and is primarily accomplished using voice radios. To ensure controllers can stay in contact with pilots, remotely located radio sites are used to provide continuous coverage. Controllers use electronic links through ground-based telecommunication lines to activate remote site radios that carry voice transmissions between air traffic controls and pilots. If ground links are unavailable, satellite communication links can be used. In the future, data link will be used for most routine communications. Backup systems are also available to ensure uninterrupted communication should a primary system fail.

Communication system implementation is broken down into five different NAS EA 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 & Oceanic Air-to-Ground Comm
4. Roadmap 4 (figure 5-8) - Air-to-Ground Data Communications
5. Roadmap 5 (figure 5-9) - Messaging Infrastructure

5.2.1 Telecom and Other Communications

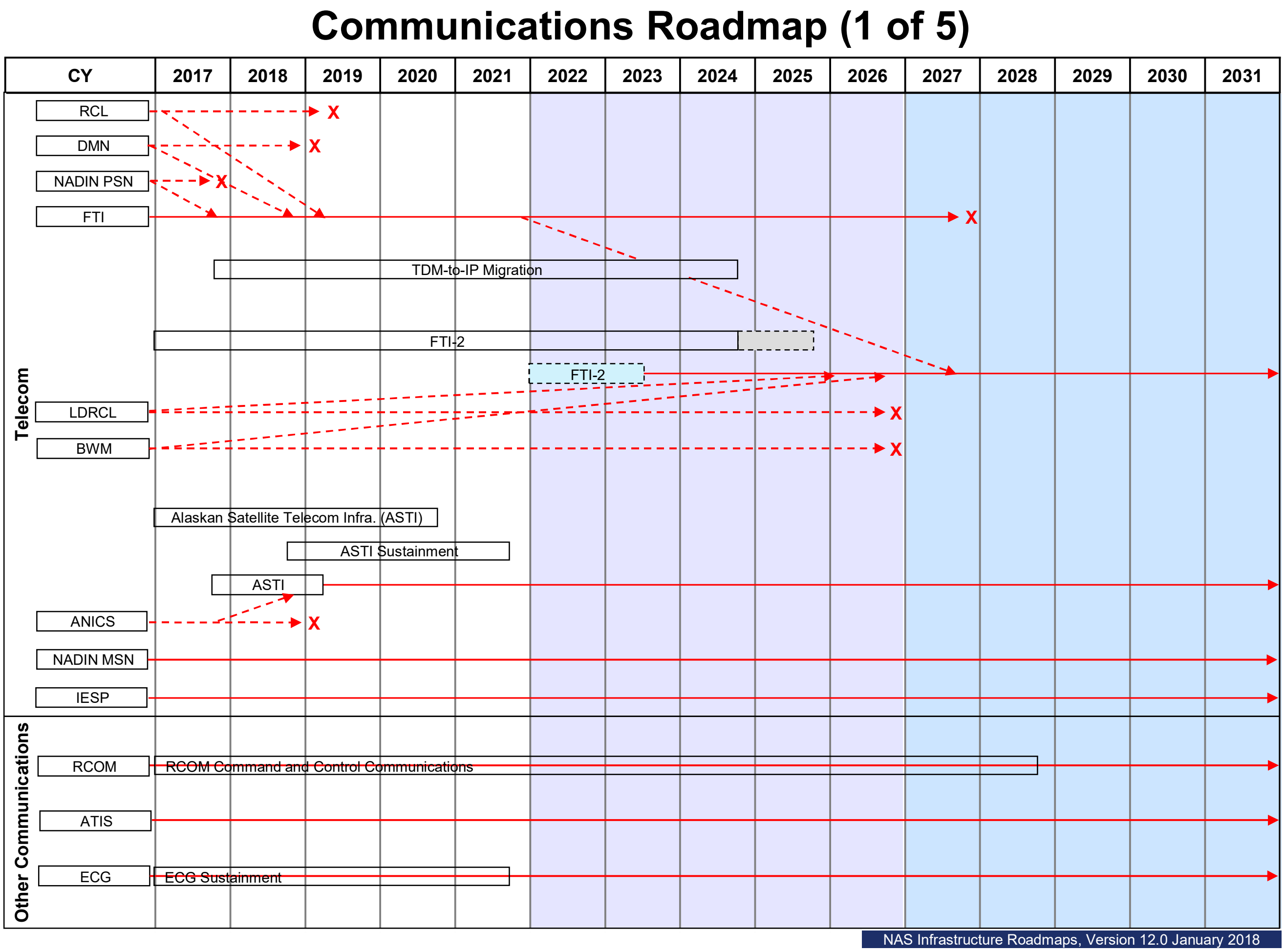

Figure 5-5 Telecom and Other Communications Roadmap

Radio Communications Link (RCL) equipment is an analog microwave system originally created to transmit radar data from remote radar sites to FAA air traffic control facilities. These systems were linked in a national network to transmit operational and administrative information to and from air traffic control facilities. RCL equipment is now obsolete and its functions are transitioning to the FAA Telecommunications Infrastructure (FTI) contract.

The Data Multiplexing Network (DMN) and the National Airspace Data Interchange Network – Package Switching Network (NADIN PSN), transmit flight plans and other important aeronautical information to air traffic facilities. The functions of DMN and NADIN PSN are also transitioning to the FTI network.

The FTI contract provides telecommunications services that are designed, engineered, and provisioned to meet FAA-specific availability, latency, and security requirements. FTI also provides enterprise-messaging services based upon Service-Oriented Architecture technologies and specialized infrastructure services such as a domain name service, network time protocol service, and security gateway services.

The Low Density Radio Communication Link (LDRCL) is a legacy analog microwave system providing a similar function as RCL (see above).

The Bandwidth Manager (BWM) is a network that uses an intelligent multiplexer to merge voice and data into a single data stream for transmission between BWM nodes located at FAA facilities.

FTI-2, C26.01-02, program (BLI 2E10) the successor program to FTI, will provide all of the capabilities currently available under the existing FTI contract plus the next generation of telecommunications, messaging, and infrastructure services required by FAA programs for the duration of the FTI-2 life cycle. FTI-2 will address the challenges associated with the phase-out of legacy TDM-based telecommunication services and incorporate the functionality of LDRCL and BWM. The program is working towards a FID.

The Time-Division Multiplexing to Internet Protocol (TDM-to-IP) Migration, M56.01-01, program (BLI 2E12) oversees the investment portfolio for TDM-to-IP migration and is conducting the systems interface development work in order to modernize NAS systems to be IP-compatible. Major U.S. telecommunications carriers plan to discontinue TDM-based services as early as calendar year 2020. More than 90% of the current FAA services obtained under the FTI contract are TDM-based. The program is working towards a FID.

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. 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 small and large facilities. ANICS provides 90% of the communications for En Route, Terminal, and Oceanic air traffic control, and Flight Services in Alaska.

The ASTI, C17.02-01, program (BLI 2E05) will modernize the ANICS to support routine, essential, and critical NAS Systems & Services. The ASTI Sustainment, C17.02-02, program (BLI 2E05) will establish yearly software/hardware releases to ensure that components fielded under ASTI remain operational through the system lifecycle.

The NADIN Message Switching Network (MSN) complies with international standards for transmitting flight plans between service providers and remains available for that purpose.

The Integrated Enterprise Service Platform (IESP) is a shared computing infrastructure that provides a common set of server and network hardware for the hosting of multiple NAS services. It leverages virtualization technology to maximize the return on investment for hardware procurements, and provides value added configuration management and high availability services. IESP uses an enterprise level Simple Network Management Protocol system that is capable of providing monitoring services for external NAS systems.

The NAS Recovery Communications (RCOM), C18.00-00, program (BLI 3A03) provides the FAA with the capability to directly manage the NAS during local, regional, and national emergencies when normal common-carrier communications are interrupted. This program provides and enhances a variety of fixed-position, portable, and transportable emergency communications systems to support crisis management and enable the FAA and other Federal agencies to exchange both classified and unclassified information to protect national security during an emergency.

The Automated Terminal Information System (ATIS) broadcasts weather and other pertinent information to pilots as they approach an airport. ATIS functions will remain operational for the entire timeframe of the roadmap.

For information about the En Route Communications Gateway (ECG) – Sustainment, A01.12-02, program, (BLI 2A02) see Automation Roadmap 1 section 5.1.1.

5.2.2 Voice Switches and Recorders

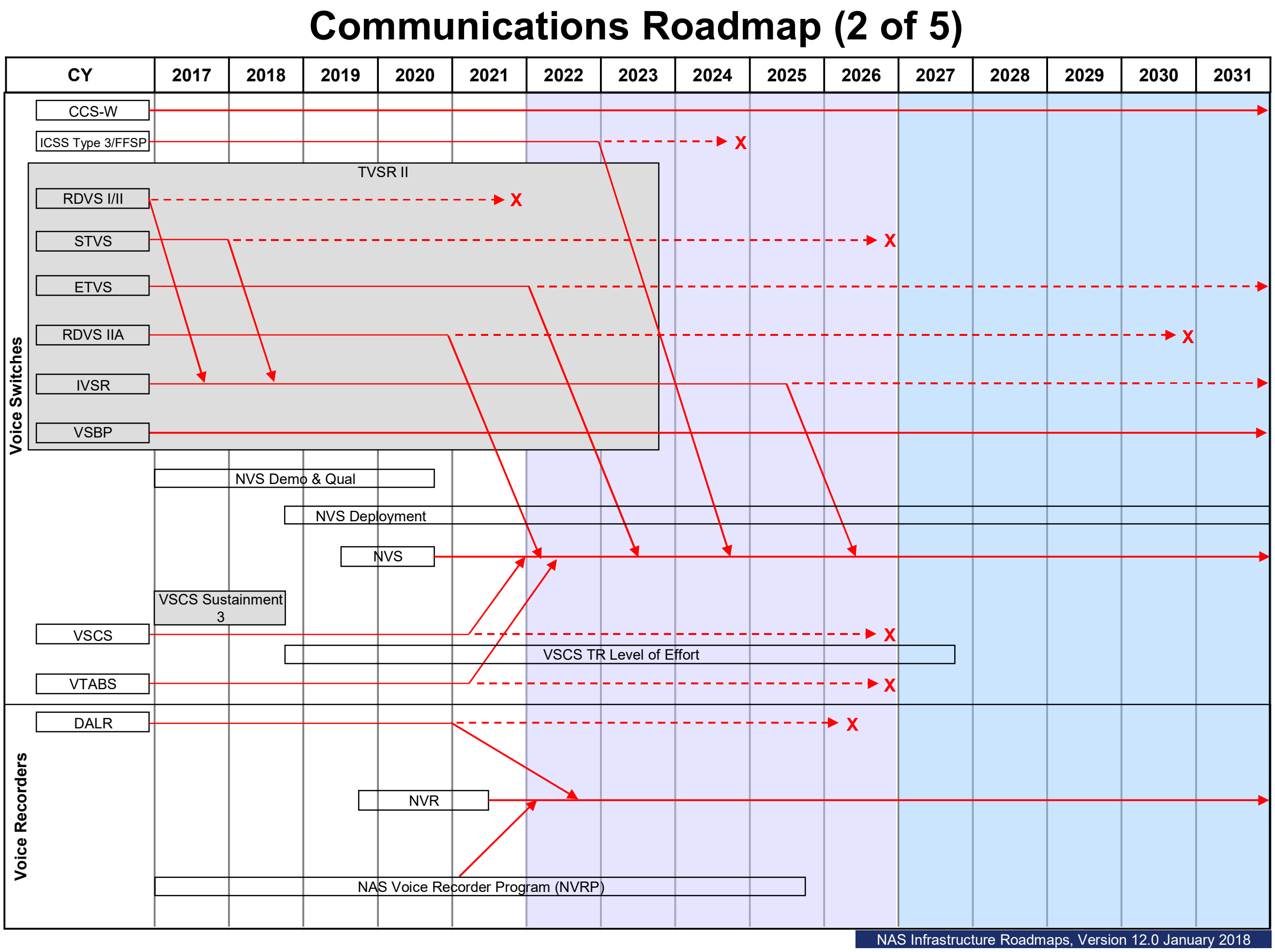

Figure 5-6 Voice Switches and Recorders Roadmap

At the top left of Figure 5-6 is the Conference Control Switch (CCS) installed at the FAA's Air Traffic Control System Command Center (ATCSCC) located in Warrenton, Va. The CCS allows the FAA specialists to stay in contact with air traffic control facilities and external users of the NAS. The ATCSCC specialists coordinate with centers, TRACONs, and users to decide how best to implement traffic management initiatives and when to use severe weather avoidance programs.

The Integrated Communication Switching System (ICSS) / Future Flight Services Program (FFSP) are installed at flight service stations. Decisions made for the FFSP will determine the future status of this switch. See also the FFSP description following Automation Roadmap 3 in section 5.1.

Terminal voice switching systems direct and control voice communications so that controllers can communicate with a properly equipped aircraft, another controller within their facility, or with a controller at another air traffic control facility. The Terminal Voice Switch Replacement (TVSR) II, C05.02-00, program (BLI 2B07) replaces and sustains aging, obsolete voice switches in ATC Towers and Terminal Radar Approach Controls to ensure controllers have reliable voice communications in the terminal environment. The program consists of several multiyear equipment contracts for voice switches that include Small Tower Voice Switches (STVS), Enhanced Terminal Voice Switches (ETVS), Rapid Deployment Voice Switches (RDVS), Voice Switch By Pass (VSBP) system, and Interim Voice Switch Replacement (IVSR). This program also establishes FAA contract vehicles with the flexibility to procure voice switch equipment for new or modernized terminal facilities. The 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.

Voice Switching and Control System (VSCS) allow the en route air traffic controllers to communicate with other Air Traffic Controllers, pilots, ground personnel, and other locations while managing and directing air traffic. The VSCS Training and Backup Switch (VTABS) are the hot backup switches that provide voice communications in the event that VSCS is unavailable. VTABS also will allow air traffic controllers to train on equipment virtually identical to VSCS.

The VSCS – Technology Refresh – Level of Effort, C01.02-05, program (BLI 2A08) will maintain ongoing analysis of Diminishing Manufacturing Sources and Material Shortages, conduct program management activities, and provide engineering support. Depending on continued engineering analyses, potential technology refresh activities may include VTABS Subsystem refresh, VSCS Control Subsystem refresh, and Position Equipment Test Set refresh. VSCS Technology Refresh Level of Effort will be a stand-alone effort starting FY 2019 and will continue to sustain VSCS/VTABS until fully replaced by NVS.

The NAS Voice System (NVS) will be implemented in two segments: 1) Demonstration & Qualification and 2) Deployment. The NVS program will replace decades old voice switch equipment in the tower, terminal, and en route facilities with a flexible, scalable, secure, digital Voice over Intranet Protocol technology. NVS will provide a nationwide capability for routing, monitoring, and sharing voice communication assets throughout the NAS and support NextGen features such as off-loading during non-peak operations. The NVS – Demonstration & Qualification, G03C.01-01, program (BLI 2B12) received FID for NAS qualification from the Joint Resources Council (JRC) in September 2014. The program will return to the JRC in FY 2019 to request FID approval for the NVS – Deployment, G03C.01-02, program (BLI 2B12) to deploy NVS to operational facilities beyond the key sites.

The Digital Audio Legal Recorder (DALR) provides a legally accepted recording capability for conversations between air traffic controllers, pilots, and ground-based air traffic facilities, and is used in all ATC facilities. These recordings are used in the investigation of accidents and incidents, and for routine evaluation of ATC operations.

The NAS Voice Recorder Program (NVRP), C23.02-01, (BLI 2B17) will replace the aging digital voice recorders and provide improved digital voice recording functionality to meet new validated safety and audit requirements to comply with Air Traffic Organization (ATO) safety orders. The program is working towards a FID.

5.2.3 Air-to-Ground Voice and Oceanic Air-to-Ground Communications

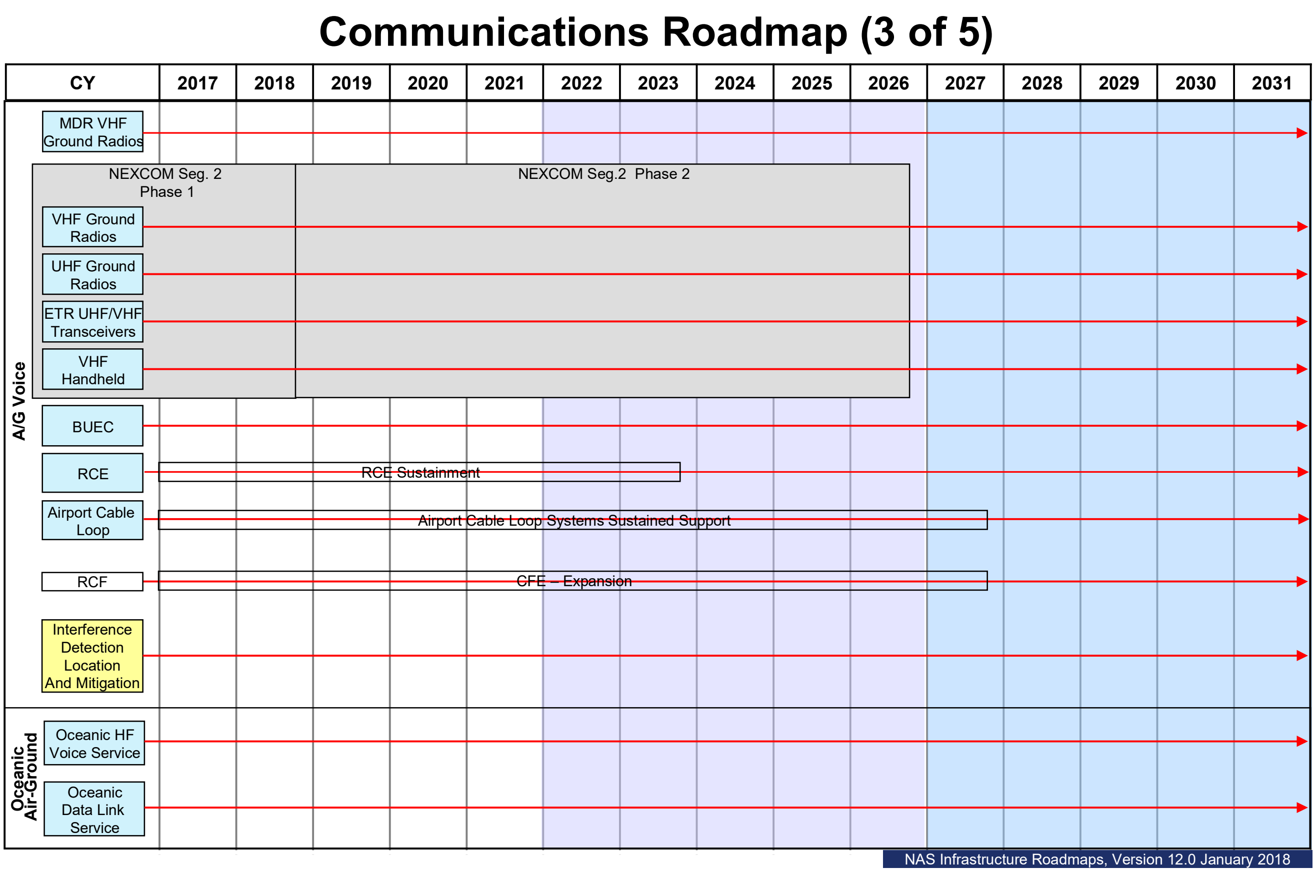

Figure 5-7 Air-to-Ground Voice and Oceanic Air-to-Ground Communications Roadmap

At the top left of Figure 5-7 is Multimode Digital Radios (MDR) Very High Frequency (VHF) Ground Radios that are used by controllers to communicate with the pilots. MDRs can operate in both the existing analog 25 kHz bandwidth voice mode protocol for channel separation, or in the more efficient 8.33 kHz bandwidth voice mode currently used in Europe. The MDRs support Voice over Internet Protocol (VoIP) and meet the requirements of the NextGen Data Communications and NVS programs.

