Joint Planning and Development Office

Next Generation Air Transportation System

Integrated Work Plan:

A Functional Outline

Version 1.0

September 30, 2008

Preface

The future of our nation's ability to move people and goods in a safe, secure, efficient and environmentally-responsible manner depends upon the successful implementation of the Next Generation Air Transportation System (NextGen). The Joint Planning and Development Office (JPDO) was established by the U.S. Congress to guide and support the creation of NextGen. To guide and facilitate the most effective execution of these efforts, the JPDO is releasing Version 1.0 of the NextGen Integrated Work Plan (IWP).

The IWP is part of a comprehensive suite of information that represents the Integrated Plan for NextGen. The Concept of Operations (ConOps) and Enterprise Architecture (EA), previously released by the JPDO, provide a common vision for how NextGen will operate in the 2025 timeframe and beyond. NextGen is a complex undertaking that requires a comprehensive plan to facilitate

The Integrated Work Plan (IWP) provides a tool to support the collaborative planning and deliberation needed among partners and stakeholders to prioritize needs, establish commitments, coordinate efforts, and focus resources on the work needed to achieve the Next Generation Air Transportation System (NextGen). The IWP provides comprehensive information about the elemental operational improvements, enablers, development and research milestones, as well as policies needed to make NextGen a reality. These IWP elements define the overall NextGen plan. This release of the IWP is intended to facilitate coordination with government and industry partners as they implement NextGen.

It is important to note that the IWP is an unconstrained plan and does not seek to define prescriptive implementation activities, nor does it address priorities of activities at this time. It proposes a path to realize the IWP elements but not the specific program steps, resources or implementation elements such as facility rollout, training, or decommissioning. The detailed planning for each IWP element is the responsibility of the NextGen Partner that has accepted the element as part of their overall mission.

IWP Version 1.0 includes a broad range of planning information with many attributes and dependencies that are difficult to digest in a written document. To fully comprehend and use the power of the information within the IWP, the Joint Planning Environment (JPE) is available at www.jpdo.gov. The JPE tool provides the user with full access to the IWP information and supports interactive analysis for decision making.

To develop IWP Version 1.0, the JPDO engaged hundreds of aviation professionals, engineers, subject matter experts, analysts and planners across the Federal government, industry, and the public for almost three years. The content has undergone a thorough review and commenting process by the public as well as government and industry partners. Over 3,000 comments were received from the review of Versions 0.1 and 0.2 and are now incorporated, as appropriate, into Version 1.0. The status of comments submitted by stakeholders can also be found at www.jpdo.gov.

JPDO will issue annual updates to the IWP that reflect new understanding from research or development efforts, changing economic or technical conditions, as well as alignment with the programmatic efforts of NextGen Partners. It will also need alignment with an avionics road map, currently under development, that will identify the expected aircraft capability and equipage strategies envisioned for NextGen. The avionics roadmap will be distributed for stakeholder comment in FY09 and subsequently incorporated into the IWP.

Document Revision Register

Version	*Document Content Added*	*Reviewer*	*Release Date*
0.1	Initial document	JPDO Working Groups, Agencies, NGATS Institute	July 31, 2007
0.2	Comments from Version 0.1 review and updates from final versions of the Research and Develop Plan and the OMB Exhibit 300	Industry, Stakeholders and Agencies	February 15, 2008
1.0	Comments from Version 0.2 review and alignment with partner plans	No comments requested. Used for planning and coordination during Fiscal Year 2009	September 30, 2008
1.X	Internal revisions from architectural alignments and updates from partner plans	Industry, Stakeholders and Agencies	TBD
2.0	Comments from 1.X review		Targeted at September 2009

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Tables of Acronyms

Term	Definition
4D	Four-Dimensional
4DT	Four-Dimensional Trajectory
ACRP	Airport Cooperative Research Program
ADIZ	Air Defense Identification Zone
ADS-B	Automatic Dependent Surveillance-Broadcast
ADS-C	Automatic Dependent Surveillance-Contract
ADSII	Air Domain Surveillance and Intelligence Integration
AEB	ASIAS Executive Board
AEDT	Aviation Environmental Design Tool
AIRE	Atlantic Interoperability Initiative to Reduce Emissions
AIRMET	Airman’s Meteorological Information
AIXM	Aeronautical Information Exchange Model
ANSP	Air Navigation Service Providers
APMT	Aviation Environmental Portfolio Management Tool
ARFF	Airport Rescue Fire Fighting
ARNS	Aeronautical Radio Navigation Service
ARTCC	Air Route Traffic Control Center
ASAS	Airborne Separation Assistance Systems
ASDE-3/X	Airport Surface Detection Equipment - Model 3/X
ASIAS	Aviation Safety Information Analysis and Sharing
ASR-9	Airport Surveillance Radar – Model 9
ASR-11	Airport Surveillance Radar - Model 11
ASR-8	Airport Surveillance Radar - Model 8
ASSP	Aviation Safety Strategic Plan
ASTM	American Society for Testing and Materials
ATC	Air Traffic Control
ATCBI-6	Air Traffic Control Beacon Interrogator - Model 6
ATCRBS	Air Traffic Control Radar Beacon System
ATCSCC	Air Traffic Control System Command Center
ATM	Air Traffic Management
ATOP	Advanced Technologies and Oceanic Procedures
ATS	Air Transportation System

Term	Definition
AVT	Automated Virtual Towers
AWG	Airport Working Group
BMP	Base Management Practices
BPR	Behavioral Pattern Recognition
CAAFI	Commercial Aviation Alternative Fuels Initiative
CAEP	Committee on Aviation Environmental Policy
CARTS	Common Automated Radar Terminal System
CATM	Collaborative Air Traffic Management
CAVS	CDTI Assisted Visual Separation
CBP	Customs Border Protection
CBRNE	Chemical, Biological, Radiological, Nuclear, and High Yield Explosive
CDA	Continuous Descent Arrival
CDM	Collaborative Decision Making
CDT	Common Data Transport
CDTI	Cockpit Display of Traffic Information
CFIT	Controlled Flight Into Terrain
CFR	Code of Federal Regulations
CLEEN	Continuous Low Energy, Emissions, and Noise
CNS	Communication, Navigation, and Surveillance
CO2	Carbon Dioxide
COCR	Communication Operating Concepts and Requirements
COI	Community of Interest
ConOps	Concept of Operations
CONUS	Continental United States
CSCE	Certified Supply Chain Entity
CSS	Cooperative Surveillance System
CTA	Controlled Time of Arrivals
CUI	Controlled Unclassified Information
D-ATIS	Digital-Automatic Terminal Information System
DHS	Department of Homeland Security
DME	Distance Measuring Equipment
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation

Term	Definition
DSP	Defense Service Provider
DSS	Decision Support Systems
DST	Decision Support Tool
EA	Enterprise Architecture
EFS	Electronic Flight Strips
EGNOS	European Geostationary Navigation Overlay Service
eLoran	Enhanced Long-Range Navigation
EMF	Environmental Management Framework
EMP	Electronic Pulse Threats
EMS	Environmental Management System
EPA	Environmental Protection Agency
ERAM	En Route Automation Modernization
ETVS	Enhance Terminal Voice Switch
EWG	Environmental Working Group
ExCom	Executive Committee
FAA	Federal Aviation Administration
FACT-2	Future Airport Capacity Task - 2
FCAPS	Fault, Configuration, Administration, Performance, and Security
FCI	Future Communications Infrastructure
FCM	Flow Contingency Management
FDP	Flight Data Processor
FDIO	Flight Data Input/Output
FID	Final Investment Decision
FIR	Flight Information Region
FIS-B	Flight Information Service-Broadcast
FLIR	Forward-Looking Infrared
FO	Flight Object
FOC	Flight Operations Center
FPS	Fixed Position Surveillance
FRAC	Facility and Service Realignment and Consolidation
FRMS	Flight Risk Management System
FRZ	Flight Restricted Zone
FSS	Flight Service Station
FTI	Federal Telecommunications Infrastructure
FY	Fiscal Year

Term	Definition
GA	General Aviation
GAGAN	GPS Aided Geo Augmented Navigation
GBAS	Ground-Based Augmentation Systems
GBNS	Ground-Based Navigation System
GHG	Green House Gases
GIG	Global Information Grid
GLONASS	Global Navigation Satellite Systems (Soviet)
GM	Governance Model
GNSS	Global Navigation Satellite Systems
GOMEX	ADS-B Gulf of Mexico
GPS	Global Positioning System
GSE	Ground Support Equipment
HAP	Hazardous Air Pollutants
HITL	Human-in-the-Loop
HOST	Host Computer System
HVAC	Heating, Ventilation, and Air Conditioning
ICAO	International Civil Aviation Organization
IFF	Identification Friend Foe
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
IOC	Initial Operational Capability
IRM	Integrated Risk Management
IRU	Internal Reference Units
IWP	Integrated Work Plan
JPDO	Joint Planning and Development Office
JPE	Joint Planning Environment
JRC	Joint Resource Council
KSN	Knowledge Sharing Network
LEO	Law Enforcement Organization
LF	Low Frequency
LPV	Localizer Performance/Vertical Guidance
LRR	Long Range Radar
MAC	Mid-Air Collision
MANPADS	Man-Portable Air Defense System

Term	Definition
MEARTS	Microprocessor Enroute Automated Radar Tracking System
METAR	Meteorological Aviation Report
MLAT	Multilateration
MM	Message Mediation
Mode S	Mode Select
MP	Dynamic Multipath
MSAS	Multi-Functional Satellite Augmentation System
MTR	Military Training Routes
N+2	Generation After Next Technology
NARP	National Aviation Research Plan
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NASSP	National Aviation Safety Strategic Plan
NAVAIDs	Navigational Aids
NCI	Net-Centric Infrastructure
NCO	National Coordination Office
NCWG	Net-Centric Working Group
NEI	Network Enabled Infrastructure
NEO	Network Enabled Operation
NEPA	National Environmental Policy Act
NEXRAD	Next Generation Weather Radar
NextGen	Next Generation Air Transportation System
NEXTOR	National Center of Excellence for Aviation Operations Research
NFtE	NextGen Forecast Engine
NOAA	National Oceanic and Atmospheric Administration
NOTAM	Notice to Airmen
NOx	Oxides of Nitrogen
NPIAS	National Plan of Integrated Airport Systems
NPRM	Notice of Propose Rule Making
NSA	National Security Airspace
NVS	NAS Voice Switch
NWP	National Weather Program
NWS	National Weather Service
OCR	Office of Collateral Responsibility
OCX	NextGen GPS Operational Control Segment

Term	Definition
ODNI	Office of the Director of National Intelligence
OEP	Operational Evolution Partnership
OEP-35	Operational Evolution Partnership Top 35 Airports
OI	Operational Improvements
OMB	Office of Management and Budget
OPD	Optimized Profile Descent
OPR	Office of Primary Responsibility
PBFA	Policy Board for Federal Aviation
PBO	Performance Based Operations
PD	Policy Decision
PIRG	Planning and Implementation Regional Group
PKI	Public Key Infrastructure
PM	Performance Management
PNT	Positioning, Navigation, and Timing
POC	Point of Contact
PRM	Precision Runway Monitor
PRMA	Precision Runway Monitor Alternate
PRS	Public Regulated Service
QoS	Quality of Service
QVL	Qualified Vendors List
R&D	Research and Development
RCP	Required Communication Performance
RFP	Request for Proposals
RNAV	Area Navigation
RNP	Required Navigation Performance
RSP	Required Surveillance Performance
RTVS	Real Time Verification System
SAPM	Security Airspace Planning and Management
SAR	Search and Rescue
SAS	Single Authoritative Source
SBAS	Satellite-Based Augmentation System
SC	Standing Committee
SID	Standard Instrument Departure
SIGMET	Significant Meteorological Information
SIR	Screening Information Request

Term	Definition
SITS	Security Integrated Tool Set
SMS	Safety Management System
SOA	Service-Oriented Architecture
SOCR	Suggested Office of Collateral Responsibility
SOPR	Suggested Office of Primary Responsibility
SPC	Senior Policy Committee
SPS	Standard Positioning Service
SRA	Security-Restricted Airspace
SRM	Safety Risk Management
SSA	Shared Situational Awareness
SSCE	Secure Supply Chain Entity
SSP	Security Service Provider
STAR	Standard Terminal Arrival Route
STARS	Standard Terminal Automation Replacement System
STFM	Surface Traffic Flow Manager
SUA	Special Use Airspace
SWIM	System-Wide Information Management
TBO	Trajectory-Based Operations
TCAS	Traffic Collision and Avoidance System
TDDS	Terminal Data Display System
TDLS	Tower Data Link Services
TERPS	Terminal Instrument Procedures (U.S. Standards)
TFDM	Tower Flight Data Manager
TFM	Traffic Flow Management
TFR	Temporary Flight Restrictions
TFS	Traffic Flow Specialists
TIS-B	Traffic Information Service-Broadcast
TM	Trajectory Management
TMA	Traffic Management Advisor
TMI	Traffic Management Initiatives
TMO	Traffic Management Operations
TRACON	Terminal Radar Approach Control
TRB	Transportation Research Board
TSA	Transportation Security Administration
UAS	Unmanned Aircraft System

Term	Definition
UAT	Universal Access Transceiver
UHF	Ultra High Frequency
ULS	Ultra Low Sulfur
US	United States
USNO	United States Naval Observatory
UTC	Universal Time Coordinate
V&V	Validation and Verification
VDL	Very High Frequency Data Link
VFR	Visual Flight Rule
VG	Voice Grade
VHF	Very High Frequency
VMC	Visual Meteorological Condition
VoIP	Voice Over Internet Protocol
VSCS	Voice Switching And Control System
WAAS	Wide Area Augmentation System
WATMI	Weather and ATM Integration
WATRS	West Atlantic Route System
WJHTC	William J. Hughes Technical Center
WMD	Weapon of Mass Destruction
WOC	Weather Observation Consolidation
WTMD	Wake Turbulence Mitigation for Departures

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Executive Summary

PURPOSE

The Integrated Work Plan (IWP) provides a tool to support the collaborative planning and deliberation needed among partners and stakeholders to prioritize needs, establish commitments, coordinate efforts, and focus resources on the work needed to achieve the Next Generation Air Transportation System (NextGen). The IWP provides comprehensive information about the elemental operational improvements, enablers, development and research milestones, as well as policies needed to make NextGen a reality. These IWP elements define the overall NextGen plan. This release of the IWP is intended to facilitate coordination with government and industry partners as they implement NextGen.

It is important to note that the IWP is an unconstrained plan and does not seek to define prescriptive implementation activities, nor does it address priorities of activities at this time. It proposes a path to realize the IWP elements but not the specific program steps, resources or implementation elements such as facility rollout, training, or decommissioning. The detailed planning for each IWP element is the responsibility of the NextGen Partner that has accepted the element as part of their overall mission.

OVERVIEW

The future of our nation's ability to move people and goods in a safe, secure, efficient, and environmentally responsible manner depends upon the successful implementation of NextGen. NextGen represents a comprehensive transformation and evolution of our nation's air transportation infrastructure, as well as how the infrastructure is developed, operated and maintained. With the 2003 enactment of the Vision 100 – Century of Aviation Reauthorization Act, a congressional mandate was issued to create the Joint Planning and Development Office (JPDO) to guide and support the creation of NextGen. As authorized under "Vision 100", the JPDO is charged with creating and carrying out an Integrated Plan for NextGen that shall include: "the national vision statement", "a description of demand and performance characteristics" required, "a multiagency research and development roadmap" necessary to overcome the most significant technical obstacles, "a description of the NextGen operational concepts", and a "timeline" to develop and deploy the system. To describe an overall path towards the 2025 characteristics, the IWP must be aligned with the near-term and mid-term plans of each Federal Partner. Therefore, this release of the IWP is intended to facilitate coordination across the NextGen Partners.

The IWP is part of a comprehensive suite of information that represents the Integrated Plan for NextGen. As shown in Figure ES-1, JPDO initially developed the NextGen Concept of Operations (ConOps) and Enterprise Architecture (EA). These core documents provide a common vision for how NextGen will operate in the 2025 timeframe and beyond, as well as a foundation for the NextGen Business Case.

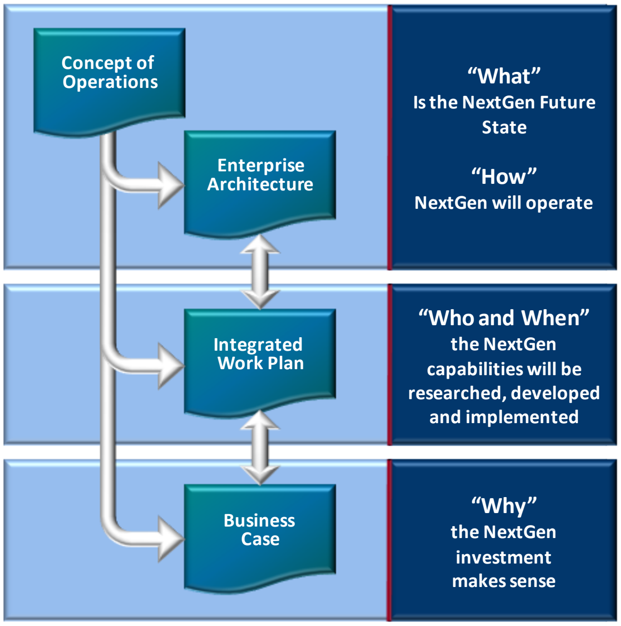


Figure ES-1 JPDO Integrated Plan Documents

NextGen requires an unprecedented level of sustained, coordinated, and integrated effort across the public and private sectors. To create and realize the benefits of this air transportation system for the 21st century, NextGen requires new and significant:

- **Automation:** Integrated information systems are needed that provide advanced trajectory, separation, capacity, flow contingency and security management functions.
- **Infrastructure:** Advanced technologies are needed that provide integrated communication, navigation, surveillance, and security infrastructure services.
- **Processes:** New automation and infrastructure requires new and revised responsibilities and integrated processes to provide increased capacities and efficiencies.
- **Collaboration:** Industry and government need to work together in new ways to define, fund, develop, implement, govern, and operate NextGen technologies, processes, and policies.
- **Integrated Operations:** NextGen operational processes and technologies require the integration of safety, security, and environmental requirements as core components.
- **Information Sharing:** Integrated operations require the broad sharing of information across many organizations and systems in an open, yet secure, manner.
- **Knowledge Development:** NextGen can benefit from formal and informal networks to enhance the creation of new knowledge, resulting in more innovative problem solving.

THE JPDO NEXTGEN ANNUAL PLANNING PROCESS

As mandated by the U.S. Congress, the JPDO leads an annual process to analyze, define, coordinate, and synchronize NextGen research, development, and implementation. Critical to this annual process is the interaction with Partners and stakeholders to receive and integrate their concerns and issues as well as incorporating their plans and progress. As shown in Figure ES-2, this annual planning process starts with the set of integrated NextGen planning information including the IWP.

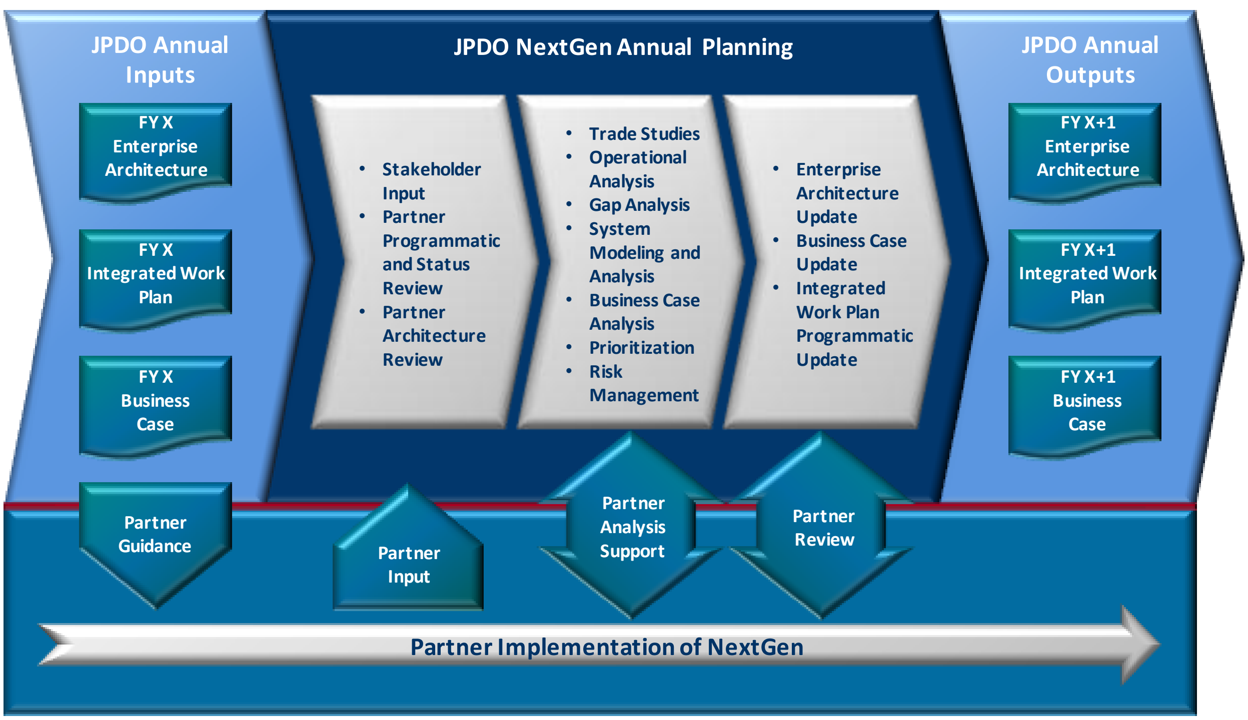


Figure ES-2 JPDO Annual Planning Process

The JPDO Partners include the aviation industry and users, aviation operators, state and local governments, as well as the Federal Partners of the Federal Aviation Administration (FAA), the Departments of Commerce (DOC), Defense (DOD), Homeland Security (DHS), and Transportation (DOT), the National Aeronautics and Space Administration (NASA), and the White House Office of Science and Technology Policy.

IWP STRUCTURE AND FUNCTIONAL AREAS

To describe the transformation to NextGen, the IWP is categorized into nine functional areas derived from the NextGen EA and ConOps. These nine areas are highly interdependent and integrated within and among each other. For brevity, the IWP does not fully describe the operational concepts and functions of each area. The reader is invited to review the NextGen ConOps and EA found at www.jpdo.gov for additional information. The IWP functional areas are:

- Trajectory and Performance-Based Operations and Support
- Airport Operations and Support
- Safety Management
- Layered Adaptive Security
- Environmental Management Framework
- Weather Information Services
- Net-Centric Infrastructure
- Positioning, Navigation and Timing Services
- Surveillance Services

The transformations needed within each functional area are described using a set of integrated planning data elements. There are five basic planning data element types within the IWP.

- **Operational Improvement (OI):** OIs describe the operational transformational changes needed to achieve the operational concepts defined in the ConOps. An OI describes a specific stage in the transformation of operations and the performance improvements expected at that point in time.

- **Enabler:** An Enabler describes the initial realization of a specific NextGen functional component needed to support one or more OIs or other Enablers. Enablers describe material components such as communication, navigation, and surveillance systems, as well as non-material components such as procedures, algorithms, and standards.

- **Policy Issue:** Many of the IWP OIs and Enablers require policy changes to support their realization, particularly related to interoperability, standardization, and governance. Policy Issues are intended to encourage decision-maker consideration of viable solution options, ranging from further analysis and open discussion for less mature issues to specific policy recommendations for more mature issues.

- **Development Activity:** Development activities describe the results needed from ongoing development or demonstration programs to support other NextGen planning efforts.

- **Research Activity:** Research activities describe basic or applied research programs and the results needed to support other NextGen planning elements.

These unique and non-overlapping planning elements define the core set of building blocks needed to achieve the NextGen vision. The current attributes of each IWP planning element include a target initial operational or availability date, the Suggested Office of Primary Responsibility (SOPR), the Suggested Office of Collaborative Responsibility (SOCR), and the dependencies of the element with other elements in the IWP. Through the definition of dates, dependencies, and organizations, the IWP is structured to define the proposed time-based, functional and organizational relationships needed to achieve the NextGen vision.

The JPDO will work closely with each of its partners to understand their needs and capabilities, and to facilitate alignment between NextGen Partner plans and the IWP. As alignment and subsequent commitments are received from NextGen Partners and these commitments are reflected in their respective plans, the suggested responsibilities will change to a designated Office of Primary Responsibility (OPR) or Office of Collateral Responsibility (OCR). As NextGen matures, the IWP along with the EA will be used to understand the collective NextGen progress, and identify and resolve cross-agency integration issues. Ultimately, as the NextGen vision is realized, the IWP will become a high-level compilation of these agency plans and the plans of other partners. Likewise, the EA maintained by JPDO will become a federation of the relevant architectures maintained by each implementing agency. Future versions of the IWP will reflect commitment status including the level of commitment and planning maturity ranging from conceptual dates to active planning targets to full partner commitments. Planning and conceptual dates should be viewed as approximate, reflecting a range of possibilities that are dependent on the results of enabling activities such as research and technical maturation.

The IWP planning elements are highly integrated with many-to-many relationships. Figure ES-3 shows an example of potential relationships between IWP elements. For example, a Policy Issue can support one or more elements of any type. Research Activities can support Enablers or Development Activities that may in turn support multiple Enablers or OIs. Enablers may support one or more OIs, or support other Enablers that in turn support OIs. There are thousands of dependencies and relationships among the IWP planning elements. All of these relationships and dependencies eventually support one or more OIs. This complex but necessary relationship matrix is difficult to present in a written document. The reader is encouraged to access the interactive Joint Planning Environment (JPE) available at [www. jpdo.gov](http://www.jpdo.gov) to view and understand the full set of relationships and dependencies among the IWP planning elements.

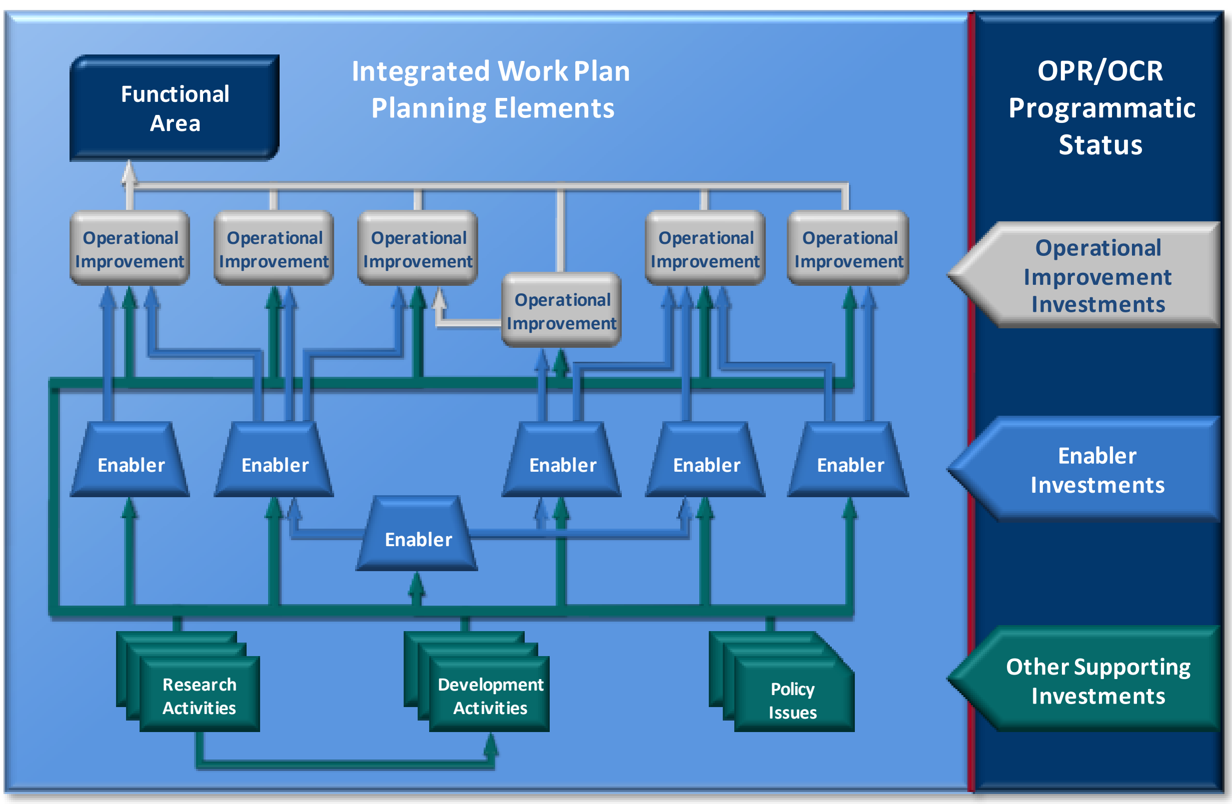


Figure ES-3 IWP Planning Elements

The following sections present a summary of each IWP functional area including highlights of the planning elements for each.