Very High Frequency (VHF) and Ultra High Frequency (UHF) Ground Radios utilize the 25 kHz bandwidth to allow controllers to communicate with civilian and military aircraft, respectively.

The Emergency Transmitter Replacement (ETR) UHF/VHF Transceivers provide emergency and backup service when primary radios are not working. VHF Handheld Transceivers are used by maintenance technicians so they can communicate with each other and with ATC tower personnel.

The Next Generation VHF and UHF Air/Ground (A/G) Communications (NEXCOM) program replaces the aging and obsolete NAS A/G analog radios with digital radios that allow direct voice communication with pilots. The NEXCOM Segment 1a program completed replacement of all 25,000 en route radios with MDRs in FY 2013 at both primary and back up communications (BUEC) sites.

The NEXCOM Segment 2 program is segmented into two phases and will ultimately replace a total of 35,000 primary and backup VHF and UHF radios at terminal and flight service facilities. Phase 1 will replace a total of 15,000 radios from FY 2009 through FY 2018. NEXCOM – Segment 2 Phase 2, C21.02-02, program (BLI 2A10) will replace a total of 20,000 radios from FY 2019 through FY 2026. The Phase 2 program will also replace Emergency Transceivers and is working towards a FID.

The Backup Emergency Communication (BUEC) is a facility that consists of radios and equipment installed at remote sites that backup the primary radios installed at Remote Communication Air Ground facilities, all of which are used by ARTCC controllers to communicate with pilots.

The Radio Control Equipment (RCE) allows voice and data communications between the air traffic controller and pilots using remotely located VHF/UHF radios accessible via the RCE and interconnection telecommunications networks.

The RCE – Sustainment, C04.01-01, program (BLI 2A06) replaces obsolete radio signaling and control equipment which controllers use to select a remote radio channel.

Airport Cable Loop are FAA-owned signal/control cable lines that feed airport surveillance radar, air/ground communications, and landing systems data and information to the tower, and operational and maintenance information to FAA-staffed facilities.

The Airport Cable Loop Systems Sustained Support, F10.00-00, program (BLI 2E04) replaces existing on-airport, copper-based, FAA-owned signal/control cable lines that have deteriorated. Where cost-effective, the program will install fiber-optic cable in a ring formation to provide redundancy and communications diversity.

The Communications Facilities Enhancement (CFE) – Expansion, C06.01-00, program (BLI 2A06) provides new, relocated, or upgraded Remote Communication Facilities (RCF) to enhance the A/G communications between air traffic control and the aircraft when there are gaps in coverage or new routes are adopted. The program also provides various upgrades to RCFs, including building and tower grounding lightning protection, and replaces cables from the equipment to the antennas when necessary to improve radio equipment performance.

The Interference Detection, Location, and Mitigation program investigates occurrences of non-FAA transmitters interfering with FAA radios and navigation systems, locates the source, and ensures that they no longer interfere with FAA controlled frequencies. The FAA has specially equipped vehicles that detect and locate the sources of interference.

The Oceanic High Frequency (HF) Voice Service allows controllers and pilots to communicate over oceanic airspace once the aircraft is out of range from ground-based VHF radios.

The Oceanic Satellite Data Link Services is used by equipped aircraft and relies on communications satellites to transfer messages to and from aircraft flying over the oceans. Once aircraft are beyond the range of radar, pilots must report their position using either HF Voice Service or satellite-based Oceanic Data Link Service when they arrive at predetermined waypoints.

5.2.4 Air-to-Ground Data Communications

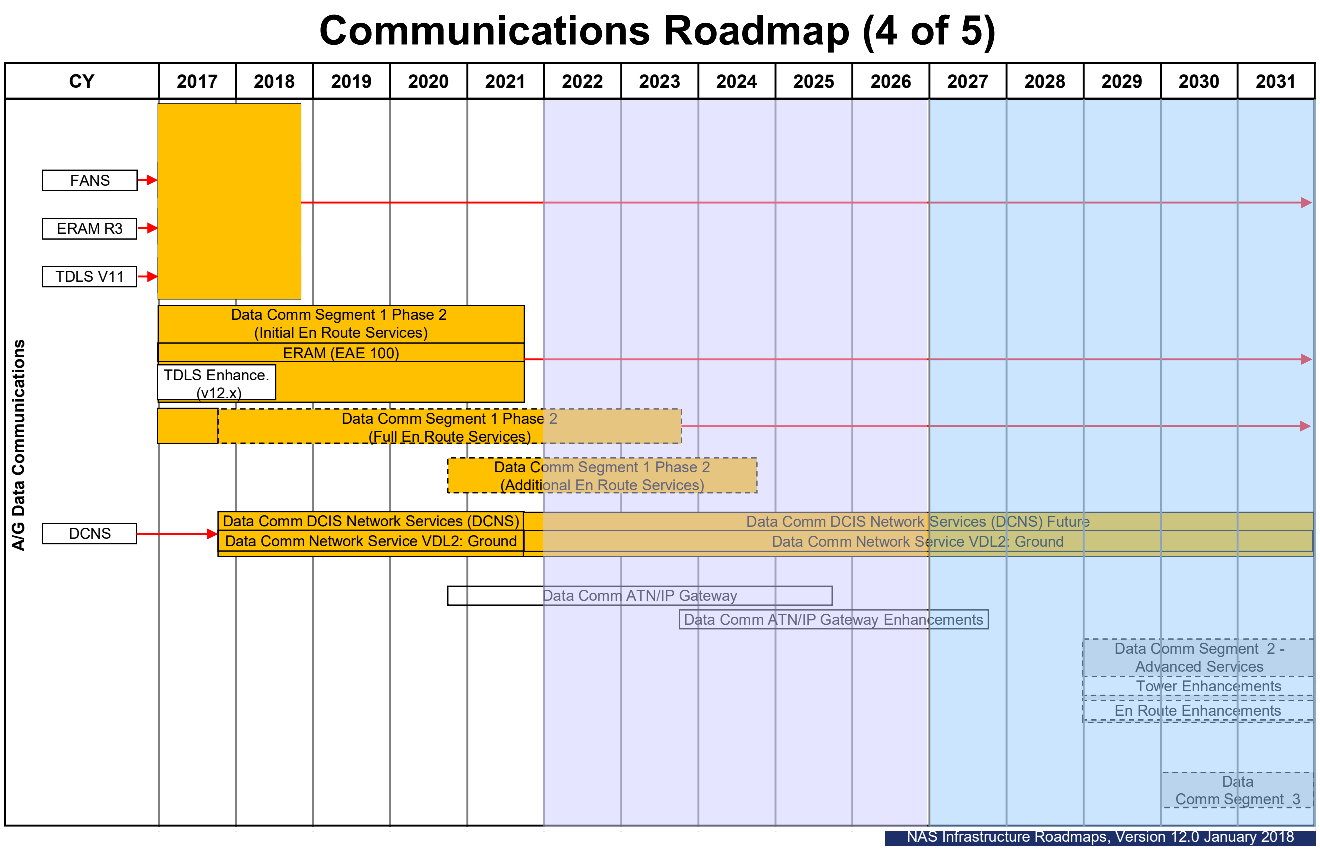

Figure 5-8 Air-to-Ground Data Communications Roadmap

The Future Air Navigation System (FANS) is an avionics system that provides data link communication between the pilot and the Air Traffic Controller using the Aircraft Communications Addressing and Reporting System network.

The En Route Automation Modernization (ERAM) system became fully operational in 2015 and supports the agency's transition to NextGen. ERAM Release 3 (R3) added functionality to support the Data Comm Segment 1 Phase 1 program.

The Tower Data Link Services (TDLS) provides data link of the as-filed flight plan, called Pre-Departure Clearance (PDC), through Airline operators to pilots preparing to depart an airport.

The Data Comm program provides data communications services between pilots and air traffic controllers. Data Comm will provide a link between ground automation and flight deck avionics for ATC clearances, instructions, traffic flow management, flight crew requests and reports. Data Comm is critical to the success of NextGen operational improvements by providing communication infrastructure enhancements. Data Comm will deliver planned NAS improvements in multiple segments with segment 1 being delivered in two phases. Segment 1 provides the initial set of data communications services integrated with automation support tools to provide NAS benefits and lay the foundation for a data-driven NAS. Segment 1 Phase 1 (S1P1) deployed the Controller-Pilot Data Link Communications (CPDLC) Departure Clearance (DCL) service in the Tower domain ahead of schedule and under budget.

The Data Comm Segment 1 Phase 2 (S1P2) Initial En Route Services, G01C.01-06, program (BLI 2A17) will deliver CPDLC data communications services to the En Route domain. The initial services will include transfer of communication/initial check-in, airborne reroutes, altimeter settings and altitudes, limited controller initiated reroutes, limited direct-to-fix messages, and limited crossing restrictions. The Data Comm En Route services will contribute to a reduction in flight delays, more efficient routes for aircraft resulting in increased operational efficiency, enhanced safety all while reducing operational costs for airspace users.

The Data Communications – S1P1 and S1P2 Data Comm Integrated Services (DCIS) Network Services, G01C.01-07, program (BLI 2A17) and the Data Communications – Segment 1 Phase 1 & Phase 2 Data Comm Integrated Services (DCIS) Network Services Future, G01C.01-11, program (BLI 2A17) will continue to expand the VHF Data Link (VDL) Mode 2 air ground network service that provides connectivity between the controllers and the cockpit. The Data Comm Network Service (DCNS) includes operations and maintenance, monitoring and control, and certification suite activities and supports both surface and en route operations.

The Data Comm Segment 1 Phase 2 program will extend Full En Route Services by providing services that are more complex. These services will include full controller initiated reroutes, full crossing restrictions, full direct-to-fix, advisory messages, and holding instructions. There is no funding requested in the CIP for this program after FY 2017.

If approved, the Data Comm Segment 2 and Segment 3 programs will further build upon CPDLC DCL and En Route services by supporting the delivery of services to enable advanced NextGen operations not possible using voice communications, such as Four Dimensional Trajectory Data Link, Advanced Interval Management, Tailored Arrivals, Digital Taxi, and dynamic Required Navigation Performance (RNP). Data Comm will also implement an Aeronautical Telecommunications Network (ATN) ground system to support advanced Baseline 2 avionics. ATN is an advanced architecture that allows ground/ground, air/ground, and avionic data subnetworks to interoperate by adopting common interface services and protocols. The Baseline 2 set of ATN standards will enable advanced operations and services, and represents the internationally harmonized standard for data communications avionics.

5.2.5 SWIM Messaging Infrastructure

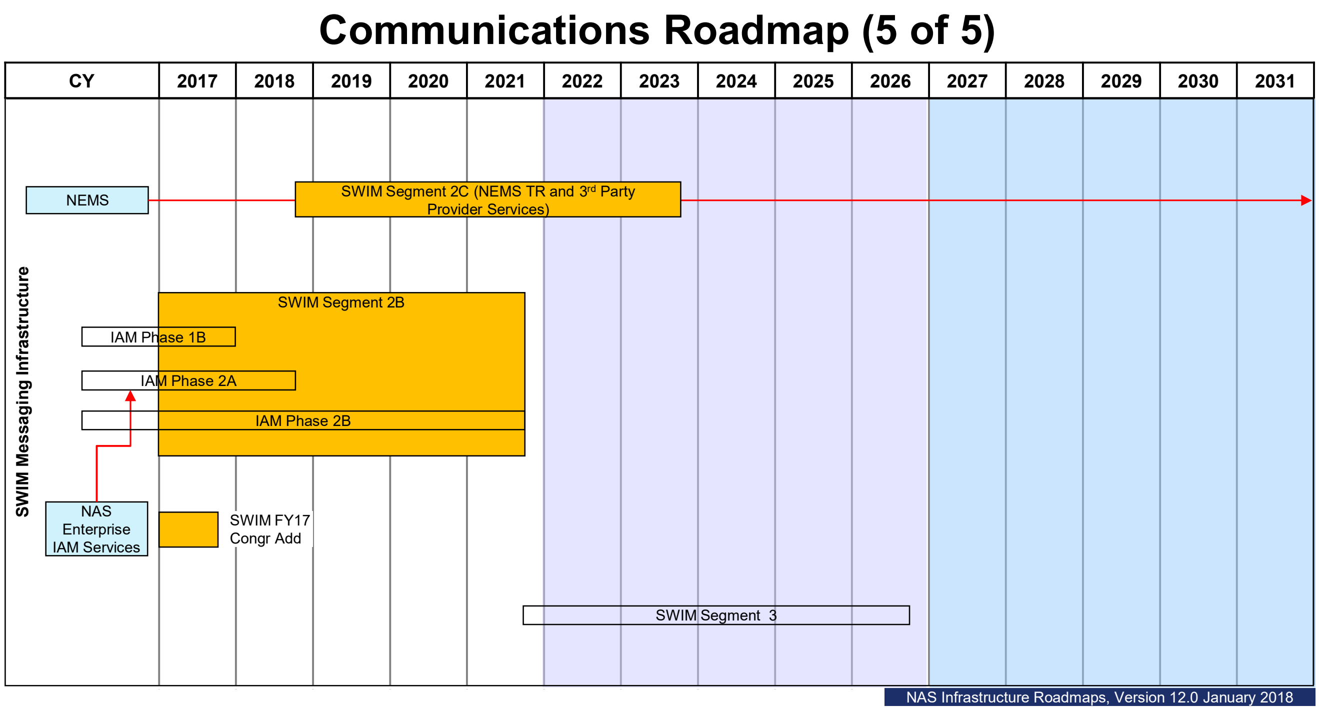

Figure 5-9 SWIM Messaging Infrastructure Roadmap

Figure 5-9 shows the System Wide Information Network (SWIM) components.

The NAS Enterprise Messaging Service (NEMS) is a FTI Service, which provides an Enterprise Service Oriented Architecture (SOA) messaging infrastructure for the NAS. NEMS supports two types of standards-based messaging exchange patterns, Publish/Subscribe, and Request/Response. The Publish/Subscribe model is used when a Service Provider continually publishes data to multiple Service Consumers. The Request/Response model is better suited for services with data exchanges on an ad-hoc basis.

NAS Enterprise Identity and Access Management (IAM) Service provides secure digital credentials for NAS messaging and web services. In alignment with the National Strategy for Trusted Identities in Cyberspace, IAM provides authentication and authorization services that ensure secure information sharing with FAA partners.

SWIM's enterprise infrastructure enables systems to publish information of interest to NAS users, request and receive information from other NAS services, and support NAS security requirements. SWIM Segment 2B, G05C.01-08, program (BLI 2A11) provides Governance to NAS programs to ensure services are SWIM compliant and meet all FAA SOA standards. Segment 2B will implement Identity and Access Management Phase 2, Enterprise Service Monitoring Phase 2 and 3, SWIM Terminal Data Distribution System Phase 2, and NAS Common Reference.

SWIM Segment 2C – NAS Enterprise Messaging Service (NEMS) Technology Refresh Infrastructure and 3rd Party Provider, G05C.01-10, program (BLI 2A11) includes additional infrastructure and capabilities to strengthen the overall NAS information system security posture. The program includes technology refresh of existing NAS Enterprise Messaging Service (NEMS) infrastructure; additional NEMS Infrastructure upgrades at eight sites to expand capacity; and adding 3rd Party Provider Services to support 500+ Tier 2 external NEMS consumers. The program is working towards a FID.

5.3 Surveillance Roadmaps

To provide separation services to aircraft, air traffic controllers must have an accurate display of all aircraft under their control. 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 and sent 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.
- ADS-B – the aircraft determines its location using a Global Positioning System (GPS) receiver or other navigation equipment and broadcasts that information to an ADS-B ground station. The ground station relays the position information to automation systems that process the data and send it to controller displays. ADS-B Out equipage has been mandated in most controlled airspace by January 1, 2020, generally, where transponders are required today.

En route and terminal facilities normally use Secondary radars for traffic separation, either the Air Traffic Control Beacon Interrogators (ATCBI) or the Mode Select (Mode S). Using ATCBI or Mode S enhances the controller's ability to separate traffic because speed and altitude information supplement the position display for each aircraft.