TRAJECTORY AND PERFORMANCE-BASED OPERATIONS AND SUPPORT

NextGen requires a fundamental shift to trajectory and performance-based operations with full situational awareness and integration of weather, safety, security, and environmental information. Trajectory-based operations (TBO) uses precise four-dimensional trajectories (4DT) that are actively managed to optimize an individual flight, as well as the overall operations of the National Airspace System (NAS). TBO requires the use of precise and timely surveillance, navigation, and weather information that is distributed and shared over a secure national integrated network. It requires new policies, processes, procedures, standards, and rules to guide TBO functions. TBO will also require the air navigation service provider (ANSP), the aircraft operator, the airport, and the aircraft to use new and advanced information systems to support active management of flights. Performance-based operations (PBO) incorporate an aircraft's performance capabilities into the management of flights and the air transportation system. NextGen will provide varying levels of service and operating flexibility, depending on the performance capability of the aircraft. Specific operations and airspace will be allocated to aircraft that meet required communications, navigation, and surveillance (CNS) performance thresholds, enabling increased capacity.

Operational Improvements: To achieve the TBO and PBO concepts defined in the NextGen vision, many OIs must be executed across multiple organizational structures, types of airspace, phases of flight, aircraft types, operating conditions, and locations. OIs must be implemented to support the direct management of flights by the ANSP and the aircraft crew. In addition, OIs will address the support functions performed by the ANSP, the aircraft operator, and many other organizations. To describe this rich diversity, the IWP presents TBO and PBO OIs in the following functional groups:

- **Trajectory Management:** Trajectory Management OIs support the NextGen transformation to the integrated management of aircraft movement on the surface and during all phases of flight, using precise 4DTs in the most efficient, safe, secure, and environmentally responsible manner possible. Trajectory Management OIs describe the evolution from today's processes where controllers guide an aircraft crew along rigidly defined routes over inefficient and constrained voice communication systems using a multitude of loosely integrated information systems with imprecise position information. From this safe, yet inefficient and capacity-limited system, Trajectory Management OIs describe: the improvements in the surface, arrival/departure, and en route domains; the increasing levels of Decision Support Tools (DST) introduced for ANSP and aircraft support; the changing roles of humans and automation; and the eventual transformation to highly efficient and flexible operations using advanced and integrated DSTs, and CNS systems.
- **Separation Management:** To achieve the NextGen goals for improved capacity, the separation between aircraft in all airspace environments must be safely reduced and effectively managed for simple as well as complex operations. Separation Management OIs describe the evolution from today's processes where controllers manage aircraft separation using a static set of separation standards and position information from radar-based systems, to future operations where separation is managed with a wide range of standards using precise and timely aircraft position information. Using increasingly sophisticated DSTs and processes, aircraft separations are closely managed and tailored to the unique needs of an aircraft and airspace to achieve the safest minimum separation from hazards such as wake turbulence, terrain, severe weather, as well as other aircraft. As separation capabilities improve, the responsibility for separation is increasingly delegated from the ANSP to properly equipped aircraft to improve efficiency and flexibility.

- **Capacity Management:** The capacity of the national airspace must be actively managed to effectively balance the demands of users with the constraints and operating conditions in all locations. Capacity Management OIs describe the evolution from today's operational models where capacity is managed at a macro level using a limited set of inflexible rules, to a future state where capacity is dynamically adjusted on a micro level with a wide range of rules that safely support demands and constraints with full situational awareness. Starting with OIs that allow for the improved scheduling and access to special use and terminal airspace, Capacity Management is improved by increasing airspace flexibility and allocation of ANSP resources. Using increasingly sophisticated DSTs, the ANSP is able to adjust airspace configurations and resources to meet the unique needs and environmental conditions for specific locations. From the initial ability to adjust specific configurations, the Capacity Management OIs describe the ability to dynamically adjust airspace configurations and classifications in full collaboration with airports, capable aircraft, and aircraft operators. To provide increased capacity, OIs also define improvements such as flow corridors and advanced Special Use Airspace (SUA) management.
- **Flow Contingency Management:** In support of the active airspace management, there will always be a need to modify plans to accommodate special or changing conditions. To optimize the overall flow and capacity of the national airspace, the Flow Contingency Management OIs describe how today's mostly manual processes, using limited DSTs, evolve to highly integrated and collaborative processes, using automated DSTs with full situational awareness. Using increasing levels of collaboration and integration between ANSP, aircraft operators, and aircraft, flights are adjusted to accommodate changing conditions. Initially adjusted and rerouted during pre-flight planning, flight plans and trajectories will eventually be dynamically adjusted during flight, using integrated processes and digital communication between the flight deck and ANSP automation. Rather than traffic management initiatives (TMIs) that broadly apply to multiple flights, flight plans will be uniquely tailored to accommodate the needs of each user, yet balanced with the overall demands, capacities, and constraints of the national airspace.

Enablers: TBO and PBO require a comprehensive set of integrated Enablers that support the active management of aircraft. These Enablers include a suite of advanced and integrated ANSP DSTs that support the following functions:

- Surface Management
- Separation Management
- Capacity and Flow Contingency Management
- Aeronautical Information Management
- Virtual Tower
- Separation Management
- Trajectory Management
- Flight Planning
- Wake Management
- Oceanic Operations

TBO and PBO also require core infrastructure Enablers that provide CNS services as defined in their respective functional areas. In coordination with, and supported by, these core infrastructure Enablers, the NextGen ANSP DSTs will provide more flexible, robust, and efficient decision support for all phases of flight. They will provide enhanced functionality, broader integration, and full situational awareness using a secure net-centric infrastructure (NCI). TBO and PBO also require aircraft and aircraft operator investments that support distributed separation and trajectory management functions, as well as requirements for safety, security, and environmental management. Aircraft and aircraft operators will need a range of new or enhanced navigation, surveillance, communication and flight management avionics, as well as flight planning and management systems. These new or enhanced DSTs and avionics require coordinated and significant investments, representing one of the greatest challenges to the success of NextGen.

Research and Development Activities: Some of the TBO and PBO concepts require further research and development (R&D) to guide the overall NextGen effort. Some of the more challenging areas include:

- The integration of safety-critical digital data exchange of information, such as 4DT and flight clearances, into the operational processes and systems used for flight management and control
- Algorithms for dynamic, real-time trajectory management, incorporating conflict management, flow optimization, and incorporation of multiple user preferences
- The allocation of roles and responsibilities between automation and humans, as well as the allocation between controllers and flight crews
- Performance-based separation standards including wake turbulence factors
- Automation-assisted en route flight plan negotiation that accommodates changing conditions, such as weather and non-routine operations
- Aircraft equipment, such as displays and alerting systems, that support independent parallel or converging runway approach procedures
- An integrated simulation and modeling environment for the National Airspace System (NAS) that incorporates elements, such as airport demand and capacity, airspace allocation, aircraft performance capabilities, as well as environmental and safety performance management.

Policy Issues: TBO and PBO are significant changes to the current operations of the air transportation system. To guide and support the development of OIs and Enablers, many policies are needed that establish governance, require standards, define roles and responsibilities, and other areas. Some of the most difficult, yet important, policies needed in the near term will help to define the "rules of the road" for priority access to airspace and runways, the prioritization of flights in congested airspace, the standardization of equipment, the use of incentives or mandates for equipage, and the optimum configuration of ANSP facilities.

AIRPORT OPERATIONS AND SUPPORT

Innovative, capacity-enhancing solutions are needed to manage expected increases in aircraft operations, passenger flow, and cargo movements. NextGen seeks to increase the overall airport capacity through transformational concepts that enable the optimum and balanced utilization of runways, ramps/aprons, gates, and passenger terminal buildings. The Airport Operations and Support functional area addresses the complex factors affecting airport functions not directly involved with air traffic management (ATM).

Operational Improvements: NextGen advancements will seek to optimize the use of existing facilities and achieve the best possible throughput of aircraft, passengers, and cargo. For example, new airport facilities will be developed using NextGen design standards for runway layout. Airside operations will be improved through better coordination of ramp operations, use of advanced winter weather capabilities, such as coordinated deicing activities, and improved situational awareness of airport demand/capacity and operational issues. Landside operations will be improved, as applicable, to the needs of specific airports, through more efficient passenger flow management, expanded and coordinated intermodal ground transportation access, and off-airport passenger and baggage processing.

Enablers: Airside and landside operations must be balanced and enhanced through new technology, management procedures, and programs to optimize airport capacity. Surveillance of airport vehicles will be integrated into NextGen capabilities, so that pilots and ground crews have situational awareness of the airport surface during low-visibility conditions. This will improve safety and reduce runway incursions, a critical need as more aircraft and ground vehicles operate on the airport surface. Because inclement weather can substantially impact surface operations, the resource systems used by airports, the ANSP and operators will integrate advanced weather information directly into decision-making. The airport environment will be able to better respond to lightning that can stop ramp operations, as well as proactively manage winter operations at airports for clearing snow from runways and deicing aircraft. NextGen Federal agencies will also partner with airports and industry to integrate remote check-in systems, intermodal transportation information systems, and advanced terminal designs to improve the overall passenger experience and reduce landside congestion.

Research and Development Activities: To guide the most effective use of airports, research is needed on travel patterns and modal choice in congested metropolitan areas, effective techniques for real-time gate management, optimized passenger movement patterns within terminals, and use of information systems for optimum airport resource management.

Policy Issues: Airports require effective collaboration of local, state, and Federal governments, as well as private organizations. Policies are needed that provide for the effective governance and collaboration among these varied interests as NextGen becomes a reality for the airport system. Near-term policy challenges include evaluating options for clarifying the federal role in airport preservation and capacity enhancements. Advocacy is envisioned as an important element to this, so that airport operators have the tools, resources, and federal support necessary to help local governments, businesses, users, and communities understand the importance of long-term airport sustainability and capacity enhancement.

WEATHER INFORMATION SERVICES

Weather plays a significant role in the majority of air transportation system delays. To reduce these delays, weather information needs to be assimilated into NextGen decision-making processes and integrated with NextGen decision support automation. The Weather Information Services functional area provides comprehensive four dimensional aviation weather information called the 4D Weather Cube, which in-turn provides a single authoritative source (SAS) of current and forecasted weather. This common weather picture is translated into potential impacts and integrated into the full suite of NextGen information management systems, allowing decision makers to have full situational awareness and the ability to minimize air transportation user disruptions due to adverse weather. This major paradigm change means weather is no longer just an end product to be viewed in a stand-alone display, requiring cognitive interpretation and impact assessment, and having little ability to significantly impact weather-related delays. Instead, weather information is designed to integrate with and support NextGen decision-oriented automation capabilities and human decision-making processes.

Operational Improvements: NextGen requires the development and execution of a weather operational structure that includes governance, standards, and collaboration of multiple organizations to detect, collect, process, forecast, and disseminate the weather information required by the 4D Weather Cube.

Enablers: The 4D Weather Cube needs: data standards and a governance structure to guide and support the development process and operations; a broad range of integrated ground, airborne, and satellite observation sources and platforms; enhanced models and processing of convective and winter storms, icing, turbulence, ceiling and visibility, volcanic ash, and space weather forecasts; and the development of supporting information systems. The methodologies and algorithms to assimilate weather information into the trajectory, separation, and capacity management systems are also critical Enablers.

Research and Development Activities: Enhanced probabilistic forecasting models/techniques, improved understanding on the optimum roles of human forecasters and automation, integration of weather forecasts and observations into the SAS, and the techniques to integrate and tailor weather information into ATM decision making and procedures requires additional R&D.

Policy Issues: Policies are needed to define the operational use of the SAS, including its integration into decision making, as well as determining responsibilities for managing separation from weather.

SAFETY MANAGEMENT

Safety Management seeks to ensure that the development and implementation of NextGen concepts achieves all of the NextGen goals while maintaining or improving safety. Achieving NextGen's goals requires a fundamental change in the way the air transportation community manages safety. Within the transition to NextGen, safety-enhancing practices and systems must be deployed as the product of an integral design-to-implementation safety management process. NextGen concepts must address current safety issues and the future safety risks of new operational concepts. Safety Management is a continuous improvement process that applies to all aspects of the aviation system throughout all phases of its lifecycle. The NextGen Safety Management approach is fully described by the products and policies produced by the JPDO Safety Working Group including the *National Aviation Safety Strategic Plan*, the *National Safety Management System Standard*, the *Aviation Safety Information Analysis and Sharing Concept of Operations*, and the *Safety Culture Improvement Resource Guide.*

Operational Improvements: The *National Aviation Safety Strategic Plan* provides specific goals, objectives, and strategies that support the transformation to NextGen and the achievement of its capacity-enhancement goals while improving safety. The Safety Management OIs were created in concert with the strategic plan's objectives, and are organized into the plan's goal areas of Safer Practices, Safer Systems, and Safer Worldwide.

- **Safer Practices** addresses the issues of consistency and completeness of safety management across government and industry, the development and enhancement of data sharing and information analysis capabilities, and the creation of safety as an inherent characteristic of NextGen. NextGen will require operational improvements that introduce new safety management systems standards, advanced information analysis and sharing approaches, and comprehensive safety culture concepts, along with enhanced methods for ensuring safety is an inherent characteristic of NextGen.
- **Safer Systems** addresses the issues of situational awareness for pilots, controllers, and other operators, and the integration of safety enhancing requirements and technologies into future systems. NextGen will require operational improvements that are supported by technology advancements for both airborne and ground-based systems.
- **Safer Worldwide** addresses the issues of consistency and compatibility of safety practices and systems across air transportation system boundaries. NextGen will require operational improvements that are brought about by increased international cooperation for aviation safety. It will also be important to improve safety across air transportation system boundaries, especially those dealing with dangerous goods.

Enablers: Safer Practices Enablers emphasize an integrated, systematic approach to safety risk management through implementation of formalized Safety Management Systems (SMS). These SMS incorporate safety data analysis processes, and the enhancement of safety certainty, operational procedures, and training supporting NextGen evolution. Safer Systems Enablers emphasize implementation of safety-enhancing technologies, which will improve safety for human-centered interfaces and enhance the safety of airborne and ground-based systems. Safer Worldwide Enablers encourage coordinating the adoption of the safer practices and safer systems technologies, policies and procedures worldwide.

Research and Development Activities: The NextGen goals are to be achieved through a combination of new policies, procedures, operations, and advances in technology deployed to safely manage all air traffic operations. Safety-related research and development is implicit in the applied research and development associated with all the capabilities described in this plan. For safer practices, research on vulnerability discovery and the development of tools to support the NextGen Aviation Safety Information Analysis and Sharing (ASIAS) capability will be required. Research and development of methods for verification and validation of complex systems to support NextGen risk assessment and certification decisions are also critically important. Research to support human performance models that accurately capture human variability and human error in highly automated NextGen systems will lead to the development of risk-reducing interfaces, procedures, and training.

Policy Issues: Many of the Safety Management Enablers will require a strategic decision or resolution of policy issues. These policies are needed to help shape, guide, and support the realization of the NextGen vision. The policy section provides the initial set of policy issues supporting the Safety Management Enablers. Safety risks must be addressed within the context of NextGen planning, incorporating safety requirements into the NextGen operational improvements and their performance estimates. Addressing safety after developing NextGen concepts will impose capacity constraints on the future air transportation system, ensuring NextGen's goals are not achieved.

LAYERED ADAPTIVE SECURITY

Layered Adaptive Security seeks to predict, prevent, detect, identify, secure, and reduce the impact from threats to the entire air transportation system, without unduly limiting mobility or making unwarranted intrusions on the civil liberties of users, providers, and employees. From reservation to destination, security will be improved with adaptive technologies, policies, and procedures that are scaled and layered to the potential threats in each area.

Operational Improvements: NextGen seeks to improve the operational efficiency and effectiveness of securing people, airports, checked baggage, cargo, mail, airspace, and aircraft throughout the air transportation system based on a risk-managed framework. NextGen security OIs are highly dependent on the coordinated development and execution of national and international policies, standards, requirements, processes, and procedures by organizations throughout the public and private sectors. Coordinated and collaborative information sharing environments must be designed, implemented, and nurtured for successful aviation security.

Enablers: NextGen security OIs and Security Service Providers (SSP) require: advanced screening, detection, and containment technologies; integrated information processing and screening systems; advanced prediction, prevention, identification, containment, and response processes; and enterprise integrated risk management systems and approaches. A near-term and fundamental need is to establish National Security Performance Requirements and Standards for the screening of passengers, carry-on luggage, cargo, and mail. A transformational Supply Chain Entity Program will reduce security risks and improve overall efficiency. An integrated flight risk management system will improve airspace security by actively assessing risks and monitoring flights.

Research and Development Activities: NextGen security requires: the development of improved people and cargo screening technologies; improved technologies for the detection of hazardous materials; flight risk assessment algorithms; integrated risk management approaches for threat determination, impacts, and overall response; and increased protection and survivability of aircraft.

Policy Issues: Improved safety certification policies, tools, and processes are needed to allow the rapid, yet safe, adoption of new technologies in the most effective manner, balancing public and private sector resources. National policies and performance standards are needed for the physical screening of all passengers, airport meeters and greeters, baggage, cargo, and mail. Standardized requirements are needed to establish the National Certified Supply Chain and National Secure Supply Chain Entity programs.

ENVIRONMENTAL MANAGEMENT FRAMEWORK

The fuel use and environmental impacts on noise, air, water, and global climate from aviation operations will be significant constraints on the capacity and flexibility of NextGen unless they can be effectively managed and mitigated. The Environmental Management Framework (EMF) functional area seeks to balance the competing goals of minimizing environmental impacts, while maximizing the ability to meet increasing air transportation service demands. The NextGen vision is for an EMF strategy that is integrated into all NextGen operations. The EMF includes an Environmental Management System (EMS) framework that provides a systematic process to identify, manage, monitor, and mitigate the environmental demands of NextGen, while meeting the increased volumes and dynamic nature of the air transportation system.

Operational Improvements: NextGen OIs that benefit the environment are achieved through the development of informed policy objectives, implementation of environmental and energy favorable operations, use of environmentally improved engine and aircraft technologies, and the use of alternative aviation fuels. These improvements address the NextGen vision of preventing or reducing aviation's noise, air quality, fuel burn, airport water quality, and global climate impacts.

Enablers: NextGen is supported by Enablers that measure, monitor, manage, and mitigate environmental impacts including advanced EMS, environmentally favorable Optimized Profile Descents (OPD), alternative aviation fuels, and advanced science models, and prediction tools and techniques.

Research and Development Activities: Aggressive R&D programs are critical to develop new technology such as aircraft, engines, and alternative fuels, as well as new operational advances to reduce aviation's environmental impact. R&D is critical to advance our scientific understanding of complex aircraft noise and emissions atmospheric impacts, and to advance modeling capabilities to predict human health and welfare responses and interrelated environmental consequences. Together, these capabilities will enable implementing cost-beneficial environmental and energy improvements to keep pace with aviation growth.

Policy Issues: New environmental policies are required to support planning, design, and implementation of a NextGen EMS and to support national and international harmonization of aviation environmental management. This includes providing a high-level direction for addressing aviation environmental impacts of primary concern for NextGen, as well as establishing a national framework for developing and applying an EMS approach to achieving NextGen environmental goals.

NET-CENTRIC INFRASTRUCTURE

The NextGen vision requires users to have timely, accurate, secure, comprehensive, and appropriate levels of information. To efficiently and effectively share information among users and systems, NextGen will be enabled by a Net-Centric Infrastructure (NCI) and related services. Examples of NextGen information provided as a service over NCI include: flow and trajectory information; advisories and alerts; surveillance information; real-time NAS configuration; and weather reports and forecasts.

Enablers: NextGen operations will be transformed by advanced communication Enablers including integrated networks, open information sharing, and data communications among aircraft and ground systems. NextGen networks require integrated voice and data network infrastructure along with standardized information and infrastructure services. Standards for certification and interoperability are critical for successful network integration. To openly share information among NextGen Partners using standardized services and networks, standards are also needed that establish formats and protocols specific to the information being shared. Creating this broad range of standards requires a governance structure and organization supported by all NextGen Partners.

Improved communications will result from a transformation of special-purpose radio systems to integrated and flexible radio systems, allowing the widespread use of data communications in lieu of voice communications for domestic airspace air traffic control (ATC) operations. The backbone of this transformation will come from the implementation of ground voice networks and integrated voice/data networks to support pilot-controller exchanges. ANSPs will provide services to support data exchange of flight information, clearances and instructions, advisories, flight position, and trajectory information necessary for flight operations, as well as information to support situation awareness on security airspaces. SSPs will provide aviation security-related information services, such as airport risks, flight risks, and airspace wavers.

Research and Development Activities: NCI requires R&D activities to guide the implementation of Enablers. Future radio communication technologies and radio spectrum requirements and alternatives must be explored. Information sharing details and stakeholder roles and responsibilities must be explored, and future voice/data integration opportunities must be identified and evaluated.

Policy Issues: NCI requires the collaboration of many local, state, and Federal government, as well as private organizations. Policies and governance structures must be explored to guide development of information access controls, trust relationships, authenticating community of interest (COI) users, and mechanisms for protecting competitive information. Finally, policies and procedures must be developed for evaluating and certifying the trustworthiness, accuracy, and integrity of information from non-government sources.

POSITIONING, NAVIGATION AND TIMING SERVICES

NextGen will be more flexible, responsive, and unconstrained using satellite-based and ground-based systems that provide accurate and universal Positioning, Navigation, and Timing (PNT) Services. The PNT Services functional area enables aircraft and ground equipment to accurately and precisely determine current location, orientation, time, and path anywhere on the globe. With this information, aircraft can apply the corrections necessary to maintain a desired position and path. Accurate and precise PNT Services also enable improved surveillance capabilities, reduced separation standards, and the synchronization of operations. The decommissioning of current ground-based navigation systems, along with the improved operations from enhanced PNT Services, will result in significant cost savings.

Enablers: NextGen PNT Services require the evolution of the Global Positioning System (GPS), including satellites transmitting dual-frequency civil signals, enhanced position and timing accuracy, and more robust integrity monitoring. It also requires a comprehensive GPS back-up capability.

Research and Development Activities: A national PNT architecture and strategy is needed that includes a backup strategy to guide NextGen PNT Services. Approach and runway lighting systems also need improvements to reduce their costs and increase effectiveness.

Policy Issues: NextGen requires national and international policies that define the performance, responsibilities, and standards to be used across all PNT service providers.

SURVEILLANCE SERVICES

The NextGen Surveillance Services functional area provides the ability to detect, identify, and monitor the movements of cooperative and non-cooperative targets. Cooperative surveillance involves the self-reporting of aircraft or vehicle surveillance information to other aircraft, vehicles, and ground-based systems. It also involves the processing and dissemination of this information to NextGen users. Non-cooperative surveillance is needed for air sovereignty and security, as well as monitoring aircraft, ground vehicles, and other objects not equipped for cooperative surveillance. Surveillance Services represents a major investment of complex equipage, ground systems, communications, processes, and procedures that must be implemented, over time, by many NextGen Partners in a cooperative and synchronized manner.

Enablers: Legacy cooperative and non-cooperative radar systems must be maintained, replaced, and updated to support a net-centric integrated surveillance environment. An integrated surveillance strategy is needed to provide the governance and guidance for the development of an integrated national surveillance capability. The full implementation of automatic dependent surveillance-broadcast (ADS-B) is needed for complete cooperative surveillance.

Research and Development Activities: To provide an integrated national surveillance capability, research is needed to determine the required characteristics of national surveillance and associated communications needs. Research will include determining needed surveillance data sources and their accuracy, timeliness, and compatibility with different operator and facility functions.

Policy Issues: A key near-term Policy Issue is the completion of the National Integrated Surveillance Plan that will define security levels, criteria and approval processes to facilitate the sharing of complementary cooperative and non-cooperative surveillance data among public and private entities. With the adoption of ADS-B as the predominant cooperative surveillance technology, an interagency agreement is needed to determine how non-cooperative surveillance technologies may be used during cooperative system failures. It is also necessary to determine whether the non-cooperative architectures of the DHS and DOD will satisfy FAA ATM performance requirements during such failures.

PARTNER ALIGNMENT WITH INVESTMENTS, ACQUISITION, AND IMPLEMENTATION

The IWP is a functional plan that outlines the proposed building blocks towards achieving the NextGen vision. NextGen will be realized through the research, development, and implementation investments that are funded and managed by each NextGen Partner. The JPDO works with all NextGen Partners to align their investments towards achieving the overall NextGen vision. As previously shown in Figures ES-2 and ES-3, the JPDO will coordinate with each Federal Partner on at least an annual basis. This allows the JPDO to make any updates needed to reflect the status of program execution, highlight cross-agency issues, and work cooperatively with the respective organizations to resolve those issues.

IWP Version 1.0 conveys the current understanding of Partner efforts and presents the suggested alignment of NextGen planning elements with each Partner's mission areas. Through the review and commenting process for previous versions of the IWP, JPDO has received over 3,000 comments and engaged in detailed discussions with Federal Partners on current and planned NextGen efforts. For example, the IWP is currently aligned with the extended definitions of near-term OIs within the FAA NextGen Implementation Plan. Additional work is needed to continue this alignment for all near-term programs, as well as with mid-term and far-term plans. It should be noted that in the event of any conflicts between the IWP and specific Federal Partner plans, the near-term Partner plans take precedence. Any mid-term conflicts will require further collaborative coordination and alignment. It should also be noted that Partner plans and efforts have been incorporated into Version 1.0 and that the appropriate adjustments have been made to the overall IWP planning elements.

Many of the OI and Enabler planning elements within the IWP require basic or applied research and the development of research concepts into full implementation readiness. To help define the near-term R&D activities needed to fully support NextGen, the JPDO released the *NextGen R&D Plan for FY2009-FY2013* in August 2007. This initial plan was a collaborative effort of the JPDO and Federal Partners, and aligns with the 2007 *National Aviation Research Plan* issued by the FAA in and the 2006 *National Aeronautics Research and Development Policy* and *2007 National Plan for Aeronautics Research and Development including Related Infrastructure* issued by the National Science and Technology Council. The results from this initial plan, as well as updates to R&D needs, have been incorporated into the IWP.

NEXT STEPS

JPDO, in collaboration with the NextGen Partners, has developed IWP Version 1.0 as the initial outline of steps needed to achieve the NextGen vision. This initial plan requires ongoing refinement and updates to reflect:

- Results and guidance from modeling, simulation, and analysis
- Results and guidance from research, demonstration, and development efforts
- Changing needs and priorities for the national air transportation system
- Plans and commitments from NextGen Partners.

As previously shown in Figure ES-2, JPDO will work with its partners to develop a formal alignment and commitment process for IWP planning elements. The IWP will be used as a tool to facilitate discussion with NextGen Partners to establish commitments, coordinate efforts, and prioritize resources, with a goal of maximizing benefits. As NextGen matures, the JPDO will work with Partners to analyze, review and modify the planning elements of the IWP. Thus, the IWP will help identify cross-agency integration issues. As a collective view of NextGen elements and status, the IWP will provide stakeholders with a comprehensive view of NextGen progress.

The IWP will also need alignment with an avionics road map, currently under development, that will identify the expected aircraft capability and equipage strategies envisioned for NextGen. Additionally, future versions of the IWP will more fully describe priorities, benefits, risks, costs, technology maturity, and more completely reflect the NextGen-related activities of all NextGen Partners.

1 INTRODUCTION

1.1 PURPOSE

The Integrated Work Plan (IWP) provides a tool to support the collaborative planning and deliberation needed among partners and stakeholders to prioritize needs, establish commitments, coordinate efforts, and focus resources on the work needed to achieve the Next Generation Air Transportation System (NextGen). The IWP provides comprehensive information about the elemental operational improvements, enablers, development and research milestones, as well as policies needed to make NextGen a reality. These IWP elements define the overall NextGen plan. This release of the IWP is intended to facilitate coordination with government and industry partners as they implement NextGen.

It is important to note that the IWP is an unconstrained plan and does not seek to define prescriptive implementation activities, nor does it address priorities of activities at this time. It proposes a path to realize the IWP elements but not the specific program steps, resources or implementation elements such as facility roll-out, training, or decommissioning. The detailed planning for each IWP element is the responsibility of the NextGen Partner that has accepted the element as part of their overall mission.

1.2 OVERVIEW

The future of our nation's ability to move people and goods in a safe, secure, efficient, and environmentally responsible manner depends upon the successful implementation of NextGen. NextGen represents a comprehensive transformation and evolution of our nation's air transportation infrastructure, as well as how the infrastructure is developed, operated and maintained. With the 2003 enactment of the Vision 100 – Century of Aviation Reauthorization Act, a congressional mandate was issued to create the Joint Planning and Development Office (JPDO) to guide and support the creation of NextGen. As authorized under "Vision 100", the JPDO is charged with creating and carrying out an Integrated Plan for NextGen that shall include: "the national vision statement", "a description of demand and performance characteristics" required, "a multiagency research and development roadmap" necessary to overcome the most significant technical obstacles, "a description of the NextGen operational concepts", and a "timeline" to develop and deploy the system. To describe an overall path towards the 2025 characteristics, the IWP must be aligned with the near-term and mid-term plans of each Federal Partner. Therefore, this release of the IWP is intended to facilitate coordination across the NextGen Partners.