Surveillance systems are shown in three different roadmaps:

1. Roadmap 1 (figure 5-10) - En Route Surveillance
2. Roadmap 2 (figure 5-11) - Terminal Surveillance
3. Roadmap 3 (figure 5-12) - Surface and Approach & Cross Domain Surveillance

5.3.1 En Route Surveillance

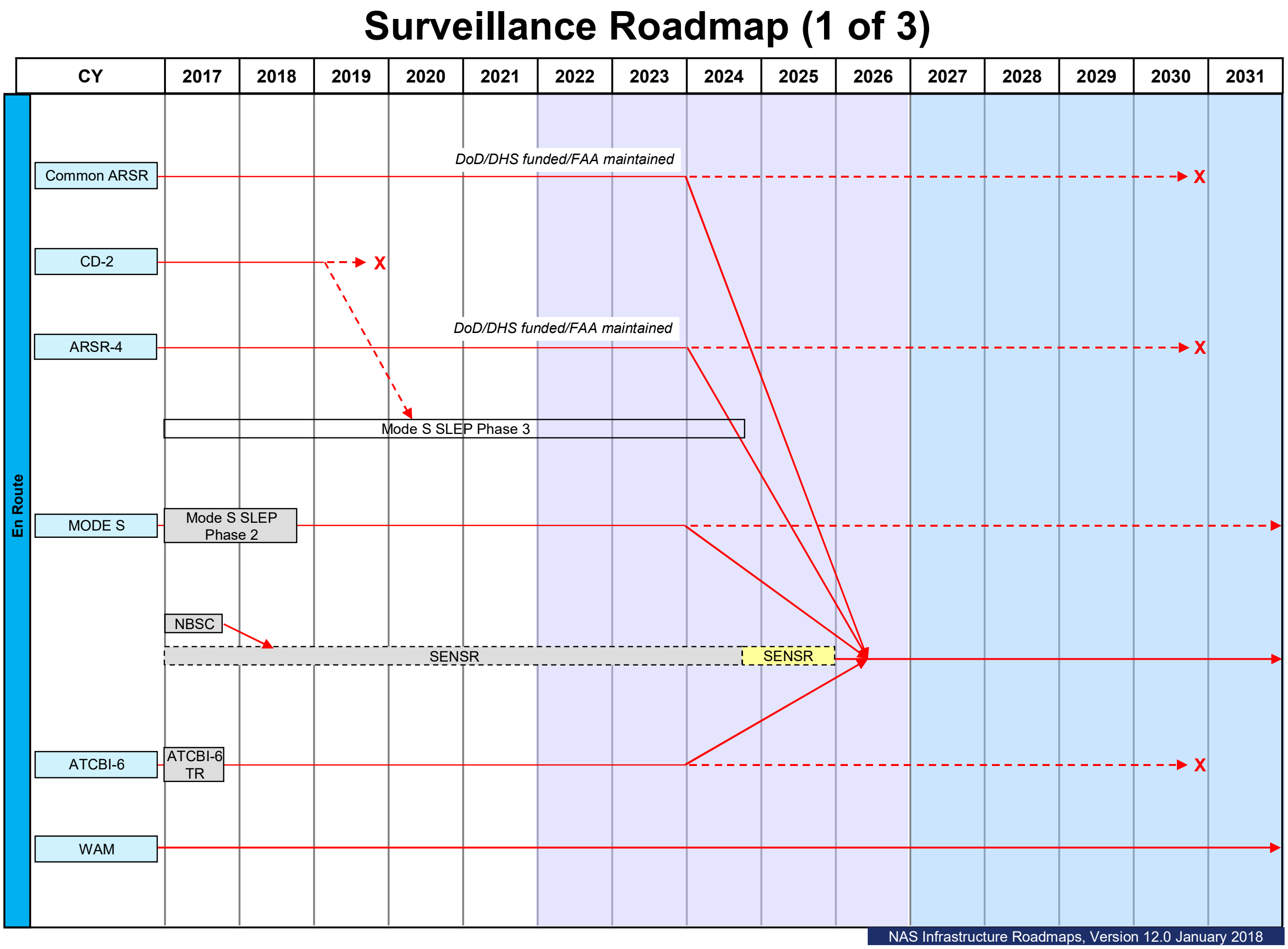

Figure 5-10 En Route Surveillance Roadmap

The Common Air Route Surveillance Radar (ARSR) (CARSR) and the ARSR-4 are long-range primary radars that are used to support defense of the national airspace and provide surveillance data to air traffic control facilities for the continental United States, Guam, and Hawaii. The DoD and Department of Homeland Security will continue to fund system upgrades of the CARSRs and ARSR-4s through the period of the roadmap to support national security.

The Common Digitizer – Model 2 (CD-2) is used to convert the analog radar and weather information provided by the primary en route radar system to a digital format to support the ATC automation systems.

The Mode Select (Mode S) system provides cooperative (secondary) aircraft surveillance in Terminal and En Route airspace. Mode S uses selective beacon detection technology to provide target data as digital formatted messages and analog video tailored for automation and display systems at TRACON and ARTCC facilities, the U.S. Department of Defense (DoD), and other users. Mode S systems are co-located with Airport Surveillance Radar Model 9 (ASR-9), ASR-8, or the CARSR.

The Mode S Service Life Extension Program (SLEP) Phase 2 program will implement modifications to the Mode S system to sustain secondary aircraft surveillance. The Mode S program is conducting an additional High Gain Open Planner Array Antenna Assessment to determine the requirements for new antenna procurements and/or the number of antennas that can be refurbished to sustain Mode S through 2026.

The Mode S SLEP Phase 3, S03.01-13, program (BLI 2B15) conducted an alternatives analysis, based on a Market Survey, and determined that a replacement of a major portion of the legacy system would provide technical benefits at lower cost to address component obsolescence. The program will replace a major portion of the legacy Mode S system with a design that incorporates modern surveillance interfaces, and defends and mitigates cyber security threats. The program is working towards a FID.

A cross-agency program titled Spectrum Efficient National Surveillance Radar (SENSR) has been initiated to make available the band 1300-1350 MHZ for reallocation to shared Federal and non-Federal use through updated radar technology. The SENSR Spectrum Pipeline Plan has been approved and the Government is receiving funds from the Spectrum Relocation Fund to conduct a two-phased feasibility assessment of the proposed spectrum reallocation. The feasibility assessment is expected to be completed by 2021.

- Phase I – Defining: The first phase would occur over approximately two years and will focus on requirements and concept development as well as documenting expected costs and information for all impacted systems.
- Phase II – Refining: The second phase will focus on maturing the selected alternative into a viable and well-planned investment program ready for Solution Implementation.

The NAS systems that utilize or maybe affected by this program include Common ARSR, ARSR-4, Mode S, ATCBI-6, TDX-2000, ASR-8, CTD, ASR-9, ASR-9 WSP, ASR-11, LLWAS, and NEXRAD.

The Next Generation Backup Surveillance Capability (NBSC) and the Next Generation Surveillance and Weather Radar Capability (NSWRC) have been subsumed by the SENSR program. In the event the SENSR program is determined to be infeasible, the FAA must provide a cost-effective replacement for legacy cooperative surveillance service as a backup for ADS-B in en route and select high density terminal environments, and in the terminal domain to provide weather information and wind shear alerts. In that case, the investment analysis activities to address shortfalls will be reinitiated for both NBSC and NSWRC.

The ATCBI-6 provides air traffic controllers with a selective interrogation capability that significantly improves the accuracy of aircraft position and altitude data provided to ATC automation systems. Additionally, the ATCBI-6, in conjunction with a co-located primary Long Range Radar, provides back-up Combined Control Facility (CCF) surveillance service to numerous TRACON facilities in the event terminal radar services are lost.

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.

5.3.2 Terminal Surveillance

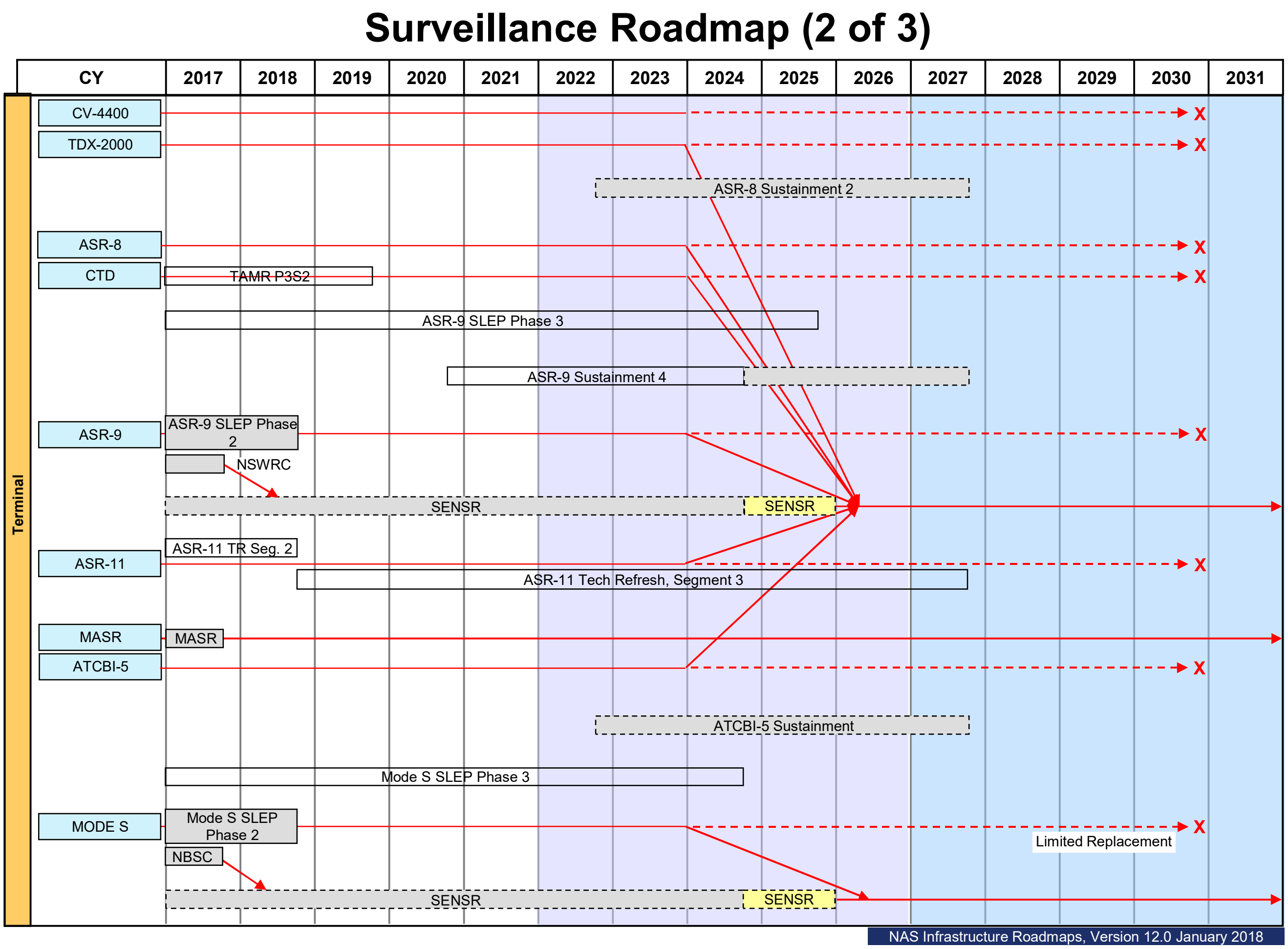

Figure 5-11 Terminal Surveillance Roadmap

The CV-4400 at the top of figure 5-11 is a legacy system that allows use of terminal radar information in en route automation systems, i.e., using terminal radar to fill gaps in en route radar coverage at selected en route centers.

The TDX-2000 is a legacy system that digitizes the output of analog radars, such as an Airport Surveillance Radar Model 8 (ASR-8), for use by more modern digital automation systems such as STARS.

For information about the Terminal Automation Modernization – Replacement (TAMR) – Phase 3, Segment 2, A04.07-02, program (2B03), see section 5.1.1, Automation Roadmap 1.

The ASR-8 is a primary radar system that requires a Common Terminal Digitizer (CTD) to be installed to convert the ASR-8's analog output to a digital input for compatibility with STARS. As more of the remaining ARTS automation systems are replaced by STARS additional CTDs will be needed.

If approved, the ASR-8 Sustainment 2 program will address sustainment of the radar as components reach end-of-life.

The ASR-9, a non-cooperative primary surveillance radar, provides aircraft position and six-level weather information to automation systems for air traffic controllers in terminal airspace. The ASR-9 also provides data to the Airport Movement Area Safety System (AMASS) and to the Airport Surface Detection Equipment – model X (ASDE-X) to aid in the prevention of accidents resulting from runway incursions.

The ASR-9 SLEP Phase 2 program will implement modifications to the ASR-9 system to sustain primary radar. The program will procure Digital Remote Surveillance Communication Interface Processor Replacement systems, Transmitter Backplanes, and Radar Data Access Point, and replenishment of depot inventory of critical components.

The ASR-9 SLEP Phase 3, S03.01-12, and ASR-9 Sustainment 4, S03.01-14, programs (BLI 2B09) replace or upgrade obsolete ASR-9 hardware and software to ensure the continued operation of the radar system. This is an ongoing program that is accomplished in phases to address obsolescence and supportability issues. Both of the programs are working towards a FID.

The Next Generation Surveillance and Weather Radar Capability (NSWRC) has been subsumed by a cross-agency program titled Spectrum Efficient National Surveillance Radar (SENSR), see Surveillance Roadmap 1 in section 5.3.1 for more information.

The ASR-11 is an integrated primary and secondary radar providing six-level weather intensity information to terminal ATC automation systems. The ASR-11 has replaced several of the radars that were not replaced by the ASR-9.

The ASR-11 Technology Refresh Segment 2 program replaces and upgrades obsolete Commercial-Off-The-Shelf (COTS) hardware and software to ensure the continued, reliable, and cost effective operation of the ASR-11 radar system in the NAS. The Segment 2 program is addressing Site Control Data Interface /Operator Maintenance Terminal obsolescence and the Uninterruptible Power Supply capacitor at end of life expectancy.

The ASR-11 Technology Refresh Segment 3, S03.02-07, program (BLI 2B10) replaces and upgrades obsolete Commercial-Off-The-Shelf hardware and software and operational performance deficiencies to ensure the continued reliable and cost effective operation of the radar system in the NAS. The program is working towards a FID.

The Mobile Airport Surveillance Radar (MASR) is a terminal surveillance radar capability that can be moved from site to site to support radar relocations, temporary planned outages to accommodate installation of upgrades to an existing radar, and emergency operations when existing systems are damaged. MASR capability is planned to continue beyond the time frame of the roadmap.

The ATCBI-5 is a secondary surveillance radar that has been operational for more than 25 years. It provides aircraft identification, altitude, airspeed and direction to terminal ATC systems.

If approved, the ATCBI-5 Sustainment program will address sustainment of the radar as components reach end-of-life.

For information about the Mode S system and Mode S SLEP Phase 3, S03.01-13, program, please refer to Surveillance Roadmap 1 in section 5.3.1 En Route Surveillance.

For information about NBSC and SENSR, refer to Surveillance Roadmap 1 in section 5.3.1 En Route Surveillance.

5.3.3 Surface and Approach & Cross Domain Surveillance

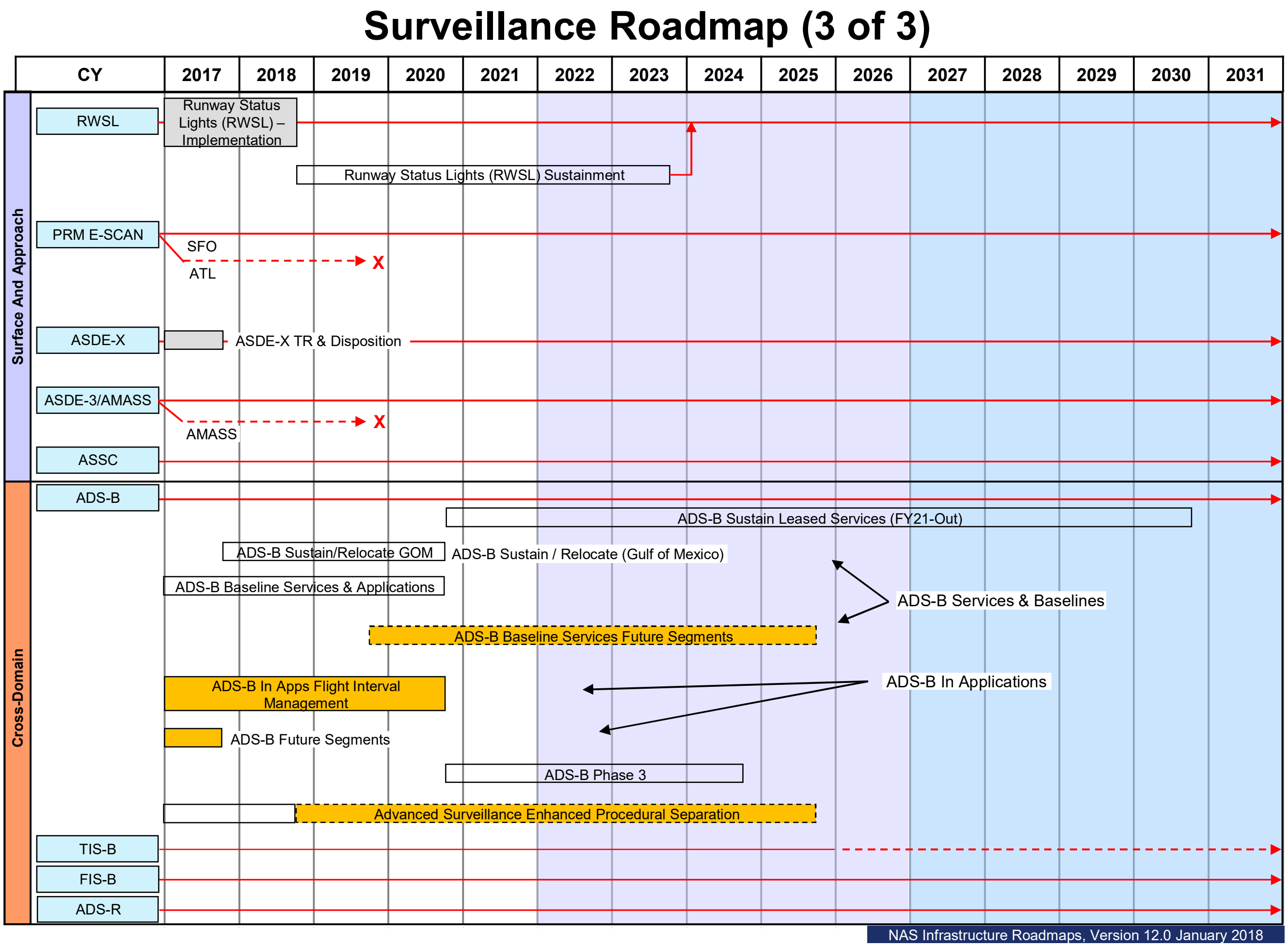

Figure 5-12 Surface and Approach & Cross Domain Surveillance Roadmap

The Runway Status Lights (RWSL) system, see top left of figure 5-12, integrates runway lighting equipment with approach and surface surveillance systems to provide a visual signal to pilots and vehicle operators indicating when it is unsafe to enter/cross or begin takeoff on the runway. The system is fully automated based on inputs from surface and terminal surveillance systems. The RWSL Implementation program is planning to have all sites operational by FY 2019.

The RWSL Sustainment, S11.01-04, program (BLI 2B11) will assess the need to replace and upgrade obsolete COTS hardware and software to ensure the continued reliable and cost effective operation of the system through its designated lifecycle. The RWSL systems were procured in late 2008, fielded between 2009 and 2019, and are intended to remain operational until replacement begins in 2026. The program is working towards a FID.

The Electronic Scan (E-SCAN) version of Precision Runway Monitor (PRM) is used to monitor the safety of aircraft conducting side-by-side simultaneous approaches to closely spaced parallel runways during Instrument Flight Rules (IFR) conditions. It achieves rapid update by moving the beam electronically rather than relying on turning the antenna. It is a secondary rapid update radar that provides the precision that controllers need to ensure that two aircraft maintain safe clearance between them while approaching closely spaced runways. The FAA Flight Standards organization has determined that required runway separation requirements can be reduced which eliminated the need for PRM at Atlanta (ATL). The PRM at San Francisco (SFO) will be sustained utilizing assets from the ATL PRM.

Airport Surface Detection Equipment Model-X (ASDE-X) enables air traffic controllers to track surface movement of aircraft and vehicles. ASDE-X Safety Logic enhances the situational awareness for air traffic controllers by using surveillance information from ASDE-X to determine if the current and/or projected positions and movement characteristics of tracked aircraft/vehicles present a potential collision situation. Visual and audible alerts are provided to the air traffic controllers when the safety logic predicts a collision.

The Airport Surface Detection Equipment Model 3 (ASDE-3) is a primary radar system that provides a display of aircraft and ground vehicles in the airport operating areas (runways and taxiways). The Airport Movement Area Safety System (AMASS) is an automation system that utilizes position information from the ASDE-3 system and terminal radars to provide an automatic visual and audio alert to controllers when it detects potential collisions between aircraft or aircraft and vehicles on or near the airport runways.

Implemented within the ADS-B NAS Wide Implementation – Baseline Services & Applications program, the Airport Surface Surveillance Capability (ASSC) is a surface multilateration system which receives inputs from multilateration sensors, ADS-B, and Airport Surveillance Radar/Mode Select (ASR/Mode S) terminal radars. Using fused target data, ASSC enhances situational awareness for tower controllers by providing in near real-time for display, the position of all transponder-equipped aircraft and ADS-B equipped ground vehicles on the airport surface movement area, and aircraft flying within five miles of the airport.

Automatic Dependent Surveillance – Broadcast (ADS-B) is an advanced surveillance technology that provides highly accurate and more comprehensive surveillance information and is an enabling technology for NextGen. Aircraft position is determined using the Global Navigation Satellite Service (GNSS), and/or an internal inertial navigational reference system, or other navigation aids. The aircraft's ADS-B equipment processes this position information, along with other flight parameters to be broadcast on the order of once a second to airborne and ground-based ADS-B receivers. This information is used to display the aircraft's position on en route and terminal automation systems.

ADS-B NAS Wide Implementation – Baseline Services & Applications (Service Volume), G02S.03-01, program (BLI 2A12) ensures continuation of the FAA subscription for ADS-B Baseline Services delivered by the prime contractor utilizing contractor owned and operated ADS-B infrastructure and service volumes already in place in the NAS. Subscription fees support the operation of the system, necessary upgrades, and eventual modernization. The program also provides Wide-area Multilateration (WAM) surveillance service capability providing aircraft location information to the automation systems. These services allow controllers to provide separation services at airports in Colorado, North Carolina, and California. Eight airports in the NAS will receive Airport Surface Surveillance Capability (ASSC), which is a surface multilateration system that receives inputs from cooperative and non-cooperative sensors.

The ADS-B Sustain Leased Services (FY21-Out), G02S.03-06, program (BLI 2A12) will continue to provide leased ADS-B services for FY 2021 and beyond. The program plans to introduce a new scope to Baseline Services & Applications by implementing a surveillance backup strategy, new mitigations for spectrum congestion, and re-competing service contracts. The program is working towards a FID.

The ADS-B NAS Wide Implementation Sustain/Relocate (Gulf of Mexico (GOM) Platform), G02S.05-01, program (BLI 2A12) will sustain availability of ADS-B services for the U.S. portion of the GOM by relocating equipment to other locations when existing platforms shut down operations.

The ADS-B NAS Wide Implementation Phase 3, G02S.06-01, program (BLI 2A12) will expand services to new locations and develop enhancements to meet FAA and user requirements. The program is working towards a FID.

ADS-B In Applications – Flight Interval Management (IM), G01S.02-01, program (BLI 1A04) consists of a set of ground and flight deck capabilities and procedures that are used in combination by air traffic controllers and flight crews to more efficiently and precisely manage spacing between aircraft.

If approved, the ADS-B Baseline Services Future Segments program will develop additional IM concepts.

The Advanced Surveillance Enhanced Procedural Separation (ASEPS) will evaluate increasing the use of current separation standards and potentially reduce separation in Oceanic Flight Information Regions. The program is updating the business case and is working towards a FID.

Traffic Information Services – Broadcast (TIS-B) is a service that provides ADS-B equipped aircraft with surveillance data about both ADS-B and non-ADS-B equipped aircraft, providing a more complete "picture" of nearby air traffic.

Flight Information Services – Broadcast (FIS-B) services provide ground-to-air broadcast of non-air traffic control advisory information that provides users with valuable, near real-time information to operate safely and efficiently. FIS-B products include graphical and textual weather reports and forecasts, Special Use Airspace Information, Notices to Airmen, and other aeronautical information.

Automatic Dependent Surveillance – Rebroadcast (ADS-R) translates and uplinks ADS-B messages received from aircraft with data links on different frequencies enabling each aircraft and vehicle to receive the information being transmitted by the other.

5.4 Navigation Roadmaps

Navigation aids (Navaids) can be electronic or visual. En route and terminal electronic aids have traditionally been ground-based radio transmitters that emit signals that allow pilots with aircraft equipped with related avionics to determine the direction and/or distance from the Navaids. The ground-based system commonly used for en route navigation is the Very High Frequency Omnidirectional Range (VOR) with Distance Measuring Equipment (DME). Aircraft equipped with GPS navigation systems are now able to navigate departure to destination routes without the ground-based aids. Visual Navaids are ground-based lighting systems that show pilots the path they need to follow during approach and landing.

Navaids also have an important role in guiding pilots to a safe landing in low visibility conditions. They support two types of approaches — precision and non-precision. Instrument Landing Systems (ILS) are used for precision approaches and allow pilots to descend to lower minimum altitudes than are possible with non-precision approaches. Localizer Performance with Vertical Guidance (LPV) is a high precision GPS/ Wide Area Augmentation System (WAAS) instrument approach procedure with a decision height of 200 feet; similar to the ILS Category I. The minimum altitude, also called the decision height, is the lowest an aircraft can descend before committing to land and the pilot must be able to see the runway at that altitude before descending further. Non-precision approaches use Navaids (other than ILS) and usually only provide lateral guidance, not vertical guidance.

Navigational aid programs are portrayed in two different roadmaps:

1. Roadmap 1 (figure 5-13) – Infrastructure, and Safety and Enhancements
2. Roadmap 2 (figure 5-14) – En Route/Terminal Navigation & Non-Precision/Precision Approach

5.4.1 Infrastructure, and Safety and Enhancements

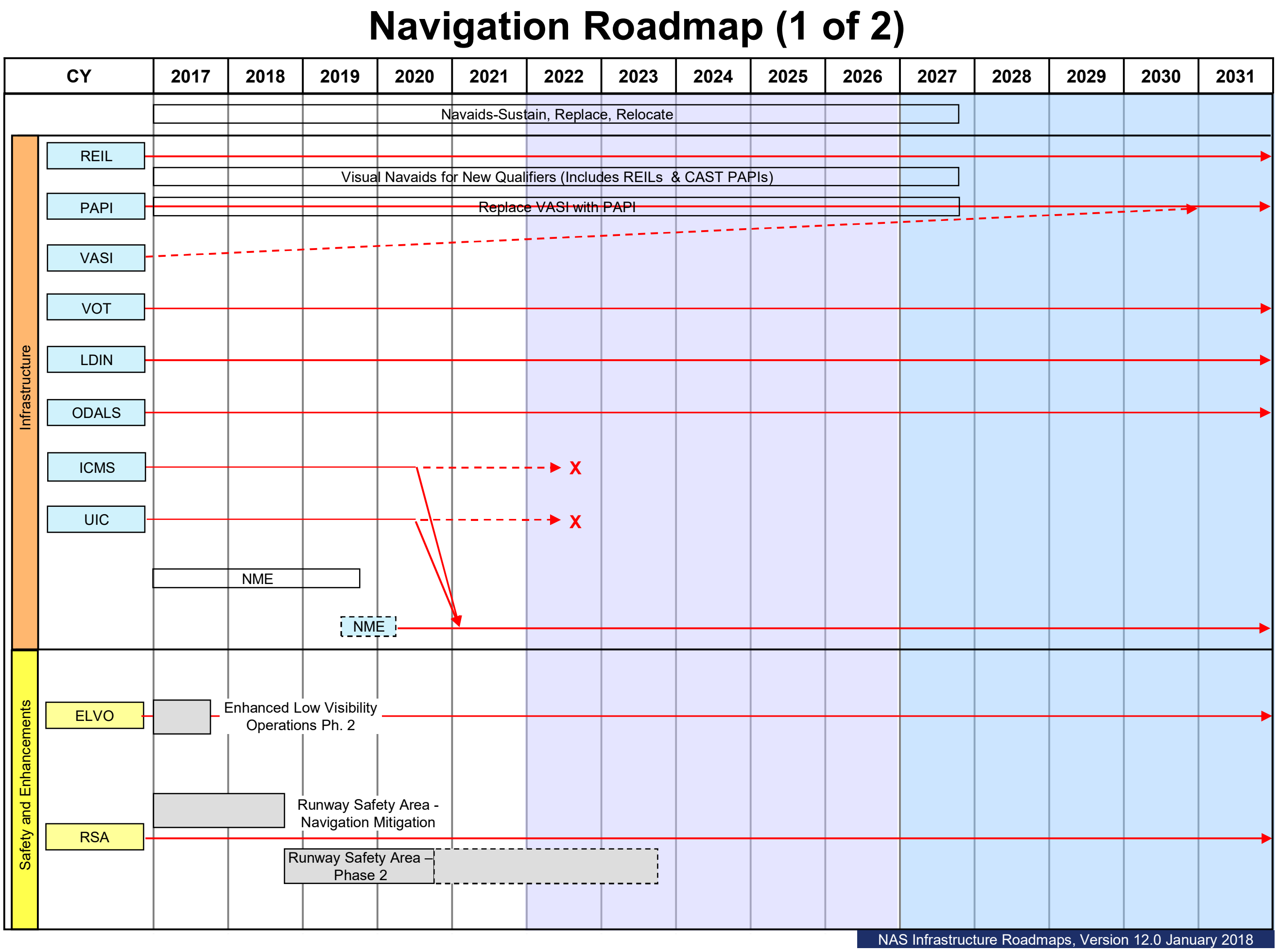

Figure 5-13 Infrastructure, and Safety and Enhancements Roadmap

In the upper portion of Figure 5-13 are Navigation Infrastructure programs that support the continued operation of existing systems.

A Runway End Identification Light (REIL) is a visual aid that provides the pilot with a rapid and positive identification of the approach end of a runway using two simultaneously flashing white lights, one on each side of the runway landing threshold.

The Navaids – Sustain, Replace, Relocate, N04.04-00, program (BLI 2D06) sustains and/or replaces Approach Lighting Systems (ALS) at sites where there is a high risk for failure of these systems and where failure would result in increased visibility minima causing schedule impacts due to delayed, diverted, or cancelled flights at the site of occurrence, connecting sites, and throughout the NAS. The ALS include Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR) for Category I approaches and High Intensity

Approach Lighting System with Sequenced Flashing Lights (ALSF-2) for Category II/III approaches. The program also replaces REILs.

Precision Approach Path Indicators (PAPI) and Visual Approach Slope Indicator (VASI) systems have a set of lights that are arranged so that the pilot sees all red lights when the aircraft is below the glideslope and all white lights when the aircraft is above the glideslope. This visual reference helps the pilot to maintain a stabilized descent and approach-slope clearance over obstructions to the runway.

The Visual Navaids for New Qualifiers, N04.01-00, program (BLI 2D06) supports the procurement, installation, and commissioning of Precision Approach Path Indicator (PAPI) and REIL systems at new qualifying runways. The program also supports a Commercial Aviation Safety Team (CAST) recommendation to implement a visual glide slope indicator approach capability on various airport runways including those affected by Land and Hold Short Operations (LAHSO) requirements.

The Replace VASI with PAPI, N04.02-00, program (BLI 2D06) will continue to replace the VASIs beyond 2030. The priority of the program is to first replace the VASI systems at approximately 329 International Civil Aviation Organization (ICAO) designated runway ends which will be completed in fiscal year 2018.

The VOT, or VOR Test, is used to check and calibrate VOR receivers in aircraft.

Lead In Light System (LDIN) and Omnidirectional Airport Lighting System (ODALS) are installed at the end of runways to help pilots determine the active runway for landing.

The Interlock Control and Monitoring System (ICMS) and Universal Interlock Controller (UIC) allow controllers to rapidly activate and deactivate the navigational aids at an airport.

The Navaids Monitoring Equipment (NME), M08.41-02, program (BLI 2D05) will provide efficiencies by combining the control and monitoring functionality currently being provided by legacy systems, i.e. ICMS and UIC, into a single solution with one common software, training, and logistics platform. The program is working towards a FID.

Enhanced Low Visibility Operations (ELVO) allows pilots to land with more limited visibility conditions than standard procedures. The ELVO Phase II program provided the equipment and procedures to allow for reduced minimums for landing and takeoff during periods of low visibility at selected airports.

The Runway Safety Area (RSA) is defined as a surface surrounding a runway suitable for reducing the risk of personal injury/aircraft damage in the event an aircraft lands long, short, or unexpectedly leaves the runway surface or taxiway during normal operations. To the extent practical, an RSA must be free of objects that are not fixed-by-function. All objects remaining within the RSA must be frangible to within three inches above the grade.

The RSA follow-on improvements – Phase 2, N17.01-02, program (BLI 2D04) will correct FAA-owned facilities and equipment that are not in compliance with RSA Standards and not part of the previous RSA Navigation Mitigation – Phase 1 program. The program will address the installation of frangible connections on identified structures as well as the relocation of facilities within and outside the RSA.

5.4.2 En Route/Terminal Navigation & Non-Precision/Precision Approach

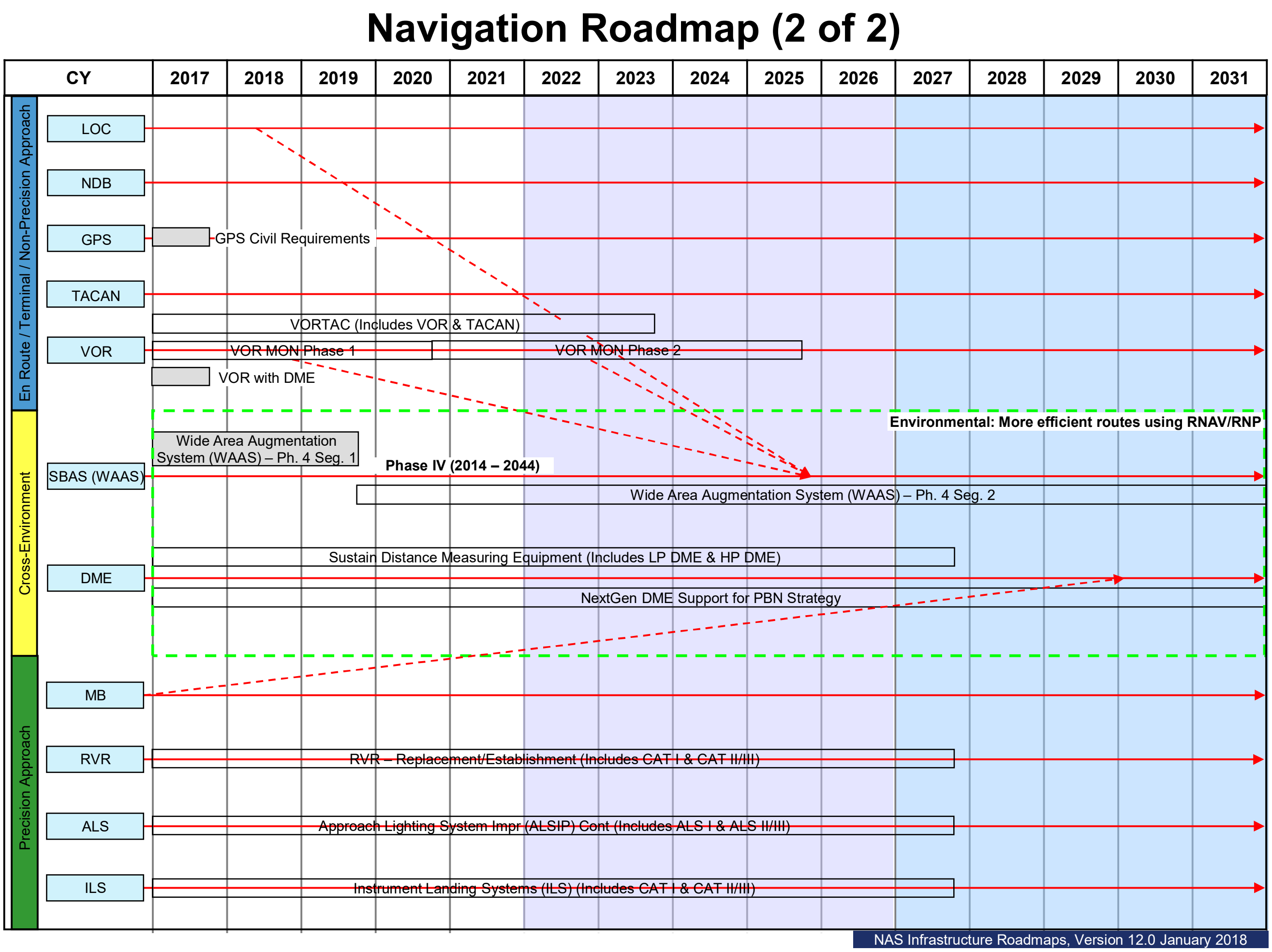

Figure 5-14 En Route/Terminal Navigation & Non-Precision/Precision Approach Roadmap

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, the LOC supports non-precision approach operations. Satellite-Based Augmentation System (SBAS) (WAAS) will begin to replace that functionality at airports where only localizers are installed.