The IWP is part of a comprehensive suite of information that represents the Integrated Plan for NextGen. As shown in Figure 1-1, JPDO initially developed the NextGen Concept of Operations (ConOps) and Enterprise Architecture (EA). These core documents provide a common vision for how NextGen will operate in the 2025 timeframe and beyond, as well as a foundation for the NextGen Business Case.

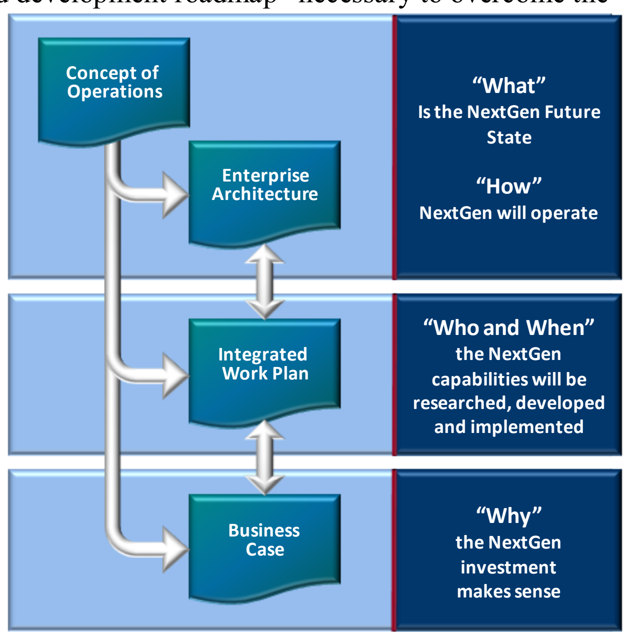


Figure 1-1 JPDO Integrated Plan Documents

NextGen requires an unprecedented level of sustained, coordinated, and integrated effort across the public and private sectors. To create and realize the benefits of this air transportation system for the 21st century, NextGen requires new and significant:

- **Automation:** Integrated information systems are needed that provide advanced trajectory, separation, capacity, flow contingency and security management functions.
- **Infrastructure:** Advanced technologies are needed that provide integrated communication, navigation, surveillance. and security infrastructure services.
- **Processes:** New automation and infrastructure requires new and revised responsibilities and integrated processes to provide increased capacities and efficiencies.
- **Collaboration:** Industry and government need to work together in new ways to define, fund, develop, implement, govern, and operate NextGen technologies, processes, and policies.
- **Integrated Operations:** NextGen operational processes and technologies require the integration of safety, security, and environmental requirements as core components.
- **Information Sharing:** Integrated operations require the broad sharing of information across many organizations and systems in an open, yet secure, manner.
- **Knowledge Development:** NextGen can benefit from formal and informal networks to enhance the creation of new knowledge, resulting in more innovative problem solving.

1.3 INTEGRATED WORK PLAN GOALS

NextGen will be achieved through the efforts of the JPDO and the NextGen Partners including:

- Department of Transportation
- Federal Aviation Administration
- National Air and Space Administration
- Department of Defense
- Department of Commerce
- Department of Homeland Security
- Aviation Industry and Users
- Aviation Operators
- State and Local Governments
- White House Office of Science and Technology Policy

The goal of the IWP is to support the JPDO and NextGen Partners by providing:

- A consolidated master plan supporting the oversight and authorization roles of the JPDO Board and Senior Policy Committee (SPC)
- An understanding of the current and planned activities across all NextGen Partners
- A collaborative planning and management mechanism across all NextGen Partners, including the delineation of roles and responsibilities
- A comprehensive description of the balanced results of research, development, and implementation activities, across all partners, needed to achieve the NextGen vision
- Identification of gaps and exceptions between current and planned NextGen activities
- Input to processes that model and analyze expected performance, operational scenarios, costs, and benefits, helping to establish budgets and priorities, manage risk, and align resources.

1.4 THE JPDO NEXTGEN ANNUAL PLANNING PROCESS

As mandated by the U.S. Congress, the JPDO leads an annual process to analyze, define, coordinate, and synchronize NextGen research, development, and implementation. Critical to this annual process is the interaction with partners and stakeholders to receive and integrate their concerns and issues, as well as incorporate their plans and progress. As shown in Figure 1-2, this annual planning process starts with the set of integrated NextGen planning information, including the IWP.

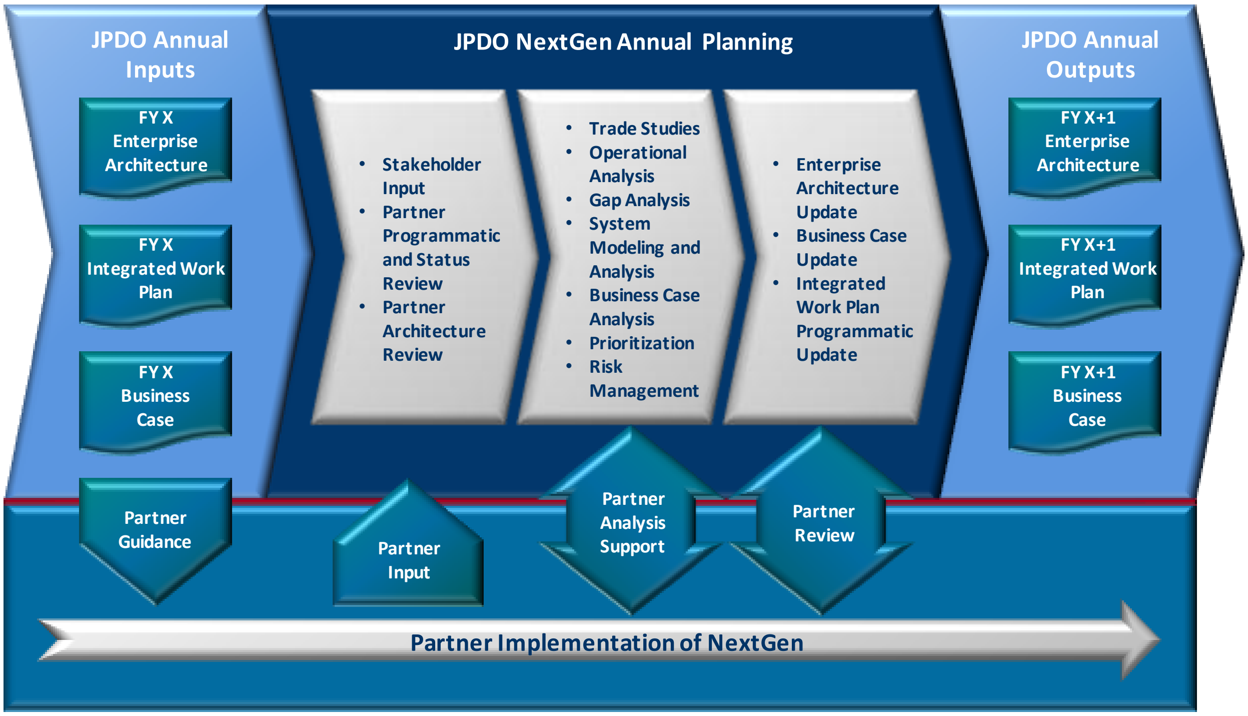


Figure 1-2 JPDO Annual Planning Process

1.5 IWP STRUCTURE AND NEXTGEN CAPABILITIES

To describe the transformation to NextGen, the IWP is categorized into nine functional areas derived from the NextGen ConOps and EA. These nine areas are highly interdependent and integrated within and among each other. For brevity, the IWP does not fully describe the operational concepts and functions of each area. The reader is invited to review the NextGen ConOps and EA, found at www.jpdo.gov, for additional information. The IWP functional areas are:

- Trajectory and Performance-Based Operations and Support
- Airport Operations and Support
- Safety Management
- Layered Adaptive Security
- Environmental Management Framework
- Weather Information Services
- Net-Centric Infrastructure
- Positioning, Navigation and Timing Services
- Surveillance Services

The transformations needed within each functional area are described using a set of integrated planning data elements. There are five basic planning data element types within the IWP:

- **Operational Improvement (OI):** OIs describe the operational transformational changes needed to achieve the operational concepts defined in the ConOps. An OI describes a specific stage in the transformation of operations and the performance improvements expected at that point in time.
- **Enabler:** An Enabler describes the initial realization of a specific NextGen functional component needed to support one or more OIs or other Enablers. Enablers describe material components, such as communication, navigation, and surveillance systems, as well as non-material components, such as procedures, algorithms, and standards.
- **Policy Issue:** Many of the IWP OIs and Enablers require policy changes to support their realization, particularly related to interoperability, standardization, and governance. Policy Issues are intended to encourage decision-maker consideration of viable solution options, ranging from further analysis and open discussion for less mature issues to specific policy recommendations for more mature issues.
- **Development Activity:** Development Activities describe the results needed from ongoing development or demonstration programs to support other NextGen planning efforts.
- **Research Activity:** Research Activities describe basic or applied research programs and the results needed to support other NextGen planning elements.

These unique and non-overlapping planning elements define the core set of building blocks needed to achieve the NextGen vision. The planning elements of the IWP are highly integrated with thousands of many-to-many relationships. Figure 1-3 shows an example of the potential relationships between IWP elements.

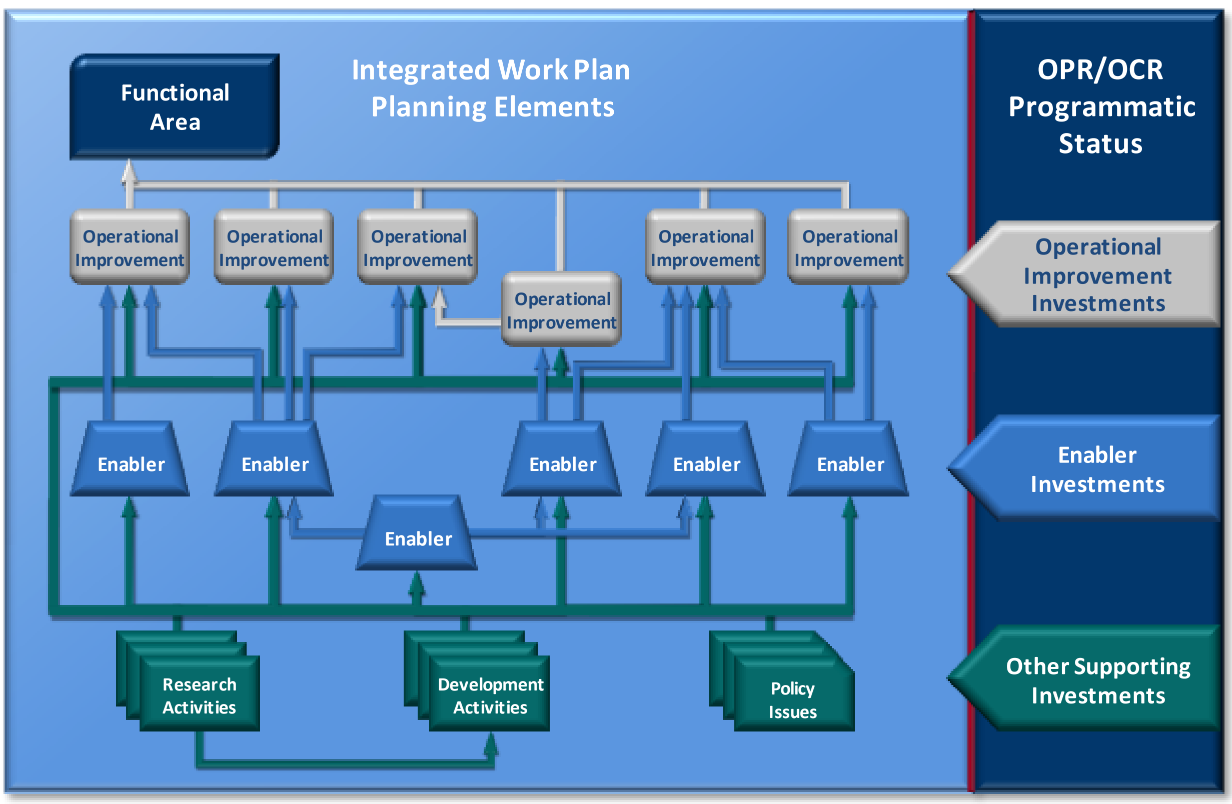


Figure 1-3 IWP Data Structure

The current attributes of each IWP planning element include a target initial operational or availability date, the Suggested Office of Primary Responsibility (SOPR), the Suggested Office of Collaborative Responsibility (SOCR), and the dependencies of the element with other elements in the IWP. Through the definition of dates, dependencies, and organizations, the IWP is structured to define the proposed time-based, functional and organizational relationships needed to achieve the NextGen vision.

The JPDO will work closely with each of its partners to understand their needs and capabilities, and to facilitate alignment between NextGen Partner plans and the IWP. As alignment and subsequent commitments are received from NextGen Partners and these commitments are reflected in their respective plans, the suggested responsibilities will change to a designated Office of Primary Responsibility (OPR) or Office of Collateral Responsibility (OCR). As NextGen matures, the IWP along with the EA will be used to understand the collective NextGen progress, and identify and resolve cross-agency integration issues. Ultimately, as the NextGen vision is realized, the IWP will become a high-level compilation of these agency plans and the plans of other partners. Likewise, the EA maintained by JPDO will become a federation of the relevant architectures maintained by each implementing agency. Future versions of the IWP will reflect commitment status including the level of commitment and planning maturity ranging from conceptual dates to active planning targets to full partner commitments. Planning and conceptual dates should be viewed as approximate, reflecting a range of possibilities that are dependent on the results of enabling activities such as research and technical maturation.

Another way to view the IWP element relationships is shown in Figure 1-4, highlighting the relationships and integration requirements for an example Enabler. The example Enabler, or reference element, in Figure 1-4 is shown to have two primary prerequisite Enablers, one primary prerequisite Development Activity, and one primary prerequisite Policy Issue. Note that these primary prerequisites also have prerequisites that are, therefore, secondary prerequisites to the reference Enabler. Similarly, the reference Enabler directly supports one OI and one Enabler. These elements also support other elements which are, therefore, indirectly supported by the reference Enabler.

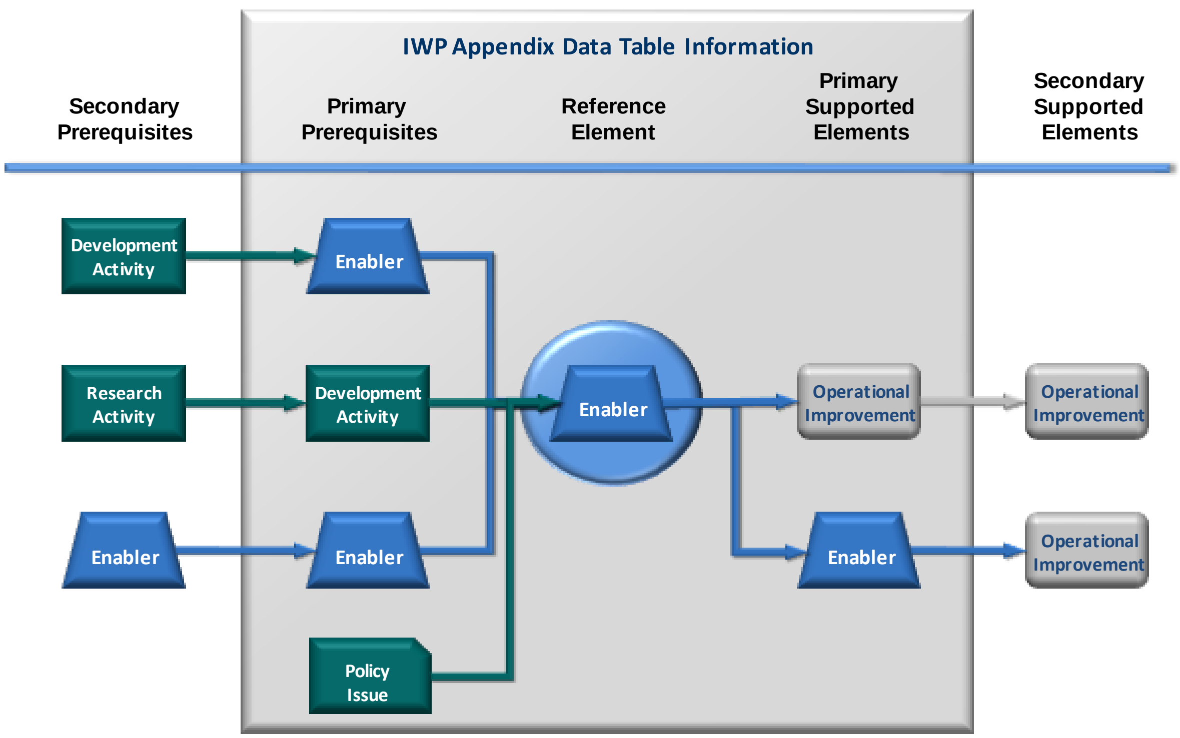


Figure 1-4 Example Integration of Prerequisite and Supported Elements

There are literally thousands of dependencies and relationships among the IWP planning elements. All of these relationships and dependencies eventually support one or more OIs. This complex, but necessary, relationship matrix is difficult to present in a written document. The tables in the Appendices list the primary prerequisite and supported elements for each reference element. The reader is strongly encouraged to access the interactive Joint Planning Environment (JPE) available at www. jpdo.gov to view and understand the full set of relationships and dependencies among the IWP planning elements.
To provide greater visibility to specific functional needs within the IWP, OIs and Enablers with similar or related functions have been grouped into Functional Groups within each Functional Area. The IWP chapters are structured to describe these Functional Groups, including a presentation of the timetables to achieve the OIs and Enablers in each Functional Group. Figure 1-5 presents the complete set of Functional Groups within the IWP.

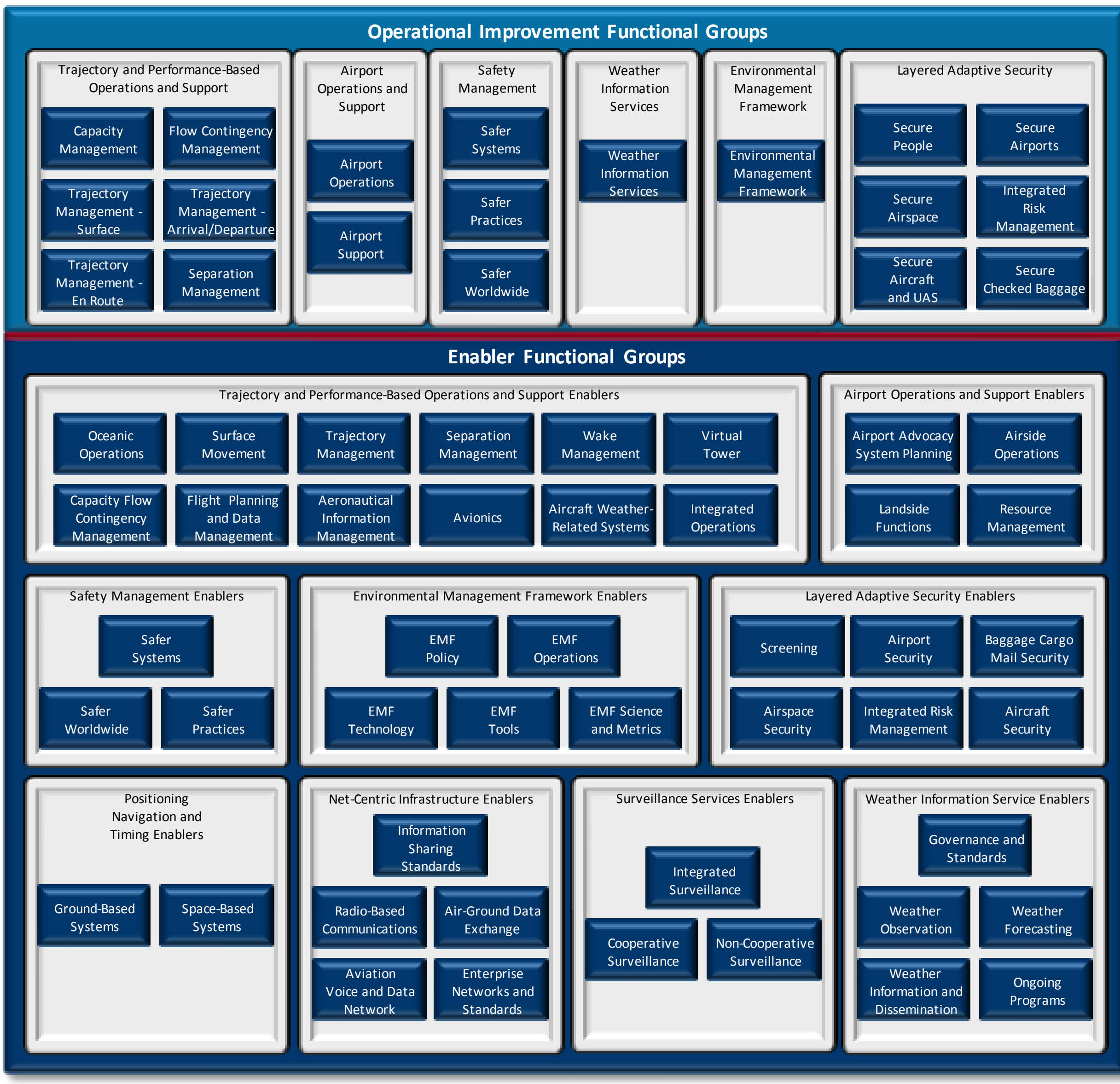


Figure 1-5 IWP Functional Groups

There are currently 811 planning elements within the IWP. Table 1-1 provides the distribution of these data elements within the Functional Areas of the IWP. Figure 1-6 provides a summary distribution of all OIs, Enablers, and Policy Issues for each planning year within the IWP. These table and figures are examples of the type of information taken from the JPE available at www.jpdo.gov.

Table 1-1 IWP Data Element Distribution

IWP Functional Area	Operational Improvements	Enablers	R&D Activities	Policy Issues
Trajectory-Based and Performance-Based Operations and Support	*62*	*73*	*78*	*12*
Airport Operations and Support	*14*	*35*	*8*	*11*
Weather Information Services	*4*	*54*	*17*	*4*
Safety Management	*10*	*68*	*37*	*10*
Layered Adaptive Security	*24*	*42*	*22*	*13*
Environmental Management Framework	*9*	*41*	*24*	*10*
Net-Centric Infrastructure	--	*56*	*6*	*4*
Positioning Navigation and Timing Services	--	*13*	*8*	*3*
Surveillance Services	--	*32*	*3*	*4*
Total	*123*	*414*	*203*	*71*

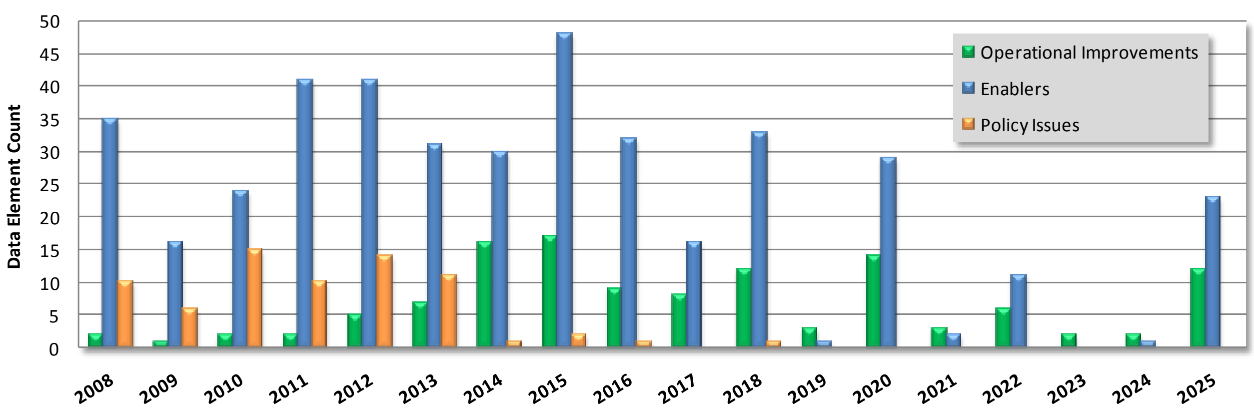


Figure 1-6 IWP Data Element Fiscal Year Distribution

1.6 DATES, LEVELS, GROUPS, DEPENDENCIES, AND ASSIGNMENTS

Through discussions and review with the JPDO Working Groups and Divisions, the NextGen Institute, and NextGen Federal Partners, IWP Version 1.0 planning elements include date, dependency, and assignment attributes. The definitions for these attributes are as follows:

- **Dates:** The planning elements within the IWP are assigned a single target date appropriate to the planning element as follows:
  - **Operational Improvements (OI):** OIs are assigned an initial operational capability (IOC) date. This date is when the OI initially provides the functions and services described for the entire OI at a specific location. The date does not describe when the OI will be fully deployed at all required locations. The IWP does not provide a full operating capability date.
  - **Enablers:** Enablers are assigned an initial availability (IA) date. This is the date the Enabler is first accessible to an OI or another Enabler. The date does not describe when the Enabler will be fully deployed at all required locations.
  - **Research & Development (R&D) Activities:** R&D activities are ongoing programs that have required outputs based on the planning elements they support. Therefore, R&D activities have one or more required completion dates that are defined using the convention of two years prior to the target date of each supported planning element.
  - **Policy Issues:** Policy Issues are assigned a required completion date. This is the date the policy issue needs to be resolved to support the OIs or Enablers dependent upon the policy.
- **Levels:** The IWP uses the Level concept to describe groups of Enablers or OIs that involve incremental improvements of similar functions or operations. In other words, when a specific function or operation will evolve over the course of the NextGen transformation, the discrete levels of improvement are defined by Enablers or OIs with the same prefix title and Level suffix. For example, the IWP defines decision support automation that will provide capacity and flow contingency management functions. There are three Enablers within the IWP that are defined as Capacity and Flow Contingency Management Decision Support - Level 1, Level 2 and Level 3, respectively. These three Enablers are developed and implemented sequentially and are dependent upon the previous level.
- **Groups:** The IWP uses the Group concept to describe groups of OIs or Enablers that provide similar or related functions. At the highest level, the IWP has organized the OIs and Enablers within a Functional Area into Functional Groups. These Functional Groups provide similar types of OIs or provide related functions. Within a Functional Group, there may also be Enablers that have very similar characteristics. These Enablers are given the same prefix and a Group suffix. For example, a core component of Air-Ground Data Exchange for Tower environment is a multi-staged group of Clearance and Instruction Services Enablers that will become available over time. There are three Enablers within the IWP that are defined as Clearance and Instruction Services Tower - Group 1, Group 2 and Group 3, respectively. These services associated with these three Enablers are developed and implemented in stages that are not necessarily dependent upon the previous group.
- **Dependencies:** Achieving NextGen requires the systematic and methodical transformation and development of many systems, processes, policies, facilities, staff, and other elements. Achieving many of these elements will depend upon the completion of other prerequisite elements. The IWP includes an initial set of dependency relationships for each OI and Enabler. These dependencies describe the functional and timing requirements of the relationship. As previously

shown in Figure 1-3, OIs and Enablers may have one or more prerequisite dependency relationships. OIs may be dependent on other OIs, as well as Enablers and Policy Issues. In some cases OIs may also be dependent upon R&D activities, but R&D Activities generally support Enablers or Policy Issues.

The primary dependencies for each OI and Enabler are listed in the Appendices I and II, respectively. **It is important to note that only the primary relationships are listed in the Appendices** since the dependencies between IWP planning elements can result in many layers depending on the complexity of the subject area. For example, an OI that is towards the end of the NextGen development will have one or more primary prerequisite OIs, Enablers, Policy Issues, or R&D Activities. Those primary prerequisite elements, in turn, may also have prerequisite elements. These secondary, tertiary, and higher prerequisites can become a very long and complex list. These other elements are just as important as the primary prerequisite elements and should be considered prerequisites, by reference, through the primary dependency relationships defined in the IWP. One of the strengths of the IWP is the definition of the relationships among IWP elements. Through high-level system engineering and integration efforts, the JPDO, partners, and stakeholders have defined the functional and timing relationships between the normalized planning elements. This rich and diverse set of relationships is best understood and analyzed using the power of the interactive JPE tool available at www.jpdo.gov.

- **Suggested Office of Primary Responsibility:** The SOPR is expected to provide the overall ownership and leadership necessary to achieve the planning element. For OIs, this will generally be achieved through the realization of many Enablers, R&D Activities, and Policy Issues. The SOPR for an OI, therefore, may need to provide internal resources, as well as coordinating external resources, to achieve the OI. For Enablers or R&D Activities, the SOPR may have more direct control of the work but may also coordinate the use of external resources, as needed. As commitments are received, the SOPR designations will change to OPR designations.

- **Suggested Office of Collateral Responsibility:** As a complex initiative, many, if not all, of the NextGen IWP elements will be achieved through the support, cooperation, and coordination of many organizations. In addition to the SOPR, a SOCR has been designated for many planning elements. As a SOCR, an organization is expected to support the SOPR in achieving the OI or Enabler. This support can be provided in many ways, including the provisions of funds, staffing, facilities, intellectual capital, or other needed resources. As commitments are received, the SOCR designations will change to OCR designations.