A Non-Directional Beacon (NDB) supports navigation by providing the pilot with direction or bearing to the NDB station relative to the aircraft. The FAA will continue operating NDBs in some remote areas where it is not economically justified to install more modern navigational aids.

The Global Positioning System (GPS) is operated by the Department of Defense (DoD). 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.

Tactical Air Navigation (TACAN) is the military equivalent of combined VOR and DME systems. VORTAC is a site where a VOR and TACAN are co-located and the VOR uses the TACAN for DME information.

A VOR is a ground-based Navaid that provides the bearing to the VOR and is used by general aviation aircraft for navigation in both en route and terminal airspace. The direct lines between VORs are used to define established air routes.

The VORTAC, N06.00-00, program (BLI 2D06) replaces, relocates, or improves VORs associated with DMEs and VORs associated with TACANs. This includes installation of a Doppler VOR electronic and antenna kits to eliminate most signal reflection restrictions caused by obstacles causing electromagnetic interference such as trees, metal buildings, transmission lines, towers, or wind farms.

The VOR – Minimum Operational Network (MON) Implementation Program – Phase 1, N06.01-01, and VOR – MON Implementation Program Phase – 2, N06.01-02, programs (BLI 2D01) will perform the work required to downsize the VOR network to the minimum required for use as a backup navigation system in the event of an unplanned GPS localized outage and allow aircraft to navigate and land safely under Instrument Flight Rules. This program supports the NAS transition from the current VOR airways to PBN consistent with NextGen goals. At the VOR MON Implementation Program Phase 1 FID in September 2015, the program was approved to discontinue approximately 74 VORs by the end of September 2020. The VOR MON Implementation Program Phase 2 is working towards a FID and will address additional sites to achieve the MON.

The SBAS also called the Wide Area Augmentation System (WAAS), supports en route and terminal navigation, and non-precision and precision approaches. GPS/WAAS support localizer performance with vertical guidance (LPVs) which is a high precision instrument approach procedure with a decision height similar to the ILS Cat I. WAAS consists of a network of 38 ground reference stations located in North America that monitor the GPS satellite signals. Three master stations collect reference station data and calculate corrections and integrity messages for each GPS satellite. The WAAS messages are broadcast to user receivers via leased navigation transponders on three commercial geostationary satellites. The receiver on the aircraft applies the corrections and uses the integrity information from the WAAS message to ensure the validity and obtains a precise navigation position.

The Wide Area Augmentation System (WAAS) – Phase IV Segment 1, N12.01-07, program (BLI 2D02) incorporates WAAS infrastructure upgrades to support the use of the new L5 frequency and to prepare for the dual frequency user capability planned for implementation in Dual Frequency Operations. The WAAS Phase IV Segment 2, N12.01-08, program (BLI 2D02) will focus on developing and deploying an initial WAAS Dual Frequency Service that will enable testing and prototyping of a future operational signal allowing usage of the L5 signal. The Segment 2 program is working towards a FID.

Distance Measuring Equipment (DME) is a radio navigation aid used by pilots to determine the aircraft's slant distance from the DME location. A Low Power (LP) DME can be collocated with an ILS to provide the pilot with an accurate distance to the touchdown area of the runway.

The Sustain DME , N09.00-00, program (BLI 2D06) is procuring and installing state-of-the-art DME systems to support replacement of DMEs that have exceeded their service life expectancy; establishes new DMEs at qualifying airports; to relocate DME facilities; and establish DMEs in lieu of Instrument Landing System markers. The new DME can respond to more than 250 interrogators from aircraft simultaneously.

The NextGen DME program, G01N.01-02, (BLI 2B19) will expand DME coverage in En Route and selected Terminal Airspace to provide a resilient, complimentary navigation service to enable DME/DME Area Navigation (RNAV) aircraft, without Inertial Reference Unit (IRU), to continue Performance Based Navigation (PBN) operations during disruptions of the Global Navigation Satellite System (GNSS).

MB (Marker Beacon) is a VHF radio beacon, usually in conjunction with an ILS, to give pilots a means to determine position along an established route to a runway.

The Runway Visual Range (RVR) provides air traffic controllers with a measurement of the visibility at key points along a runway, touchdown, midpoint, and rollout. RVR data is used to decide whether it is safe to take off or land during limited visibility conditions.

The RVR – Replacement/Establishment, N08.02-00, program (BLI 2D04) replaces old RVR equipment with new PC-based RVR equipment which is also safer because the visibility sensors are mounted on frangible structures that break away if accidently struck by an aircraft during take-off or landing.

Approach Lighting Systems (ALS) (I, II, III) helps the pilot see the end of the runway and transition from instrument to visual flight for landing before reaching runway minimums. ALSs include Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR) for Category I approaches and High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2) for Category II/III approaches.

The Approach Lighting System Improvement Program (ALSIP) Continuation, N04.03-00, program (BLI 2D06) improves the safety of ALSs built before 1975. It upgrades the MALSR and ALSF-2 systems to current standards and reduces the potential severity of take-off and landing accidents by replacing rigid structures, and the entire approach lighting system, with lightweight and low-impact frangible structures that collapse or break apart upon impact.

ILSs provide both vertical and lateral guidance information for the pilot to allow safe landings to touchdown and rollout. These systems allow properly equipped aircraft to land safely with a stabilized approach to a runway which improves both system safety and airport capacity for landing properly equipped aircraft in adverse weather conditions at runways equipped with an ILS and the appropriate ALS. There are three categories of ILS, i.e., Category I (CAT I), CAT II, and CAT III. The lowest altitude at which a pilot is able to decide whether to land or abort, known as the decision height, and how far away the pilot can see the runway, or runway visual range, defines each category.

The ILS, N03.01-00, program (2D06) supports the installation of ILSs and/or High Intensity ALSF-2 for the establishment of new Category II/III precision approach procedures as well as replacing old ILSs that have exceeded their service life and/or the manufacture no longer provides support.

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. Weather information will be even more important when NextGen direct or user chosen trajectory 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 are 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 to avoid damage to the aircraft and the potential for injuring passengers. The FAA has a lead role in collecting and distributing aviation weather data; particularly hazardous weather. The FAA distributes hazardous weather 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.

Weather sensors include weather radars and surface observation systems that measure atmospheric parameters, such as surface temperature, barometric pressure, relative humidity, cloud bases and tops, prevailing wind speed and direction, and occurrences of 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 that 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 4-15) - Weather Sensors
2. Roadmap 2 (figure 4-16) - Weather Dissemination, Processing, and Display

5.5.1 Weather Sensors

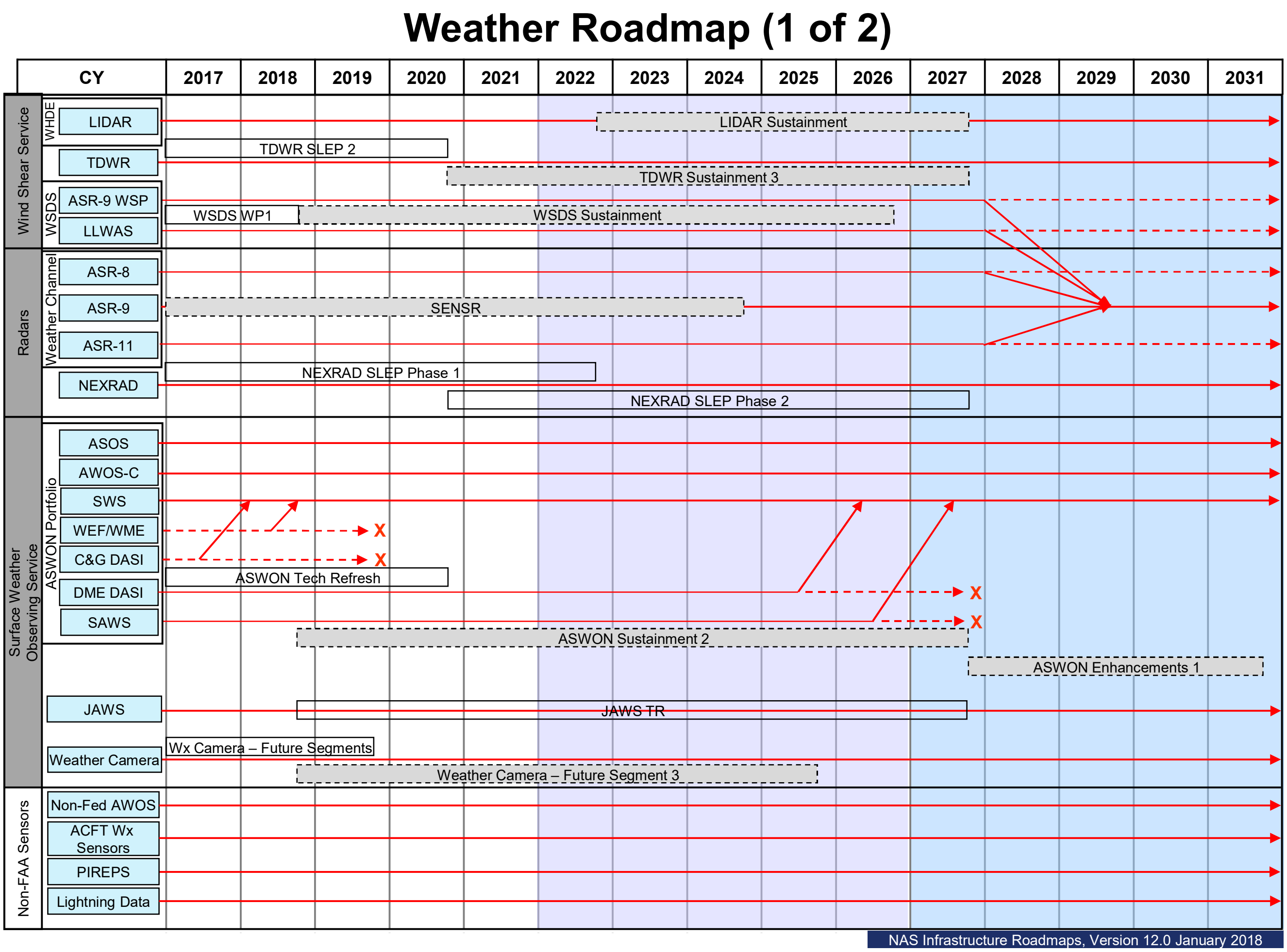

Figure 5-15 Weather Sensors Roadmap

At the top left of Figure 5-15 is the Wind Shear Service portfolio which includes:

- Light Detection and Ranging (LIDAR) system;
- Terminal Doppler Weather Radar (TDWR);
- Airport Surveillance Radar-9 (ASR-9) Wind Shear Processor (WSP); and
- Low Level Wind Shear Alert System (LLWAS).

The LIDAR system uses lasers to detect dry microbursts and gust fronts in high plains and mountain environment that radar systems may not detect. If approved, the LIDAR Sustainment program will address extending the systems service life.

TDWRs provide vital information and warnings regarding hazardous windshear conditions, precipitation, gust fronts, and microbursts to air traffic controllers managing arriving and departing flights in the terminal area.

TDWR SLEP Phase 2, W03.03-02, program (BLI 2B01) is a sustainment effort to extend the service life of the system. It will replace TDWR components that were not addressed in Phase 1 that have deteriorated over time or have become obsolete or unsupportable.

If approved, the TDWR – Sustainment 3 program will continue to replace TDWR components that have deteriorated over time; have become obsolete; or are unsupportable.

Airports with significant wind shear risk that have a lower volume of air traffic are served by the ASR-9 WSP, a lower cost alternative to TDWR. The ASR-9 WSP processes weather from the two dimensional Doppler search radar signals, which are its standard format to detect wind shear which approximates the output of the TDWR. See the description for SENSR under Surveillance Roadmap 1 in section 5.3.1 En Route Surveillance.

LLWAS 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 measure surface winds only and do not detect wind shear above the surface in the approach or departure paths.

Wind Shear Detection Services (WSDS) Work Package 1 is a portfolio program that will address obsolescence and supportability issues of the legacy ASR-9 WSP, LLWAS, and Wind Measuring Equipment (WME). See below for a system description of WME.

If approved, the WSDS Sustainment program will address obsolescence of the WSP and LLWAS. The program will ensure continuation of the existing service levels provided by these legacy systems by upgrading the components necessary to resolve obsolescence and supportability issues.

The next three systems are the ASR-8/9/11 Weather Channel that detect precipitation, wind, and thunderstorms that affect aircraft in flight. See the description for SENSR under Surveillance Roadmap 1 in section 5.3.1 En Route Surveillance.

Next Generation Weather Radar (NEXRAD) is a long range weather radar system that detects, analyzes, and transmits weather information for use by the ATC System Command Center, en route, terminal, and flight service facilities. The NWS collects and redistributes NEXRAD weather data from the radars they operate and from some of the 12 FAA NEXRAD radars to create forecasts. This weather information helps determine location, time of arrival, and severity of weather conditions to advise aircraft on recommended routes.

The NEXRAD Service Life Extension Program (SLEP) Phase 1, W02.02-02, program (BLI 2A03) is a refurbishment program to extend the service life of 12 FAA-owned NEXRAD systems. The NEXRAD SLEP Phase 2, W02.02-03, program (BLI 2A03) will coordinate with 2nd level engineering and NWS Maintenance Logistics Center to identify sustainability issues of the NEXRAD system and is working toward a FID.

The Aviation Surface Weather Observation Network (ASWON) is a portfolio that consists of the Automated Surface Observing System (ASOS), Automated Weather Observation System (AWOS) model C, Surface Weather System (SWS), Wind Equipment Series F (F-420) (WEF) / WME, Digital Altimeter Setting Indicator (DASI), and Stand Alone Weather Sensor (SAWS). All of these systems are located at airports and collectively measure and report weather conditions including temperature, barometric pressure, visibility, precipitation type and amount, cloud height and coverage, and wind speed and direction.

The ASWON Technology Refresh, W01.03-01, program (BLI 2C01) will provide compatible technology upgrades and/or replacements to the five legacy ASWON systems (ASOS, AWOS-C, AWSS, WEF, and DASI) which are experiencing obsolescence, supportability, and maintainability issues. The technology refresh effort will enable these systems to continue to provide weather information to support the safe operation of the NAS. Deployment of SWS will replace the WEF / WME and DASI functions by FY 2019.

If approved, the ASWON Sustainment 2 program will provide required technology upgrades and/or replacements of the ASWON systems (ASOS, AWOS-C, SWS, DASI, and SAWS) which are experiencing obsolescence, supportability, and maintainability issues. This technology refresh will allow these systems sustain the required level of service to support NAS operations.

If approved, the ASWON Enhancements 1 program will improve the functionality of systems within the portfolio starting in the FY 2028 time frame.

The Juneau Airport Weather System (JAWS) measures and transmits wind information to the Juneau Automated Flight Service Station (AFSS), Alaska Airlines, and the National Weather Service for weather forecasting. Other Alaska aviation users access JAWS data via the Internet. It is essential for pilots to be aware of wind conditions that affect approach and departure paths because of the restrictive geographical features on both sides of the corridor in and out of the Juneau Airport.

The Juneau Airport Wind System (JAWS) – Technology Refresh, W10.01-02, program (BLI 2C05) will include replacement of computers and controllers, radios, firmware and software, anemometers, and profilers. The program is working towards a FID.

Weather Cameras are installed at airports and strategic en route locations in Alaska to provide pilots, dispatchers, and flight service station specialists with real-time video weather information. These images are designated as an FAA Advisory weather product to be used for enhanced situational awareness and provide pilots, dispatchers, and Flight Service Station Specialists with up-to-date weather conditions at airports, mountain passes, and strategic locations where weather is known to be a potential hazard.

The Weather Camera Program – Future Segments, M08.31-02, program (BLI 2C04) ensures that camera network services are available, reliable, responsive, and accessible to pilots and aviation user groups.

If approved, the Weather Camera Program – Future Segment 3 program will expand camera services to aviators that fly throughout the CONUS and Hawaii by using Third Party Image Hosting. The program may host images from state DOT owned airports and other critical en route locations such as mountain passes and other areas where weather-related accidents and flight interruptions are known to occur.

Non-FAA Sensors at the bottom left of the roadmap are 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 provide supplemental data to FAA sensors. Aircraft weather sensors can provide humidity, wind speed, and atmospheric pressure readings that are helpful in forecasting weather conditions. Pilot Reports (PIREPS) provide real time reports on the weather along major flight routes. Lightning Data systems provide air traffic facilities important information about the location and intensity of thunderstorms.