The Integrated Fabric of NextGen

NextGen is a complex system of systems with many elements that require integration across time, organizations, and functions. The effective weaving and integration of these elements will create the strong, yet flexible, fabric of NextGen. Like other fabrics, it appears differently depending on the point of view. It must be formed into pieces and tailored to meet the needs of the customer resulting in a fine garment. The main body of the IWP printed document shows one view of the pieces that will be tailored to create NextGen. The appendices show another view of the threads that will be woven or integrated together to create the fabric of NextGen. Together, these elements eventually form NextGen to support the safe, secure, efficient, effective, and environmentally-responsible operation of the national airspace system (NAS).

1.7 PARTNER ALIGNMENT WITH INVESTMENTS, ACQUISITION, AND IMPLEMENTATION

The IWP is a functional plan that outlines the proposed building blocks towards achieving the NextGen vision. NextGen will be realized through the research, development, and implementation investments that are funded and managed by each NextGen Partner. The JPDO works with all NextGen Partners to align their investments towards achieving the overall NextGen vision. As previously shown in Figures ES-2 and ES-3, the JPDO will coordinate with each Federal Partner on at least an annual basis. This allows the JPDO to make any updates needed to reflect the status of program execution, highlight cross-agency issues, and work cooperatively with the respective organizations to resolve those issues.

IWP Version 1.0 conveys the current understanding of Partner efforts and presents the suggested alignment of NextGen planning elements with each Partner's mission areas. Through the review and commenting process for previous versions of the IWP, JPDO has received over 3,000 comments and engaged in detailed discussions with Federal Partners on current and planned NextGen efforts. For example, the IWP is currently aligned with the extended definitions of near-term OIs within the FAA NextGen Implementation Plan. Additional work is needed to continue this alignment for all near-term programs, as well as with mid-term and far-term plans. It should be noted that in the event of any conflicts between the IWP and specific Federal Partner plans, the near-term Partner plans take precedence. Any mid-term conflicts will require further collaborative coordination and alignment. It should also be noted that Partner plans and efforts have been incorporated into Version 1.0 and that the appropriate adjustments have been made to the overall IWP planning elements.

Many of the OI and Enabler planning elements within the IWP require basic or applied research and the development of research concepts into full implementation readiness. To help define the near-term R&D activities needed to fully support NextGen, the JPDO released the *NextGen R&D Plan for FY2009-FY2013* in August 2007. This initial plan was a collaborative effort of the JPDO and Federal Partners, and aligns with the 2007 *National Aviation Research Plan* issued by the FAA in and the 2006 *National Aeronautics Research and Development Policy* and *2007 National Plan for Aeronautics Research and Development including Related Infrastructure* issued by the National Science and Technology Council. The results from this initial plan, as well as updates to R&D needs, have been incorporated into the IWP.

1.8 HOW TO USE THE IWP

The IWP document is structured into chapters and appendices as follows:

- Chapter 2 Trajectory and Performance-Based Operations and Support
- Chapter 3 Airport Operations and Support
- Chapter 4 Weather Information Services
- Chapter 5 Safety Management
- Chapter 6 Layered Adaptive Security
- Chapter 7 Environmental Management Framework
- Chapter 8 Net-Centric Infrastructure
- Chapter 9 Positioning, Navigation, and Timing Services
- Chapter 10 Surveillance Services
- Appendix I Operational Improvements
- Appendix II Enablers
- Appendix III Research and Development Activities
- Appendix IV Policy Issues
- Appendix V Suggested Partner Responsibilities
- Appendix VI Draft NextGen Capabilities
- Appendix VII Glossary

Each chapter focuses on a Functional area and is structured to describe the OI and Enabler Functional Groups, previously presented in Figure 1-5, as well as the R&D Activities and Policy Issues aligned to the Functional Area. The chapters present the IWP planning data elements in the summary form of timetables. More complete descriptions of the data elements are presented in the data tables of Appendices I-IV. The following pages present an overview on how to read the timetables and data tables of the IWP. Appendix V presents a summary listing of suggested partner alignments for planning elements. Appendix VI presents an introduction of the draft NextGen capabilities to be used in future versions of the IWP. Finally, Appendix VII provides a glossary of IWP terms.

Operational Improvement and Enabler Timetable

❷

❶ Trajectory Management - En Route/Multi-Domain Operational Improvements	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
OI-0304: Flexible Entry Times for Oceanic Tracks						O	2013											
OI-0305: Continuous Flight Day Evaluation							O	2014										
OI-0352: Automated Clearance Delivery and Frequency Changes							O	2014										
OI-0358: Trajectory Flight Data Management											O	2018						
OI-0360: Automation-Assisted Trajectory Negotiation													O	2020				
OI-0369: Automated Negotiation/Separation Management																2024	O	
OI-0370: Trajectory-Based Management - Full Gate-To-Gate																	2025	O

❸ (data element listing) ❹ (IOC indicators)

This is an example of an Operational Improvement timetable. Enabler timetables have a similar structure.

Operational Improvement or Enabler Timetable Legend

❶ **Functional Group Title:** OIs and Enablers are aligned to a Functional Group within each Functional Area. The title bar indicates the Functional Group of planning elements listed in the specific timetable.

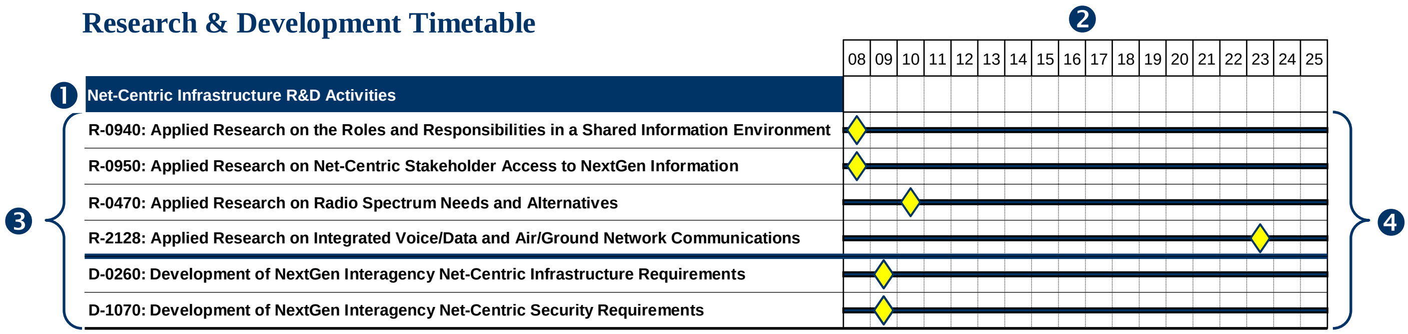
❷ **Time Scale:** The time scale lists the Federal fiscal years (FY) used in the timetable beginning in the current FY and ending with the target of FY 2025.

❸ **Data Element Listing:** This listing displays the unique identification number and name of the OI or Enabler data elements aligned to the Functional Group. The list of data elements is presented in date order only and does not indicate any relationship between elements. The data elements in the timetable may have dependencies with other elements in the timetable, as well as elements in other timetables. Descriptions of these data elements, including their primary dependencies and organizational alignments, can be found in Appendix I for OIs and Appendix II for Enablers. Full data element information including the relationships and dependencies to all IWP elements is available in the interactive Joint Planning Environment available at www.jpdo.gov.

❹ **Operational Improvement - Initial Operational Capability (IOC) Indicators:** This date represents the initial instantiation of the OI at a specific location or area. The OI may have more than one instantiation or may be used throughout the NAS. Additional instantiation information is not included in the IWP. OIs IOC dates are indicated with a green square with the character 'O' in the box.

Enabler - Initial Availability (IA) Indicators: This date represents the initial instantiation of the Enabler and is first available for use by an OI or another Enabler. The Enabler may have more than one instantiation or may be used throughout the NAS. Enabler IA dates are indicated by a blue square with the character "E" in the box.

Research & Development Timetable



Research & Development Timetable Legend

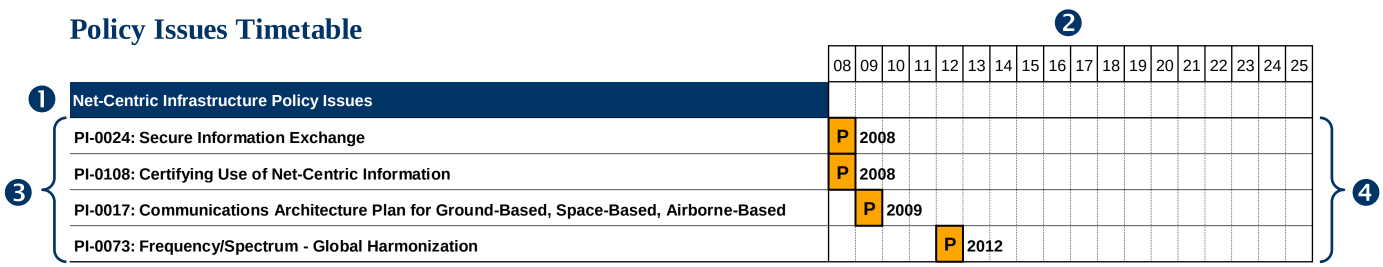
❶ **Functional Area Title:** R&D Activities are aligned to a specific Functional Area. The title bar indicates the Functional Area of R&D Activities listed in the timetable.

❷ **Time Scale:** The time bar lists the Federal fiscal years (FY) used in the timetable beginning in the current FY and ending with the target of FY 2025.

❸ **Research & Development Listing:** This listing displays the unique identification number and name of the R&D Activities aligned to the Functional Area. Research Activities are listed first, presented in date order of the first required completion date of the activity. Development Activities are listed below Research Activities and are also listed in order of the first required completion date. The R&D Activities in the timetable may have dependencies with other activities in the timetable, as well as to many OIs and Enablers. Descriptions of these data elements can be found in Appendix III. Full data element information, including the relationships to all IWP elements, is best viewed on the interactive JPE available at www.jpdo.gov.

❹ **Required Completion Indicators:** Within the IWP, R&D is considered as ongoing activities. At particular times during the activity, a specific output is required from the R&D activity for the implementation of other planning elements. The horizontal black bar represents the ongoing nature of the R&D activity and each yellow diamond represents the date when an output is required for a specific supported element. The full length of the horizontal bar is not intended to convey that the R&D activity will have an indefinite life. It may end at the completion of the last required output. This will be determined by the overall needs of the program.

Policy Issues Timetable



Policy Timetable Legend

❶ **Functional Area Title:** Policy Issues are aligned to a specific Functional Area. The title bar indicates the Functional Area of Policy Issues listed in the timetable.

❷ **Time Scale:** The time bar lists the federal fiscal years (FY) used in the timetable beginning in the current FY and ending with the target of FY 2025.

❸ **Policy Issue Listing:** This listing displays the unique identification number and name of each Policy Issue aligned to the Functional Area. Full descriptions are provided in Appendix IV or the JPE.

❹ **Initial Decision Indicators:** The date by which the first decision on a given Policy Issue must be made in order to effectively support dependent Enablers or OIs. An Initial Decision is simply the first step toward full completion, as many Policy Issues may require ongoing analysis or a series of decisions.

Operational Improvement Data Table - Appendix I

OI-0304 Flexible Entry Times for Oceanic Tracks

❶ ***Description:*** Flexible entry times into oceanic tracks or flows allow greater use of user-preferred trajectories. Under the Oceanic Trajectory Management Four Dimensional pre-departure concept, flexible entry times into oceanic tracks allow aircraft to fly minimum time/fuel paths. Air Navigation Service Provider (ANSP) automation reviews the request and negotiates adjustments to entry time requests. By incorporating entry optimization algorithms within the request review process, flights trade-off some near-term suboptimal profiles to achieve more optimal oceanic profiles.

❷ ***Functional Drivers:*** Oceanic route efficiency is improved through collaborative negotiation of entry times and track loading and oceanic traffic handling is improved through comparison of current routes against desired profiles to identify beneficial control actions. The negotiation for entry times includes looking ahead to plan near-term climbs when loading tracks. Oceanic 4D profiles of active flights are continually examined to determine control actions that enhance oceanic capacity while providing improved efficiency within traffic flows.

❸ ***SOPR:*** FAA ❻ ***SOPR Unique Reference:*** 104012

❹ ***SOCR:*** NASA ❼ ***Primary Supported OIs:***

❺ ***OI Group:*** Trajectory Management - En Route/Multi-Domain Operational Improvements

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
OI-0304: Flexible Entry Times for Oceanic Tracks						O	2013 ❽											
❾ **EN-0160: Oceanic Web Enabled Collaborative Trajectory Planning**		E	2009															
EN-0161: Oceanic Trajectory - 4DT En Route		E	2009															
EN-0162: Development of Flexible Oceanic Entry Points				E	2011													❿
PI-0082: Oceanic Airspace Policy						P	2013											

Operational Improvement Data Table Legend

❶ **Operational Improvement Description:** The OI description defines the specific operational transformation or an improved level of performance of NextGen operations. It provides the context, constraints, and measures of the improved operations, as well as a summary of the required elements needed to achieve the operational performance improvement.

❷ **Functional Drivers:** Additional information that provides functional requirements of the OI.

❸ **SOPR:** The suggested partner that will have primary responsibility for this OI.

❹ **SOCR:** The suggested partner (s) that will collaborate with the SOPR to implement the OI.

❺ **OI Group:** The Functional Group where the OI is classified.

❻ **SOPR Unique Reference:** If the OI is aligned with a specific SOPR program or defined investment, the unique reference used within the SOPR is listed in this field. For the OI's aligned with the FAA, this unique reference is the NAS Architecture OI number.

❼ **Primary Supported OIs:** If the OI is required to support other OIs, this field lists those OIs that are directly supported by the reference OI. Other OIs may also be supported by the reference OI through secondary relationships with the primary supported OIs.

❽ **Initial Operational Capability (IOC):** The reference OI number, title and IOC date are listed on the first line of the timetable. The IOC date is listed, as well as indicated, with a green square with an O label in the IOC year within the timetable.

❾ **Primary Prerequisites:** The lines of the timetable list the primary prerequisite planning element that are required to implement the reference OI. Further information on the listed planning elements including secondary prerequisites can be found in the Appendix or the JPE available at www.jpdo.gov.

❿ **Prerequisite's Initial Availability Date:** The timetable lists the initial availability dates for each prerequisite Enabler, R&D Activity, and Policy Issue, or IOC date for prerequisite OIs. Each of the elements listed are key for the realization of this particular improvement and must be available before or on the IOC date.

Enabler Data Table - Appendix II

EN-0162 Development of Flexible Oceanic Entry Points

❶ ***Description:*** The development of Flexible Oceanic Entry Points will provide Aircraft Dispatchers and Traffic Flow Managers the flexibility to adjust the Oceanic entry points. This will require web enabled collaborative four-dimensional trajectory (4DT) planning.