5.5.2 Weather Dissemination, Processing, and Display

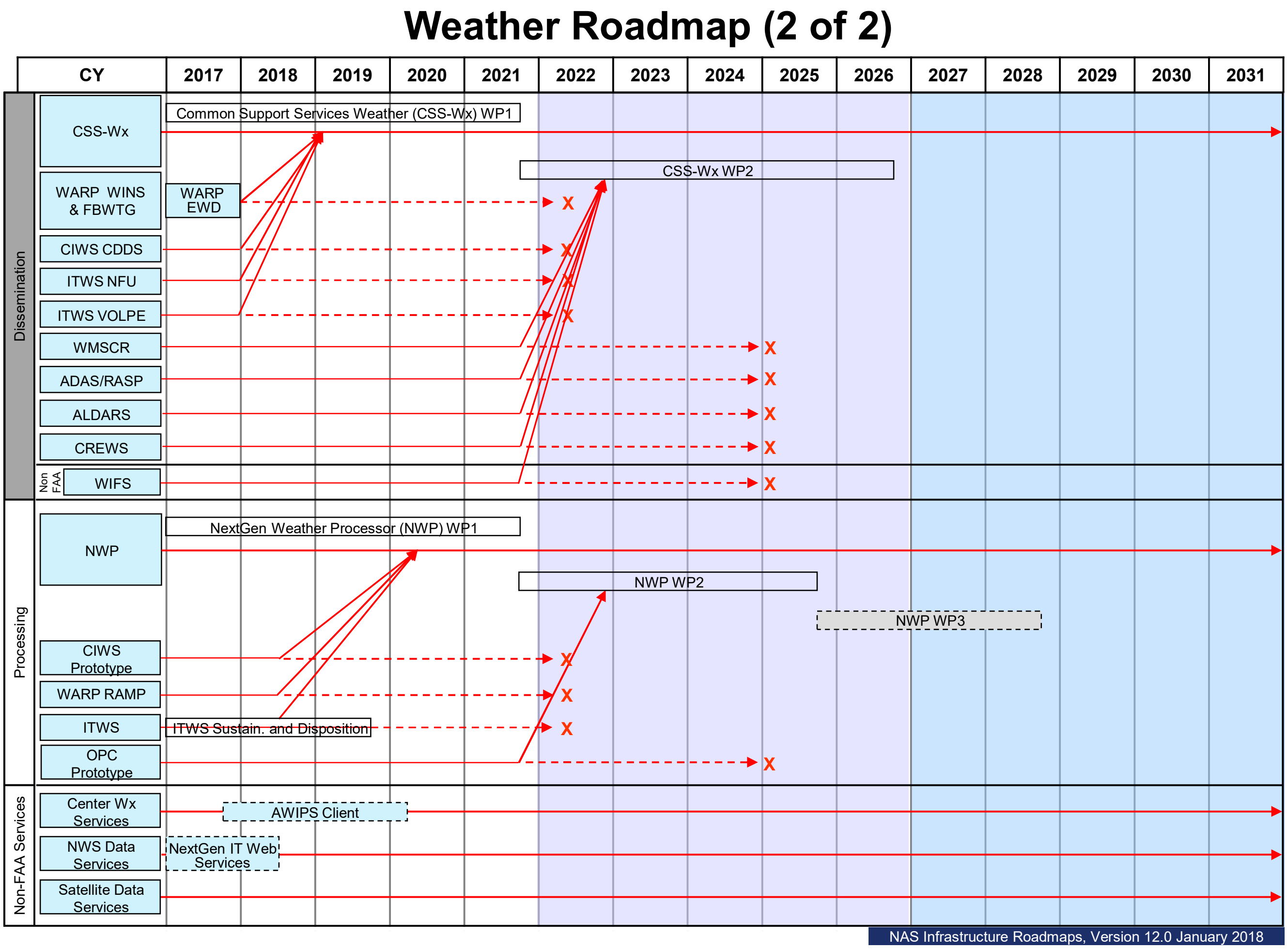

Figure 5-16 Weather Dissemination, Processing, and Display Roadmap

On the left side of Figure 5-16 shows Weather Dissemination Roadmap and the new Common Support Services – Weather (CSS-Wx) system. Implemented under the CSS-Wx Work Package 1 program described below, CSS-Wx will enable universal access and the standardization of weather information for dissemination to users via System Wide Information Management (SWIM).

Continuing with the legacy Weather Dissemination systems, the Weather and Radar Processor (WARP) Weather Information Network Server (WINS) is a centralized weather data server and is located at the 21 ARTCCs. WINS provides WARP data and weather products to other systems throughout the NAS. Weather products include regional and national radar mosaics, alphanumeric text messages, meteorological model outputs (gridded weather forecast data), weather advisories (SIGMETS for icing or turbulence), minute-by-minute weather observations, and lightning data.

WARP WINS has been upgraded with an Enhanced Weather Information Network Server Dissemination (WARP EWD) capability which incorporated additional weather products and expanded service to new customers.

The WARP FAA Bulk Weather Telecommunication Gateway (FBWTG) provides NWS gridded weather forecast data to WARP and Integrated Terminal Weather System (ITWS).

The Corridor Integrated Weather System (CIWS) Data Distribution System (CDDS) enables 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) National Weather Service Filter Unit (ITWS NFU) sends data collected by FAA to the NWS to use for weather forecasting. The ITWS Volpe established an Internet connection to the ITWS weather data for external users.

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 Automated Weather Observation System (AWOS) Data Acquisition System (ADAS) / Regional ADAS Service Processor (RASP) are communication links that transmit AWOS and ASOS data to air traffic facilities. The data collected is important to pilots and dispatchers as they prepare and file flight plans, and it is vital for weather forecasting. These systems feed data directly to air traffic control facilities and support automated broadcast of weather information to pilots and provide regular updates to forecast models. ADAS also correlates cloud-to-ground lightning strike information with AWOS and ASOS data to better determine the location of nearby thunderstorm activity.

The Automated Lightning Detection and Reporting System (ALDARS) uses a network of sensors throughout the NAS to triangulate lightning strikes and then send messages to each automated airport station informing it of the proximity of any lightning strikes.

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

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

The System Wide Information Management (SWIM) – Common Support Services (CSS-Wx) Work Package 1, G05C.01-06, program (BLI 2A11) will establish an aviation weather publishing capability for the NAS. It will enable universal access and the standardization of weather information for dissemination to users via SWIM. The program will consolidate several legacy weather dissemination systems such as WARP EWD, FBWTG, CIWS CDDS, ITWS NFU, and ITWS Volpe and be the FAA's single provider of aviation weather data for integration into NextGen enhanced Decision Support Tools. The implementation of CSS-Wx is interdependent with NextGen Weather Processor (NWP) (G04W.03-02).

The SWIM CSS-Wx Work Package 2, G05C.01-09, program will subsume additional legacy weather dissemination systems such as WMSCR, ADAS, ALDARS, CREWS, and WIFS and provide additional Web services, filtering, and complex queries capabilities. The program is working towards a FID.

Under the Weather Roadmap 2, Processing, is the CIWS Prototype which 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 WARP Radar Acquisition and Mosaic Processor (RAMP) is an automated processing system that directly connects to the NEXRAD radars in the vicinity of the ARTCC to create regional radar mosaics. The RAMP integrates NWS, radar data, and mosaics for display on en route controller displays. WARP and NWS data is also used by center weather service unit meteorologists to aid in their forecast of weather conditions in the ARTCC's airspace.

ITWS provides air traffic managers with graphic, full-color displays of essential weather information affecting major U.S. airports. ITWS integrates weather data from a number of sources and provides a single, easily used and understood display of supported products.

ITWS – Sustainment & Disposition program is funding a lifetime buy of all necessary and available spare parts of the legacy hardware, to attempt to sustain the current system until it is fully replaced by NWP. The program will also fund a contingency plan to mitigate potential accelerated hardware failures. See BLI 2B18 for more information about the ITWS – Sustainment & Disposition, W07.01-02, program.

Offshore Precipitation Capability (OPC) prototype is a system that creates radar-like mosaic products at the same time scale as current CONUS-based products, with the goal of providing offshore situational awareness for air traffic controllers beyond the range of current weather radar. The OPC mosaics are merged with mosaics from land-based radar to provide a consistent depiction of storms extending offshore that is updated every few minutes.

Next Generation Weather Processor (NWP), Work Package 1 (WP1), G04W.03-02, program (BLI 2A15) will replace and enhance the current processing functionality of the ITWS, CIWS, and WARP systems; generate aviation weather products with expanded coverage areas and faster update rates; generate zero to eight hour aviation weather products; generate safety critical wind shear alerts and real-time weather radar information; and perform translation of convective weather into weather constraint areas. NWP WP2, G04W.03-03, program (BLI 2A15) will enhance weather algorithms and generate additional advanced products such as new radar mosaic, predictive products, weather avoidance fields, and terminal products. NWP will also incorporate the OPC functionality. The NWP WP2 program is working towards a FID.

If approved, the NWP WP3 program will provide additional enhancements for future weather products.

Non-FAA services at the bottom left of the roadmap provide data from the NWS ground and satellite sensors to FAA for use by the NWS meteorologist who interpret and forecast weather at the FAA end route centers. Center Weather, NWS Data, and Satellite Data Services comprise a distributed “virtual” database that will receive weather data directly from sensors, NWS, NOAA, and other sources and then, either automatically or by request, send this data to FAA facilities and users so that observations and forecasts can be more widely and consistently distributed via network-enabled communications (NextGen IT Web Services). Decision support tools will use this weather information to assist users in understanding weather constraints and taking actions to reduce risk for aviation operations.

An Advanced Weather Information Processing System (AWIPS) is being developed by the NWS and the National Center for Environmental Prediction to replace existing Center Weather Services.

6 Facilities

The FAA maintains and operates thousands of staffed and unstaffed operational facilities that must be maintained and modernized. The largest staffed facilities are the 21 en route centers that house hundreds of employees and the systems and equipment to control aircraft in the en route environment. Other operational facilities with significant staff include the more than 500 ATCT and 157 TRACON facilities that control arrival and departure traffic to and from airports in the terminal environment.

There are more than 12,000 unstaffed facilities and shelters that house systems essential for communications, navigation, surveillance, and weather monitoring. Much of this equipment is located in remote areas and housed in aging buildings that require renovation. Many of these facilities have deteriorating steel towers and foundations. Some newer unstaffed buildings and structures require more frequent renovation because they are located in harsher conditions near the ocean or on a mountaintop. Replacing roofing, electric power generators, heating/cooling, and structural and security components is essential to sustaining full operation of these facilities in the NAS.

Both the William J. Hughes Technical Center (WJHTC) in Atlantic City, NJ and the Mike Monroney Aeronautical Center (MMAC) in Oklahoma City, OK, have many buildings. Each year these complexes receive funds to upgrade and/or replace infrastructure, and to improve and modernize buildings that support research and development, test and evaluation, operational and second level field support, training, logistics, and management functions. The MMAC operates under a lease from the Oklahoma City Airport Trust. The requested funds are used to pay the cost of the annual lease and to renovate buildings and supporting infrastructure, such as electrical and mechanical equipment. The WJHTC provides the integrated NAS platform used for research, development, test, evaluation, and field support for all NAS and NextGen acquisition programs within the FAA. Annual funding is required to upgrade and reconfigure the laboratories to accommodate acceptance testing for new equipment and to test modifications to existing equipment.

The ATCT / TRACON Replacement program includes planned funding for the replacement of existing ATCT and TRACON facilities. The projects are funded in five segments and are scheduled based on FAA priorities. A project typically spans a period of 5-10 years from inception to completion depending upon its size and complexity. The budget for each segment of a project includes all of the funds needed to complete the segment but it may take more than one year to finish the work. Funding is allocated to the segments based upon FAA's priorities with consideration given to maintaining the overall 5-year funding estimates for the program.

The ATCT / TRACON Modernization program renovates or replaces specific exterior or interior components of existing towers and TRACONs, such as elevators, heating ventilation and cooling equipment, roofs, or other infrastructure that the FAA must upgrade to keep these facilities functioning.

The ARTCC and Combined Control Facility (CCF) Building Improvements program supports en route air traffic operations and service-level availability by providing life cycle management of the physical plant infrastructure at the 21 ARTCCs and 2 CCF facilities. The FAA upgrades and improves ARTCC facilities by replacing heating and cooling systems, upgrading electrical power distribution systems, replacing obsolete fire detection and protection systems, and sustaining other facility infrastructure components to meet current and new mission requirements.

The Alaska Flight Service Facility Modernization program sustains, replaces, or relocates Flight Service facilities in Alaska to ensure security, continuity of flight service operations, and adapt to geographical changes in service demand. The program corrects deficiencies such as substandard lightning, grounding and bonding protection; electrical systems; and heating and cooling systems that could disrupt flight service operations.

Capital investments that support facilities are shown below in Table 6-1.

BLI #	CIP Title	CIP #
1A02	William J. Hughes Technical Center Laboratories	F14.00-00
1A03	William J. Hughes Technical Center Building & Plant Support	F16.00-00
2A04	Air Route Traffic Control Center (ARTCC) & Combined Control Facility (CCF) Building Improvements	F06.01-00
2A07	Long Range Radar (LRR) Improvements – Infrastructure Upgrades/Sustain	S04.02-03
2B05	Air Traffic Control Tower (ATCT)/Terminal Radar Approach Control (TRACON) Replacement	F01.02-00
2B06	Air Traffic Control Tower (ATCT)/Terminal Radar Approach Control (TRACON) Modernization	F01.01-00
2B06	Facility Realignment Implementation	F02.10-02
2B08	Environmental and Occupational Safety and Health (EOSH)	F13.03-00
2C03	Alaska Flight Service Facility Modernization (AFSFM)	F05.04-02
2E01	Fuel Storage Tank Replacement Management	F13.01-00
2E02	Unstaffed Infrastructure Sustainment (UIS)	F12.00-00
2E02	FAA Employee Housing and Life Safety Shelter System Services	F20.01-01
2E06	Decommissioning – Real Property Disposition	F26.01-01
2E07	Power Systems Sustained Support (PS3) – Future Segments	F11.01-02
2E08	Energy Management and Compliance (EMC)	F13.04-02
2E09	Child Care Centers – Infrastructure Sustainment 1	F22.01-01
3A01	Environmental Cleanup / Hazardous Materials (HAZMAT)	F13.02-00
3A04	Facility Security Risk Management (FSRM) – Two	F24.01-02
3A11	Mobile Asset Management Program	F31.01-01
3B01	Aeronautical Center Infrastructure Modernization	F18.00-00
4A04	Aeronautical Center Lease	F19.00-00

Table 6-1 Facility Programs

7 NAS and Mission Support

The FAA must continually monitor, refresh, and enhance systems to ensure the availability, reliability, and accuracy of the equipment and infrastructure that make up the NAS. The ongoing transformation to NextGen requires systems research and changes to NAS infrastructure, including automation, communication, navigation, and surveillance systems; the development of new procedures; and personnel training in order to realize the projected benefits from NextGen. To support this transition, the NAS must be sustained to ensure the uninterrupted delivery of current services while maintaining the required level of safety expected and relied upon by the aviation community.

Capital investments that support NAS and Mission Support are shown below in Table 7-1.

BLI #	CIP Title	CIP #
1A01	Runway Incursion Reduction Program (RIRP) – ATDP	S09.02-00
1A01	System Capacity, Planning, and Improvements – ATDP	M08.28-00
1A01	Operations Concept Validation and Infrastructure Evolution – ATDP	M08.29-00
1A01	Major Airspace Redesign – ATDP	M08.28-04
1A01	Strategy and Evaluation – ATDP	M46.01-01
1A01	Dynamic Capital Planning	M47.01-01
1A01	Operational Analysis and Reporting System (OARS) – Phase 1	M08.32-03
1A01	Operational Modeling Analysis and Data	M52.01-01
1A01	Enterprise Management, Integration, Planning and Performance Evaluation for NextGen	M03.04-01
1A02	William J. Hughes Technical Center Laboratories – Flight Program Consolidation – Sustainment	F14.01-01
2A16	Airborne Collision Avoidance System X (ACAS X) – Segment 1	M54.01-01
2D03	Instrument Flight Procedures Automation (IFPA) – Sustainment 2	A14.02-03
2E03	Aircraft Related Equipment (ARE) Program	M12.00-00
2E03	Flight Simulation Testing and Research Technologies (START) – Sustainment 1	M12.01-04
3A05	Information Systems Security	M31.00-00
3A05	Critical Infrastructure Cybersecurity (NAS)	M31.05-01
3A10	National Test Equipment Program	M17.01-01
3A13	Tower Simulation System (TSS) – Sustainment 1	M20.01-04
3A14	Logistics Center Support System (LCSS) – Segment 2	M21.04-01
3A14	Logistics Center Support System (LCSS) – Sustainment	M21.04-02
3B02	Distance Learning	M10.00-00
4A01	CIP Systems Engineering & Development Support – Systems Engineering Contract	M03.03-01
4A01	Provide Air Navigation Facilities (ANF)/Air Traffic Control (ATC) Support (Quick Response)	M08.01-00
4A02	Program Support Leases	M08.06-00
4A03	NAS Regional/Center Logistics Support Services	M05.00-00
4A05	NAS Implementation Support Contract (NISC)	M22.00-00
4A05	Configuration Management Automation (CMA) – Phase 1	M03.01-02
4A06	Technical Support Services Contract (TSSC)	M02.00-00
4A07	Resource Tracking Program (RTP)	M08.14-00
4A08	CIP Systems Engineering & Architecture – Center for Advanced Aviation System	M03.02-00

Table 7-1 NAS and Mission Support Programs

8 Estimated Funding by Budget Line Item

The following table shows funding by Budget Line Item, dollars in millions, for capital programs in the FY 2019 to FY 2023 timeframe. The funding levels in this table reflect policy levels assumed in the President's Budget.

BLI Number	Capital Budget Line Item (BLI) Program	FY 2019 Budget	FY 2020 Est.	FY 2021 Est.	FY 2022 Est.	FY 2023 Est.
	Activity 1: Engineering, Development, Test and Evaluation	**$166.9**	**$179.5**	**$204.2**	**$219.0**	**$204.8**
1A01	Advanced Technology Development and Prototyping (ATDP)	$33.0	$35.0	$34.1	$34.2	$30.0
1A02	William J. Hughes Technical Center Facilities	$21.0	$20.0	$20.0	$20.0	$20.0
1A03	William J. Hughes Technical Center Infrastructure Sustainment	$12.0	$10.0	$10.0	$10.0	$10.0
1A04	NextGen – Separation Management Portfolio	$16.6	$21.5	$26.6	$41.2	$43.5
1A05	NextGen – Traffic Flow Management (TFM) Portfolio	$14.0	$11.0	$13.0	$18.0	$11.0
1A06	NextGen – On Demand NAS Portfolio	$20.5	$29.5	$35.5	$29.6	$26.3
1A07	NextGen – NAS Infrastructure Portfolio	$13.5	$15.5	$25.0	$26.0	$26.0
1A08	NextGen – Support Portfolio	$12.8	$10.0	$11.0	$11.0	$9.0
1A09	NextGen – Unmanned Aircraft Systems (UAS)	$14.0	$17.0	$20.0	$20.0	$20.0
1A10	NextGen – Enterprise, Concept Development, Human Factors, & Demonstrations	$9.5	$10.0	$9.0	$9.0	$9.0
	Activity 2: Procurement and Modernization of Air Traffic	**$1,681.2**	**$1,669.3**	**$1,619.9**	**$1,620.3**	**$1,644.7**
	A. En Route Programs	**$689.1**	**$658.5**	**$610.2**	**$628.5**	**$635.2**
2A01	NextGen – En Route Automation Modernization (ERAM) – System Enhancements and Technology Refresh	$102.1	$96.6	$73.2	$82.7	$92.0
2A02	En Route Communications Gateway (ECG)	$1.7	$2.8	$2.9	$0.0	$0.0
2A03	Next Generation Weather Radar (NEXRAD)	$5.5	$4.0	$6.1	$5.4	$7.5
2A04	Air Route Traffic Control Center (ARTCC) & Combined Control Facility (CCF) Building Improvements	$88.1	$82.6	$82.7	$82.8	$82.6
2A05	Air Traffic Management (ATM)	$6.2	$19.9	$25.2	$28.0	$23.8
2A06	Air/Ground Communications Infrastructure	$10.5	$7.9	$8.0	$8.1	$7.9
2A07	Air Traffic Control En Route Radar Facilities Improvements	$6.6	$6.3	$6.4	$6.5	$6.3
2A08	Voice Switching Control System (VSCS)	$11.4	$11.7	$12.1	$12.4	$13.0
2A09	Oceanic Automation System	$17.5	$13.6	$10.0	$10.0	$10.0
2A10	Next Generation Very High Frequency Air/Ground Communications System (NEXCOM)	$50.0	$50.0	$50.0	$50.0	$50.0
2A11	NextGen – System-Wide Information Management (SWIM)	$58.8	$42.6	$28.5	$32.2	$40.0
2A12	NextGen – Automatic Dependent Surveillance - Broadcast (ADS-B) NAS Wide Implementation	$123.7	$123.5	$135.0	$135.0	$137.0
2A13	NextGen – Collaborative Air Traffic Management Technologies Portfolio	$17.7	$24.3	$15.0	$5.6	$17.0
2A14	NextGen – Time Based Flow Management (TBFM) Portfolio	$21.2	$36.3	$44.8	$46.9	$25.0
2A15	NextGen – Next Generation Weather Processor (NWP)	$24.7	$16.0	$6.2	$25.0	$25.0
2A16	Airborne Collision Avoidance System X (ACAS X)	$7.7	$6.9	$5.1	$0.0	$0.0
2A17	NextGen – Data Communication in support of NextGen	$113.9	$89.6	$72.1	$64.0	$66.1

BLI Number	Capital Budget Line Item (BLI) Program	FY 2019 Budget	FY 2020 Est.	FY 2021 Est.	FY 2022 Est.	FY 2023 Est.
2A18	Offshore Automation	$14.0	$15.0	$20.0	$25.0	$30.0
2A19	En Route Improvements	$1.0	$2.0	$2.0	$2.0	$2.0
2A20	Commercial Space Integration	$7.0	$7.0	$5.0	$7.0	$0.0
	B. Terminal Programs	**$522.7**	**$552.1**	**$549.8**	**$538.9**	**$559.7**
2B01	Terminal Doppler Weather Radar (TDWR) – Provide	$4.5	$2.2	$0.0	$0.0	$0.0
2B02	Standard Terminal Automation Replacement System (STARS)	$66.9	$51.3	$41.9	$50.0	$50.0
2B03	Terminal Automation Modernization / Replacement Program (TAMR Phase 3)	$9.0	$0.0	$0.0	$0.0	$0.0
2B04	Terminal Automation Program	$8.5	$9.0	$9.0	$9.0	$10.0
2B05	Terminal Air Traffic Control Facilities – Replace	$19.2	$14.0	$70.0	$107.0	$140.0
2B06	ATCT/Terminal Radar Approach Control (TRACON) Facilities – Improve	$95.9	$92.6	$77.7	$47.7	$42.6
2B07	Terminal Voice Switch Replacement (TVSR)	$9.6	$6.0	$6.0	$6.0	$5.0
2B08	NAS Facilities OSHA and Environmental Standards Compliance	$41.9	$42.0	$42.0	$42.0	$42.0
2B09	Airport Surveillance Radar (ASR-9)	$12.8	$12.6	$17.1	$14.3	$17.1
2B10	Terminal Digital Radar (ASR-11) Technology Refresh	$1.0	$4.4	$4.4	$4.4	$4.4
2B11	Runway Status Lights (RWSL)	$2.0	$3.5	$3.5	$5.0	$5.0
2B12	NextGen – National Airspace System Voice System (NVS)	$43.2	$116.6	$105.5	$106.6	$113.9
2B13	Integrated Display System (IDS)	$19.5	$24.0	$34.2	$45.0	$50.0
2B14	Remote Monitoring and Logging System (RMLS)	$18.1	$16.4	$15.6	$16.7	$0.0
2B15	Mode S Service Life Extension Program (SLEP)	$15.4	$25.2	$19.2	$8.3	$10.3
2B16	NextGen – Terminal Flight Data Manager (TFDM)	$119.3	$112.8	$78.7	$47.9	$39.4
2B17	NAS Voice Recorder Program (NVRP)	$14.0	$14.5	$17.0	$21.0	$22.0
2B18	Integrated Terminal Weather System (ITWS)	$2.1	$0.0	$0.0	$0.0	$0.0
2B19	NextGen – Performance Based Navigation & Metroplex Portfolio	$20.0	$5.0	$8.0	$8.0	$8.0
	C. Flight Service Programs	**$25.8**	**$16.8**	**$5.9**	**$3.6**	**$3.3**
2C01	Aviation Surface Weather Observation System	$11.0	$3.0	$0.0	$0.0	$0.0
2C02	Future Flight Services Program (FFSP)	$10.1	$10.1	$2.0	$0.0	$0.0
2C03	Alaska Flight Service Facility Modernization (AFSFM)	$2.7	$2.8	$2.9	$2.9	$2.8
2C04	Weather Camera Program	$1.1	$0.0	$0.0	$0.0	$0.0
2C05	Juneau Airport Wind System (JAWS) – Technology Refresh	$1.0	$1.0	$1.0	$0.7	$0.5

BLI Number	Capital Budget Line Item (BLI) Program	FY 2019 Budget	FY 2020 Est.	FY 2021 Est.	FY 2022 Est.	FY 2023 Est.
	D. Landing and Navigation Aids Programs	**$160.1**	**$161.1**	**$173.9**	**$183.8**	**$186.0**
2D01	VHF Omnidirectional Radio Range (VOR) Minimum Operating Network (MON)	$15.0	$18.0	$17.3	$19.4	$19.4
2D02	Wide Area Augmentation System (WAAS) for GPS	$96.3	$93.6	$99.5	$98.5	$96.8
2D03	Instrument Flight Procedures Automation (IFPA)	$1.4	$1.1	$0.0	$0.0	$0.0
2D04	Runway Safety Areas – Navigation Mitigation	$2.0	$1.4	$0.0	$0.0	$0.0
2D05	NAVAIDS Monitoring Equipment	$3.0	$0.0	$0.0	$0.0	$0.0
2D06	Legacy Navigation Aids Portfolio	$42.4	$47.0	$57.1	$65.9	$69.8
	E. Other ATC Facilities Programs	**$283.5**	**$280.8**	**$280.3**	**$265.7**	**$260.7**
2E01	Fuel Storage Tank Replacement and Management	$25.7	$22.0	$22.0	$22.0	$22.0
2E02	Unstaffed Infrastructure Sustainment	$51.1	$50.3	$47.1	$46.7	$42.7
2E03	Aircraft Related Equipment Program	$13.0	$13.0	$13.0	$9.0	$9.0
2E04	Airport Cable Loop Systems – Sustained Support	$10.0	$10.0	$10.0	$10.0	$10.0
2E05	Alaskan Satellite Telecommunication Infrastructure (ASTI)	$16.3	$4.3	$4.0	$0.0	$0.0
2E06	Facilities Decommissioning	$9.0	$10.0	$10.0	$10.0	$10.0
2E07	Electrical Power Systems – Sustain/Support	$140.8	$140.0	$140.0	$140.0	$140.0
2E08	Energy Management and Compliance (EMC)	$2.4	$6.2	$6.2	$0.0	$0.0
2E09	Child Care Center Sustainment	$1.0	$1.5	$1.0	$1.0	$1.0
2E10	FAA Telecommunications Infrastructure 2	$6.7	$11.5	$15.0	$15.0	$15.0
2E11	Data, Visualization, Analysis and Reporting System (DVARS)	$4.5	$4.5	$4.5	$4.5	$4.5
2E12	Time-Division Multiplexing to Internet Protocol (TDM-to-IP) Migration	$3.0	$4.0	$4.0	$4.0	$3.0
2E13X	Independent Operational Assessment	$0.0	$3.5	$3.5	$3.5	$3.5
	Activity 3: Non-Air Traffic Control Facilities and Equipment	**$201.9**	**$189.0**	**$202.3**	**$179.8**	**$147.1**
	A. Support Programs	**$186.6**	**$174.0**	**$187.3**	**$164.8**	**$132.1**
3A01	Hazardous Materials Management	$29.8	$31.0	$31.0	$31.0	$31.0
3A02	Aviation Safety Analysis System (ASAS)	$18.9	$19.7	$21.5	$22.0	$19.1
3A03	National Airspace System (NAS) Recovery Communications (RCOM)	$12.2	$12.0	$12.0	$12.0	$12.0
3A04	Facility Security Risk Management	$18.6	$15.0	$14.9	$12.1	$0.0
3A05	Information Security	$16.0	$17.8	$18.5	$18.2	$17.0
3A06	System Approach for Safety Oversight (SASO)	$25.4	$23.1	$23.7	$25.4	$23.0
3A07	Aviation Safety Knowledge Management Environment (ASKME)	$6.0	$5.3	$8.4	$9.8	$12.0
3A08	Aerospace Medical Equipment Needs (AMEN)	$14.1	$13.8	$19.9	$5.0	$0.0

BLI Number	Capital Budget Line Item (BLI) Program	FY 2019 Budget	FY 2020 Est.	FY 2021 Est.	FY 2022 Est.	FY 2023 Est.
3A09	NextGen – System Safety Management Portfolio	$14.7	$15.0	$15.0	$15.0	$15.0
3A10	National Test Equipment Program	$5.0	$3.0	$3.0	$3.0	$3.0
3A11	Mobile Assets Management Program	$2.2	$1.5	$2.0	$2.0	$0.0
3A12	Aerospace Medicine Safety Information System (AMSIS)	$16.1	$13.8	$11.7	$7.8	$0.0
3A13	Tower Simulation System (TSS) Technology Refresh	$0.5	$0.0	$0.0	$0.0	$0.0
3A14	Logistics Support System and Facilities (LSSF)	$7.1	$3.0	$5.7	$1.5	$0.0
	B. Training, Equipment and Facilities	**$15.3**	**$15.0**	**$15.0**	**$15.0**	**$15.0**
3B01	Aeronautical Center Infrastructure Modernization	$14.3	$14.0	$14.0	$14.0	$14.0
3B02	Distance Learning	$1.0	$1.0	$1.0	$1.0	$1.0
	Activity 4: Facilities and Equipment Mission Support	**$227.0**	**$229.6**	**$232.1**	**$232.5**	**$252.0**
4A01	System Engineering and Development Support	$38.0	$38.0	$38.0	$38.0	$38.0
4A02	Program Support Leases	$47.0	$50.0	$50.0	$50.0	$50.0
4A03	Logistics and Acquisition Support Services	$11.0	$11.0	$11.0	$11.0	$11.0
4A04	Mike Monroney Aeronautical Center Leases	$20.2	$20.6	$21.1	$21.5	$22.0
4A05	Transition Engineering Support	$17.0	$16.0	$15.0	$15.0	$15.0
4A06	Technical Support Services Contract (TSSC)	$23.0	$23.0	$23.0	$23.0	$23.0
4A07	Resource Tracking Program (RTP)	$6.0	$8.0	$8.0	$8.0	$8.0
4A08	Center for Advanced Aviation System Development (CAASD)	$57.0	$57.0	$60.0	$60.0	$60.0
4A09	NextGen – Aeronautical Information Management Program	$6.8	$5.0	$5.0	$5.0	$25.0
4A10	NextGen – Cross Agency NextGen Management	$1.0	$1.0	$1.0	$1.0	$0.0
	Activity 5: Personnel Compensation, Benefits and Travel	**$489.6**	**$499.2**	**$508.1**	**$515.0**	**$518.0**
5A01	Personnel and Related Expenses	$489.6	$499.2	$508.1	$515.0	$518.0
	Note: BLI numbers with X represent outyear programs not requested in the FY 2019 President's Budget.					
	Total Year Funding	**$2,766.6**	**$2,766.6**	**$2,766.6**	**$2,766.6**	**$2,766.6**
	Targets	**$2,766.6**	**$2,766.6**	**$2,766.6**	**$2,766.6**	**$2,766.6**

9 Information for Major Capital Programs

Because of the criticality of on-budget and on-time acquisitions to the efficient transition to NextGen, the Government Accountability Office (GAO) was directed to determine the status of Air Traffic Organization's performance in acquiring ATC systems.

In response to a prior GAO recommendation to identify regular reporting to Congress and the public on FAA's overall performance in acquiring ATC systems, the table below provides the most recent information on FAA's major capital programs.

FAA's major active programs are defined as those classified as Acquisition Category (ACAT) 1, 2, 3, or are of strategic importance to the agency. These are typically programs with total F&E costs greater than $100 million and/or those that have significant impact, complexity, risk, sensitivity, safety, or security issues. For more information on ACATs see: http://fast.faa.gov/NFFCA_Acquisition_Categories.cfm .

Programs that have completed their acquisition phase since the last publication of the CIP appear on the final page of this section, Major Programs with Completed Acquisition Phase, but are not shown in subsequent publications.

FAA Capital Programs
Current Information for Major Programs

Programs	Original Baseline			Rebaseline			Current Estimate		Comments
	Original APB Date	Completion Date	Budget $M	Rebaseline APB Date	Revised Completion Date	Revised Budget $M	Completion Date	Budget $M	
Automatic Dependent Surveillance Broadcast (ADS-B) – Baseline Services & Applications FY14 - 20 ACAT 1	May-12	Sep-20	$960.4				Sep-20	$971.5	**Current Estimate vs. Original Baseline:** The $11.1M (-1.2% variance) is associated with additional funds provided to support the General Aviation (GA) aircraft incentive program to address "key barriers" to ADS-B out equipage identified by the Equip 2020 team.
Collaborative Air Traffic Management Technologies (CATMT) Work Package 4 (WP4) ACAT 3 New Investment (NI)	Jun-17	Sep-22	$78.6				Sep-22	$78.6	**NOTE:** New Addition. Final Investment Decision (FID) approved by the JRC in Jun-17.
Common Support Services (CSS) Weather (Wx) ACAT 1	Mar-15	Aug-22	$120.1				Aug-22	$120.1	
Data Communications (Data Comm) Segment 1, Phase 1 (S1P1) ACAT 1	May-12	May-19	$741.4				May-19*	$718.7	**Current Estimate vs. Original Baseline:** *The FAA completed the Controller Pilot Data Link Communications (CPDLC) Departure Clearance (DCL) deployment waterfall in Dec 2016, 29 months ahead of the original baseline of May 2019 and under budget. There are remaining activities to be performed under this phase of the Data Comm program, to include: executing the remaining portion of the equipage initiative, delivering pre-planned air traffic control and flight deck enhancements, and continuing industry outreach and coordination.
Data Communications (Data Comm) Segment 1, Phase 2 (S1P2), Initial En Route Services ACAT 1	Oct-14	Feb-21	$816.7				Feb-21	$816.7	

FAA Capital Programs
Current Information for Major Programs

Programs	Original Baseline			Rebaseline			Current Estimate		Comments
	Original APB Date	Completion Date	Budget $M	Rebaseline APB Date	Revised Completion Date	Revised Budget $M	Completion Date	Budget $M	
Data Communications (Data Comm) Segment 1, Phase 2 (S1P2), Full En Route Services ACAT 1 New Investment	Aug-16	Dec-23	$421.4				Dec-23	$421.4	There is no funding requested in the Facilities and Equipment (F&E) budget for this program after FY17.
En Route Automation Modernization (ERAM) Enhancements 2 ACAT 1	Dec-16	Dec-23	$253.6				Sep-26	$253.6	**Current Estimate vs. Original Baseline:** The schedule delay of 33 months (-39.3% variance) is associated with budgetary actions that impacted the program since the approval of their Final Investment Decision (FID) in Dec-16. Starting with the FY18 President's Budget, the program's funding was reduced significantly. In addition, due to lower outyear funding targets the program funding profile has been extended two (2) years to FY25.
ERAM Sustainment 2 (Formerly known as Technology Refresh 2) ACAT 4TR	Dec-16	Sep-20	$279.2				Sep-20	$279.2	
Facility Security and Risk Management (FSRM) 2 ACAT 2	Jun-11	Sep-22	$182.5				Sep-22	$182.5	

FAA Capital Programs
Current Information for Major Programs

Programs	Original Baseline			Rebaseline			Current Estimate		Comments
	Original APB Date	Completion Date	Budget $M	Rebaseline APB Date	Revised Completion Date	Revised Budget $M	Completion Date	Budget $M	
Logistics Center Support System (LCSS) ACAT 2	Apr-10	Apr-14	$67.4	Apr-14	Apr-16	$79.4	Mar-20	$104.1	**Rebaseline vs. Original Baseline:** The schedule delay of 24 months (-50% variance) and cost increase of $12M (-17.8% variance) is associated with the following factors: 1) Business processes developed during the Business Process Reengineering (BPR) phase did not address system interactions between functional areas; 2) delays in developing interfaces with legacy systems; 3) complexity of the tool integration required for interfaces; and 4) changes in contract and program management. In Apr-14, the JRC approved a Baseline Change Decision (BCD) for LCSS. **Current Estimate vs Rebaseline:** The program is projected to be completed in Mar-20 (-65.3% variance) with an estimated cost at completion of $104.1M (-31.1% variance). The schedule and cost increases are associated with 1) user and system requirements that were identified after the Initial Operational Capability (IOC), that remain to be developed; 2) workarounds as a result of unmet requirements that did not have documentation to support the remaining development; 3) related work processes and system interfaces that were not fully defined or documented that resulted in additional requirements to be developed to meet user needs; 4) efforts to stabilize defects found during initial production.
NAS Voice System (NVS) Demonstration and Qualification Phase ACAT 1	Sep-14	Mar-20	$294.2				Sep-20	$299.2	**Current Estimate vs Original Baseline:** The schedule delay of 6 months (-6.52% variance) and cost increase of $5M (-1.7% variance) are associated with contractor performance and ongoing software development, testing and logistics required to achieve an In-Service Decision.

FAA Capital Programs
Current Information for Major Programs

	Original Baseline			Rebaseline			Current Estimate		
Programs	Original APB Date	Completion Date	Budget $M	Rebaseline APB Date	Revised Completion Date	Revised Budget $M	Completion Date	Budget $M	Comments
Next Generational Weather Processor (NWP) ACAT 1	Mar-15	Aug-22	$189.3				Aug-22	$189.3	
Next Generation Air-to-Ground Communication System (NEXCOM) - Segment 2, Phase 1 ACAT 2	Sep-11	Sep-18	$285.9				Sep-18	$285.9	
NEXCOM - Segment 2, Phase 2 ACAT 2 NI	Aug-17	Dec-26	$334.2				Dec-26	$334.2	**NOTE:** New Addition. Final Investment Decision (FID) approved by the JRC in Jun-17.

FAA Capital Programs
Current Information for Major Programs

	Original Baseline			Rebaseline			Current Estimate		
Programs	Original APB Date	Completion Date	Budget $M	Rebaseline APB Date	Revised Completion Date	Revised Budget $M	Completion Date	Budget $M	Comments
Runway Status Lights (RWSL) ACAT 1	Jan-10	Oct-15	$327.4	Jul-13	Sep-17	$366.7	Jun-19	$366.7	**Rebaseline vs. Original Baseline:** In Jul-13 the JRC approved a BCD for the RWSL program. The JRC determined to minimize the cost exposure to the baseline, deployment will be limited to the 16 airports that have been fully committed and San Francisco International for a total of 17 airports. This results in a reduction of 6 airports (26.1% variance) from the original 23 airports approved at the FID in Jan-10. The cost increase ($39.3M, -12% variance) and schedule delay (23 months, -26.1% variance) are attributed to the following factors: (1) construction plans changed due to costlier techniques by Airport Authorities; (2) limited runway/taxiway surface availability to meet installation schedules; (3) requirement changes that included increases in the light count, the switch from incandescent lights to LED, and the increased supportability for these requirements; (4) costly duct bank and shelter installations; (5) under estimation of site and depot spares costs; and (6) additional engineering development for supportability enhancements. **Current Estimate vs. Rebaseline**: The 21 month schedule delay (-18.9%) is attributed to the addition of Boston, Dallas/Ft. Worth, and San Deigo Airports to the baseline. These 3 locations currently have prototype systems and were included in the original baseline. These airports have committed to a work share agreement with the FAA to upgrade the prototypes to baseline systems. The work share agreements will allow the FAA to complete the work at the 3 airports with no impact to the rebaseline budget.

FAA Capital Programs
Current Information for Major Programs

Programs	Original Baseline			Rebaseline			Current Estimate		Comments
	Original APB Date	Completion Date	Budget $M	Rebaseline APB Date	Revised Completion Date	Revised Budget $M	Completion Date	Budget $M	
System Approach for Safety Oversight (SASO) Phase 3 (Formerly known as Phase 2B Segment 1A) ACAT 3 NI	Feb-16	May-23	$135.7				May-23	$135.6	
System Wide Information Management (SWIM) Segment 2B ACAT 2	Oct-15	Sep-21	$119.6				Sep-21	$119.6	
Standard Terminal Automation Replacement System (STARS) Technology Refresh/Sustainment 2 ACAT 4TR	Sep-17	May-22	$102.1				May-22	$102.1	**NOTE:** New Addition. FID approved by JRC in Sep-17.
Terminal Automation Modernization and Replacement (TAMR), Phase 3, Segment 2 (P3 S2) ACAT 2	Sep-12	Aug-19	$462.5				Aug-19	$496.8	**Current Estimate vs. Original Baseline**: The current cost increase of $34.3M (-7.4% variance) is associated with the impact of higher prime costs.
Terminal Automation Modernization and Replacement (TAMR), Phase 1 Technology Refresh ACAT 2	Sep-12	Feb-20	$531.5				Feb-20	$531.5	

FAA Capital Programs
Current Information for Major Programs

	Original Baseline			Rebaseline			Current Estimate		
Programs	Original APB Date	Completion Date	Budget $M	Rebaseline APB Date	Revised Completion Date	Revised Budget $M	Completion Date	Budget $M	Comments
Terminal Flight Data Manager (TFDM) ACAT 1 NI	Jun-16	Sep-28	$795.2				Sep-28	$795.2	
Time Based Flow Management (TBFM) WP3 ACAT 3NI	Apr-15	Sep-22	$188.3				Sep-22	$188.3	
Wide Area Augmentation System (WAAS) Phase IV, Segment 1 - Dual Frequency Operations (DFO) ACAT 1	May-14	Sep-19	$603.2				Sep-19	$603.2	

FAA Capital Programs
Major Programs with Completed Acquisition Phase

	Original Baseline			Rebaseline			Actual Results		
Programs	Original APB Date	Completion Date	Budget $M	Rebaseline-APB Date	Revised Completion Date	Revised Budget $M	Completion Date	Budget $M	Comments
ERAM System Enhancements and Technology Refresh (SETR) ACAT 1	Sep-13	Sep-17	$152.9				Sep-17	$133.2	**Actual Result vs. Original Baseline:** The program completed on schedule and under budget.
System Wide Information Management (SWIM) Segment 2A ACAT 2	Jul-12	Dec-17	$120.2				Dec-17	$113.5	**Actual Result vs. Original Baseline:** The program completed on schedule and under budget.

10 Conclusion

Allocating FAA's limited resources to address competing NAS priorities requires continuous planning and analysis. The FY 2019-2023 CIP includes the programs needed to meet this challenge within the target levels of F&E funding over the next five years. Each year, the CIP programs are reviewed to assess progress made in delivering planned capabilities, infrastructure, and services. As necessary, adjustments are made to the CIP to ensure that critical capabilities are delivered on schedule and new programs initiated to meet changing mission needs.

The FAA is developing solutions for safely integrating in the NAS an increasing number of commercial space operations and recreational and commercial drones. The agency is working diligently to ensure the delivery of NextGen capabilities as promised and remains committed to providing aviation services with a level of safety that are unrivaled in the world.

The link for the CIP and the other online references in this document are provided below for your convenience.

- Capital Investment Plan at http://www.faa.gov/air_traffic/publications/cip/
- The Economic Impact of Civil Aviation on the U.S. Economy at http://www.faa.gov/air_traffic/publications/media/2016-economic-impact-report_FINAL.pdf
- FAA Aerospace Forecast for Fiscal Years 2017-2037 at http://www.faa.gov/data_research/aviation/aerospace_forecasts/
- NextGen Implementation Plan at http://www.faa.gov/nextgen/library/
- NextGen Performance Snapshots at http://www.faa.gov/nextgen/snapshots/
- Acquisition Categories at http://fast.faa.gov/NFFCA_Acquisition_Categories.cfm

11 Acronyms & Abbreviations

--Number--	
4D	four dimensional
4DT	four-dimensional trajectories
--A--	
ACAT	acquisition category
ACE-IDS	ASOS controller equipment-information display system
ACFT	aircraft
ACS	aeronautical common services or ASOS controller equipment
ADAS	AWOS (automated weather observing system) data acquisition system
ADS-B	automatic dependent surveillance-broadcast
ADS-R	automatic dependent surveillance-rebroadcast
AEFS	advanced electronic flight strip system
AFSS	automated flight service station
A/G	air-to-ground
AGIS	airport geographic information system
AIM	aeronautical information management
AIMM	aeronautical information management modernization
AIR	FAA Aircraft Certification Service
AISR	aeronautical information system replacement
AIXM	aeronautical information exchange model
ALDARS	automated lightning detection and reporting system
ALS	approach lighting system
ALSF-2	approach lighting system with sequenced flashing light model 2
ALSIP	approach lighting system improvement program
AMASS	airport movement area safety system
AMEN	aerospace medical equipment needs
AMMS	automated maintenance management system
AMS	acquisition management system
AMSIS	aerospace medicine safety information system
ANICS	Alaskan national airspace system interfacility communications system
ANSP	air navigation service provider
ARMT	airspace resource management tool
ARSR	air route surveillance radar
ARTCC	air route traffic control center
ARTS IE/IIE/IIIE	automated radar terminal system models IE, IIE, or IIIE
ASDE-3	airport surface detection equipment model 3 (primary radar)
ASDE-X	airport surface detection equipment model x (safety logic)
ASEPS	advanced surveillance enhanced procedural separation
ASKME	aviation safety knowledge management environment
ASOS	automated surface observing system
ASR-8, 9 11	airport surveillance radar model 8, 9, and 11
ASSC	airport surface surveillance capability
ASTI	Alaskan satellite telecommunication infrastructure
ASWON	aviation surface weather observation network
ATC	air traffic control

ATCBI-5, 6	ATC beacon interrogator model 5, and 6
ATCSCC	Air Traffic Control System Command Center
ATCT	air traffic control tower
ATIS	automated terminal information service
ATM	air traffic management
ATN	aeronautical telecommunication network
ATO	Air Traffic Organization
ATOP	advanced technologies and oceanic procedures
AVS	FAA Office of Aviation Safety
AWIPS	advanced weather interactive processing system
AWOS	automated weather observing system
AWOS-C	AWOS model C
AWSS	automated weather sensor systems
--B--	
BLI	budget line item
BUEC	back up emergency communications
BWM	bandwidth manager
--C--	
CA	collision avoidance
CAMI	Civil Aerospace Medical Institute
CARF	central altitude reservation function
CARSR	common air route surveillance radar
CAST	commercial aviation safety team
CAT (I, II, or III)	category of precision approach capability
CATM	collaborative air traffic management
CATMT	collaborative air traffic management technologies
CCF	combined control facility
CCS	conference control switch
CCS-W	conference control switch – Warrenton
CD-2	common digitizer – model 2
CDDS	CIWS data distribution system
CFE	communications facilities enhancement
CFR	code of federal regulations
CIP	capital investment plan
CIWS	corridor integrated weather system
CONUS	continental United States
CO	current operation
COTS	Commercial-off-the-shelf
CPDLC	controller-pilot data link communications
CRDRD	concept & requirements definition readiness decision
CREWS	CTAS remote weather system
CSPO	closely spaced parallel operations
CSPR	closely spaced parallel runways
CSSD	common status and structure data
CSS-FD	common support services – flight data
CSS-Wx	common support services – weather
CTAS	center/TRACON automation system

CTD	common terminal digitizer
CTS	coded time source
CV-4400	system to use terminal radar information in en route automation systems
--D--	
DALR	digital audio legal recorder
DASI	digital altimeter setting indicator
Data Comm	data communications
DBRITE	digital bright radar indicator tower equipment
DCIS	data communications integrated services
DCL	departure clearance
DCNS	data comm network services (air/ground)
DME	distance measuring equipment
DME/DME	RNAV using multiple DMEs
DMN	data multiplexing network or data exchange messaging nodes
DoD	Department of Defense
DOT	Department of Transportation
DOTS+	dynamic ocean tracking system plus
DSP	departure spacing program
DSR	display system replacement
DUATS	direct user access terminal system
DVARS	data visualization, analysis and reporting system
--E--	
EA	enterprise architecture
ECG	en route communications gateway
EFS	electronic flight strips
EFSTS	electronic flight strip transfer system
E-IDS	enterprise information display system
ELITE	enhanced local integrated tower equipment
ELVO	enhanced low visibility operations
EMC	energy management and compliance
EOL	end-of-life
ERAM	en route automation modernization
ERIDS	en route information display system
E-Scan	electronic scan version of PRM (precision runway monitor)
ETVS	enhanced terminal voice switch
EWD	enhanced weather information network server (WINS) distribution
--F--	
F-420	wind sensor series F-420
FAA	Federal Aviation Administration
FANS	future air navigation system
FBWTG	FAA bulk weather telecommunication gateway
FDIO	flight data input/output
FDP2K	flight data processing 2000
F&E	facilities and equipment
FFSP	future flight services program

FID	final investment decision
FIS-B	flight information services – broadcast
FIXM	flight information exchange model
FNS	federal NOTAM system
FTI	FAA telecommunications infrastructure
FTI-2	successor program to FTI
FY	fiscal year
--G--	
G1/G2	STARS generation 1/2
GA	general aviation
GAO	Government Accountability Office
GDP	gross domestic product
GIS	geographic information system
GNSS	global navigation satellite system or service
GOM	Gulf of Mexico
GPS	global positioning system
--H--	
HADDS	HOST ATM data distribution system
HF	high frequency or human factors
HOST	Host Computer System
--I--	
IAM	identity and access management
IARD	investment analysis readiness decision
ICAO	International Civil Aviation Organization
ICMS	Interlock control and monitoring system
ICSS	integrated communication switching system
IDAC	integrated departure/arrival capability
IDP	improved demand predictions
IDRP	integrated departure route planning
IDS	integrated display system
IESP	integrated enterprise service platform
IFR	instrument flight rules
IID	initial investment decision
ILS (I, II, or III)	instrument landing system (category I, II, or III)
IM	interval management
IMC	instrument meteorological conditions
IP	internet protocol
IRU	inertial reference unit
ITWS	integrated terminal weather system
IVSR	interim voice switch replacement
--J--	
JAWS	Juneau airport wind system
JRC	joint resources council

--K--	
--L--	
L1 C/A	GPS legacy civil frequency
L5	GPS second civil frequency
L1/L5	GPS dual frequency for WAAS users
LAHSO	land and hold short operations
LDIN	lead in light system
LDRCL	low-density radio communication link
LIDAR	light detection and ranging
LITE	local integrated tower equipment
LLWAS	low level wind shear alert system
LOC	localizer
LP	localizer performance or low power
LPV	localizer performance with vertical guidance
--M--	
MALSR	medium-intensity approach light system with runway alignment indicator lights
MASR	mobile airport surveillance radar
MB	marker beacons
MDR	multimode digital radios
Micro-EARTS	microprocessor en route automated radar tracking system
MMAC	Mike Monroney Aeronautical Center
Mode S	mode select
MON	minimum operating (or operational) network
MSN	message switching network
--N--	
NADIN MSN	national airspace data interchange network – message switching network
NADIN PSN	national airspace data interchange network – package switching network
NAIMES	NAS aeronautical information management enterprise system
NARP	national aviation research plan
NAS	national airspace system
NASE	NAS adaptation services environment
NAS EA	NAS enterprise architecture
NASR	national airspace system resources
Navaids	navigation aids
NBSC	NextGen backup surveillance capability
NDB	non-directional beacon
NEMS	NAS enterprise messaging service
NEXCOM	next generation air/ground communications
NEXRAD	next generation weather radar
NextGen	next generation air transportation system
NIDS	NAS information display system
NME	navaids monitoring equipment
NOAA	National Oceanic and Atmospheric Administration
NOP	national offload program
NOTAM	notices to airmen

NSWRC	next generation surveillance and weather radar capability
NVR	NAS voice recorder
NVRP	NAS voice recorder program
NVS	NAS voice system
NWP	NextGen weather processor
NWS	National Weather Service
--O--	
OASIS	operational and supportability implementation system
ODALS	omnidirectional airport lighting system
OEAAA	obstruction evaluation/airport airspace analysis
OFDPS	offshore flight data processing system
OIs	operational improvements
OMB	Office of Management and Budget
OPC	offshore precipitation capability
OPS	operations
OPSNET	operations network
OSHA	Occupational Safety and Health Administration
--P--	
PAPI	precision approach path indicator
PBN	performance-based navigation
PC	personal computer
PDARS	performance data analysis and reporting system
PDC	pre-departure clearance
PIREPS	pilot reports
PRM	precision runway monitor
PRM E-SCAN	precision runway monitor – electronic scan radar
PSN	package switching network
--Q--	
--R--	
RAMP	radar acquisition and mosaic processor
RASP	regional AWOS data acquisition system (ADAS) service processor
RCE	radio control equipment
RCF	remote communication facilities
RCISS	regulation and certification infrastructure for system safety
RCL	radio communication link
RCOM	NAS recovery communications
RDVS	rapid deployment voice switch
REIL	runway end identifier lights
RMLS	remote monitoring and logging system
RNAV	area navigation
RNP	required navigation performance
RPM	revenue passenger miles
RSA	runway safety area
RVR	runway visual range

RWSL	runway status lights
--S--	
S1P1	segment 1, phase 1
S1P2	segment 1, phase 2
SAA	special activity airspace
SAMS	special use airspace management system
SAS	safety assurance system
SASO	system approach for safety oversight
SAWS	standalone weather sensors
SBAS	satellite based augmentation system
SDAT	sector design and analysis tool
SDI	space data integrator
SENSR	spectrum efficient national surveillance radar
SFMEE	strategic flow management engineering enhancement
SIGMETS	significant meteorological information
SLEP	service life extension program
SMA	surface movement advisor
SMS	safety management system
SOA	service oriented architecture
STARS	standard terminal automation replacement system
STARS (E, L, or E/L)	STARS enhanced/local integrated tower equipment (ELITE)
STVS	small tower voice switch
SWIM	system wide information management
SWS	surface weather system
--T--	
TACAN	tactical air navigation
TAMR	terminal automation modernization replacement
TBFM	time based flow management
TBO	trajectory based operations
TCW	terminal control workstation
TDLS	tower data link service
TDM	time division multiplexing
TDM-to-IP	TDM to internet protocol
TDW	tower display workstation
TDWR	terminal Doppler weather radar
TDX-2000	target data extractor–2000 digitizer (converts analog data to digital)
Tech Ops	Technical Operations
TFDM	terminal flight data manager
TFM	traffic flow management
TFM-I	TFM improvements
TFMS	TFM system
TFR Bldr	temporary flight restriction builder
TIS-B	traffic information services-broadcast
TMI	traffic management initiatives
TMU	traffic management units
TR	technology refresh

TRACON	terminal radar approach control
TSAS	terminal sequencing and spacing
TVSR	terminal voice switch replacement
--U--	
UAS	unmanned aircraft systems
UHF	ultra high frequency
UIC	universal interlock controller
URET	user request evaluation tool
USNS	United States NOTAM (notice to airmen) system
--V--	
VASI	visual approach slope indicator
VDL	VHF data link
VHF	very high frequency
VoIP	voice over internet protocol
Volpe	Volpe National Transportation Center in Cambridge, MA
VOR	very high frequency omnidirectional range
VOT	VOR test
VORTAC	VOR collocated with TACAN
VSCS	voice switching and control system
VSBP	voice switch by pass
VTABS	VSCS training and backup switches
--W--	
WAAS	wide area augmentation system
WAFS	world area forecast system
WAM	wide area multilateration
WARP	weather and radar processor
WEF	wind equipment series F-420
WIFS	WAFS internet file service
WINS	weather information network server
WJHTC	William J. Hughes Technical Center
WME	wind measuring equipment
WMSCR	weather message switching center replacement
WP	work package
WSDD	web service description documents
WSDS	wind shear detection services
WSP	wind shear processor
Wx	weather
–X–	
WiWAVES	wind & wave evacuation and survival
WSRF	water survival research facility
–Y–	
–Z–	