❷ ***SOPR:*** FAA

❸ ***SOCR:***

❹ ***Primary Supported OIs:*** OI-0304

❺ ***Primary Supported Enablers:***

❻ ***Enabler Group:*** Oceanic Operations Enablers

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-0162: Development of Flexible Oceanic Entry Points				E	2011 ❼													
❽ D-0150: Collaborative Negotiation Capabilities for Expanded Oceanic Track Entry Points		D	2009															❾

Enabler Data Table Legend

❶ **Enabler Description:** The Enabler description defines the material or non-material solution that will contribute and support an OI or another Enabler.

❷ **SOPR:** The suggested partner that will have primary responsibility for this Enabler.

❸ **SOCR:** The suggested partner (s) that will collaborate with the SOPR to implement the Enabler.

❹ **Primary Supported OIs:** If the Enabler is required to support OIs, this field lists those OIs that are directly supported by the reference Enabler. Other OIs may also be supported by the reference Enabler through secondary relationships with the primary supported OIs.

❺ **Primary Supported Enablers:** If the Enabler is required to support other Enablers, this field lists those Enablers that are directly supported by the reference Enabler. Other Enablers may also be supported by the reference Enabler through secondary relationships with the primary supported Enablers.

❻ **Enabler Group:** The Functional Group where the Enabler is aligned.

❼ **Initial Availability (IA):** The reference Enabler number, title, and IA date are listed on the first line of the timetable. The IA date is listed, as well as indicated, with a blue square with a E label in the IA year within the timetable.

❽ **Primary Prerequisites:** The lines of the timetable list the primary prerequisite planning element that are required to implement the reference Enabler. Further information on the listed planning elements, including secondary prerequisites, can be found in the Appendix or the JPE available at www.jpdo.gov.

❾ **Prerequisite's Initial Availability Date:** The timetable lists the IA dates for each prerequisite Enabler, R&D Activity, and Policy Issue. Each of the elements listed are key for the realization of this reference Enabler and must be available on or before the IA date.

Research & Development Data Table - Appendix III

D-1070 Development of NextGen Interagency Net-Centric Security Requirements

❶ ***Description:*** Development of information security plans and guidelines to support information sharing among NextGen Partners that include security policies, protocols, performance measure criteria, assessment evaluation procedures, as well as certification, verification and validation methodologies of authorized users and providers of secured and non-secured information. This is important to support agency policy decisions about sharing information.

❷ ***SOPR:*** DOD

❸ ***SOCR:*** FAA, DOC, DHS

❹ **Agency Programs:** FAA – Next Gen – SWIM

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
D-1070: Development of NextGen Interagency Net-Centric Security Requirements																		
❺ R-0940: Applied Research on the Roles and Responsibilities in a Shared Information Environment	R	D	2009															
R-0950: Applied Research on Net-Centric Stakeholder Access to NextGen Information	R	D	2009															
❻ EN-1015: Enterprise Network Management Standards		D	—	E	2011													
EN-1016: Enterprise Networks Infrastructure Services Standards		D	—	E	2011													
EN-1043: Enterprise Networks Security Services Standards		D	—	E	2011													

❼ (Prerequisite rows) ❽ (Successor rows)

Research & Development Data Table Legend

❶ **Research/Development Description:** The description defines the focus of the area being researched and/or developed, including the context and desired results.

❷ **SOPR:** The suggested partner that will have primary responsibility to conduct the reference Research or Development Activity.

❸ **SOCR:** The suggested partner (s) that will collaborate with the SOPR to conduct the particular Research or Development Activity.

❹ **Agency Programs:** The existing or planned programs within one or more agencies that align to the reference Research or Development Activity.

❺ **Prerequisite Elements:** For Development Activities only, the timetable lists the identification number and title of any prerequisite Research Activities of the reference Development Activity. Note that Research Activities do not have prerequisite elements. The line can be recognized as a prerequisite if there is a R in a box to the left of box with a D. Further information on the listed planning elements, including secondary prerequisites, can be found in the Appendix or the JPE available at www.jpdo.gov.

❻ **Successor Elements:** The timetable lists the identification number and title of all elements supported by the reference Research or Development Activity. The line can be recognized as a supported element if there is a labeled box to the right of the box with a D if the table is for a Development Activity. Similarly for Research Activities, it is a supported element if there is a labeled box to the right of the box with a R. The label in the box to the far right will indicate if the supported elements is an Enabler (E), Development Activity(D) or OI (O).

❼ **Required Prerequisite Date:** R&D Activities are ongoing activities and do not have prescribed dates. R&D Activities have required output dates that are determined by their supported elements. By convention within the IWP, R&D Activities are due two years prior to the target date of the supported element. Therefore, if a Development Activity has a Research Activity prerequisite, the earliest required completion date is displayed for the Development Activity, and the listed Research Activity is required two years prior to this date. If this calculated research date falls before the current fiscal year, it is placed in the current fiscal year's box to retain the prerequisite's visual traceability.

❽ **Required Completion Date:** The required date for a Research or Development Activity is set by convention to be two years prior to the target date of the supported element. This target date is the initial availability date for Enablers and IOC date for OIs. The timetable shows a labeled box and the target date of the supported elements to the far right on each line. The required date for the Research or Development Activity is the year where the box with the R or D is placed respectively. If this required date falls before the current fiscal year, it is placed in the current fiscal year to retain visual traceability.

Policy Data Table - Appendix IV

PI-0017 Communications Architecture Plan for Ground-Based, Space-Based, Airborne-Based and/or Performance-Based Architectures

❶ ***Description:*** Policies should be developed to define a strategy for communications services to ensure that performance and avionics standards will be in place when needed for ground-based, space-based, airborne-based, and/or performance-based architectures. This should include a decision on whether an "airborne internet" approach is used.

❷ ***SOPR:*** DOD ❸ ***SOCR:*** DHS, DOC, FAA, Industry ❹ ***Initial Decision:*** 2009

❺ ***Primary Supported OIs:*** OI-0321, OI-0327, OI-0344, OI-0358, OI-0362

❻ ***Primary Supported Enablers:*** EN-1010, EN-1037, EN-1061, EN-1203, EN-1204, EN-1205

Policy Issue Data Table Legend

❶ **Policy Issue Description:** The Policy Issue description defines the issues and desired results of policy deliberations and actions that will support an improved level of performance or specific capability of NextGen operations.

❷ **SOPR:** The suggested partner that will have primary responsibility for this Policy Issue.

❸ **SOCR:** The suggested partner (s) that will collaborate with the SOPR to achieve the Policy Issue.

❹ **Initial Decision:** The date by which the first decision on a given Policy Issue must be made in order to effectively support dependent Enablers or OIs. An initial decision is simply the first step toward full completion, as many Policy Issues may require ongoing analysis or a series of decisions.

❺ **Primary Supported OIs:** This lists OIs that are dependent upon this policy's initial decision or follow-on decisions.

❻ **Primary Supported Enablers:** This lists Enablers that are dependent upon this policy's initial decision or follow-on decisions.

1.9 IWP CAPABILITIES AND THE JOINT PLANNING ENVIRONMENT

The IWP will mature in future versions to describe how the planning elements support NextGen Capabilities. NextGen Capabilities are the common focal points for the IWP, ConOps, and the EA. To describe the relationship between Functional Areas and capabilities, the beginning of each Functional Area chapter presents the alignment between the Functional Area and the relevant NextGen Capabilities. The titles of the capabilities are listed below and are described in Appendix VI.

- Provide Collaborative Capacity Management
- Provide Collaborative Flow Contingency Management
- Provide Efficient Trajectory Management
- Provide Flexible Separation Management
- Provide Effective Information Sharing Environment
- Provide Integrated Regulatory & Risk Management
- Provide Flexible Airport Facility and Surface Operations

The contents of the IWP and the other NextGen planning documents represent a significant collection of information describing the overall NextGen plan. The planning data elements and their inter-dependencies create a complex web of interconnected data that must be collaboratively enhanced and analyzed to optimize the NextGen investment portfolio; to track implementation progress against NextGen Capabilities; and to assess the related technical, operational, programmatic, and economic risks. This can only be achieved through the creation and management of a fully relational environment that supports the integration, normalization, manipulation, and visualization of the information in a consistent manner.

The JPDO released the web-accessible JPE to present the detailed NextGen information and relationships in a clear and structured framework. JPE users may search across the latest releases of the NextGen planning documents or view data by capability, agency, data element type, or agency specific framework. JPE users also have access to features, such as detailed reports, charts, and graphs. Subsequent releases of the JPE will provide additional federated capabilities that will allow the JPDO to collect, validate, analyze, and report the status of committed research, development, and implementation activities of the NextGen stakeholders. As this information is captured in JPE, it will provide the additional depth needed for detailed analysis of priorities, benefits, risks, costs, research, and technology maturity to perform objective alternative analysis, derive the case for NextGen, and inform stakeholder investment decision making.

The NextGen JPE is accessible online at www.jpdo.gov. Information on how to navigate and use the JPE is available through the online help feature located on the JPE website.

2 Trajectory and Performance-Based Operations and Support

The Next Generation Air Transportation System (NextGen) seeks to safely accommodate significantly increased air traffic demand in the most efficient, effective, environmentally responsible, and secure manner possible. This must be achieved by balancing the needs of users, operators, communities, and the nation using limited resources and the coordinated efforts of all stakeholders. To achieve this goal, the air transportation system needs to realize the fundamental transformation to Trajectory and Performance-Based Operations and Support.

The Trajectory and Performance-Based Operations and Support functional area provides the fundamental components of the following NextGen Capabilities: *Provide Efficient Trajectory Management, Provide Flexible Separation Management, Provide Collaborative Capacity Management, Provide Collaborative Flow Contingency Management, and Provide Flexible Airport Facility and Surface Operations*. The Trajectory and Performance-Based Operations and Support functional area supports the following goals of these Capabilities:

- Provide trajectories that minimize the frequency and complexity of aircraft conflicts, within the flow, through Trajectory Negotiation, adjusting individual aircraft trajectory, and/or sequencing when resource contention requires.
- Establish and maintain safe aircraft separation, predict conflicts, and identify resolutions (e.g., course, speed, altitude, etc.) in real time to accommodate increasing capacity demands and traffic levels using automation (e.g. decision support systems) while applying reduced separation standards. Separation management ensures aircraft or vehicles maintain safe separation minima from other aircraft or vehicles, protected airspace, terrain, weather, or other hazards.
- Dynamically balance forecasted airspace and airport demand, utilization, and aviation security requirements in collaboration with enterprise stakeholders, through proactive strategic planning and automation (e.g. decision support systems), using airspace and airport design requirements, standards and configuration conditions, and with consideration of other air transportation system resources.
- Provide optimal, synchronized, and safe strategic flow initiatives, and minimized operational impacts in collaboration with enterprise stakeholders, through real- or near real-time resolutions informed by probabilistic decision making addressing large demand/capacity imbalances within capacity management plans.
- Reallocate or reconfigure the airport facility and surface assets to maintain an acceptable level of service, accommodating the increase in passenger and cargo demand levels or changes in operational requirements, through infrastructure development, predictive analyses, automation (e.g. decision support systems), and improvements to technology and procedures.
- Improve information required by aviation regulation, situational awareness and enhanced decision making by managing, integrating, and flexibly delivering, relevant and reliable data and information (e.g., advisories, signals, and alerts), on demand, and in a format that is secure and available to authorized users in a unified and coordinated environment.

2.1 INTRODUCTION

This chapter presents the results, timing and dependencies of work efforts necessary to achieve the NextGen vision for Trajectory and Performance-Based Operations and Support. The most fundamental requirement of NextGen is to safely accommodate significantly increased traffic, and to do this in airspace that is already congested, such as between heavily traveled city pairs and near the busiest airports. To meet this need, NextGen requires a fundamental shift to trajectory-based and performance-based operations with full situational awareness and integration of weather, safety, security, and environmental information.

- **Trajectory-Based Operations (TBO)** uses precise four-dimensional trajectories (4DT) that are actively managed to optimize an individual flight as well as the overall operations of the national airspace. TBO requires the use of precise and timely surveillance, navigation, and weather information that is distributed and shared over a secure national integrated network. It requires new policies, processes, procedures, standards, and rules to guide TBO functions. TBO also requires the air navigation service provider (ANSP), the aircraft operator, the airport, and the aircraft to use new and advanced information systems to support active management of flights.

  This fundamental transformation to TBO enables major increases in throughput. The ability to accurately manage trajectories facilitates more efficient and safe separation assurance and reduced separations. The delegation of separation to capable aircraft for specific operations also improves efficiency and throughput. With TBO, peak demand at the busiest airports is accommodated with highly efficient and optimized arrival/departure operations supported by advanced aircraft and ANSP capabilities.

- **Performance-Based Operations (PBO)** incorporates an aircraft's performance capabilities into the management of flights and the air transportation system. NextGen provides varying levels of service and operating flexibility depending on the performance capability of the aircraft. Specific operations and airspace is allocated to aircraft that meet required communications, navigation, and surveillance performance thresholds, enabling increased capacity.

  PBO provides a foundational transformation of NextGen. Regulations and procedural requirements are described in performance terms rather than in terms specific to technology or equipment. When operationally advantageous, priority is given to aircraft that have the capability to increase the efficiency of the overall air traffic system, such as in delegated separation operations. The performance-based definition, delivery of services, and levels of service encourage private sector innovation and enable efficiencies throughout NextGen. Minimum performance levels are required to maximize capacity in congested airspace during specific periods of time.

  Service providers can apply service tiers to offer different performance level guarantees to users of the system. Users can then make the appropriate tradeoffs, between investments and desired levels of service to best meet their needs. Thus, a benefit of PBO is that service providers can define capability improvements, in terms of the users' existing equipage, thus maximizing the value of the stakeholder's investments.

To describe the efforts needed to realize the NextGen vision for TBO and PBO, this chapter first presents the Operational Improvements (OIs) needed to achieve the TBO and PBO functional needs for Separation Management, Trajectory Management, Capacity Management, and Flow Contingency Management. These OIs are then followed by sections describing their required Enablers, Research and Development (R&D) Activities, and Policy Issues.

2.2 TRAJECTORY AND PERFORMANCE-BASED OPERATIONAL IMPROVEMENTS

To achieve the NextGen vision for TBO and PBO, many OIs must be executed across multiple organizations, types of airspace, phases of flight, aircraft types, operating conditions, and locations. OIs must be implemented that support the cooperative management of flights by the ANSP and the aircraft crew. OIs must also address the support functions performed by the ANSP, the aircraft operator, and many other organizations. To describe this rich diversity, the TBO and PBO OIs have been aligned into six functional groups as shown in summary in Figure 2-1. The OI functional groups are described in the following sections. Full descriptions of each OI, including their integration with other IWP elements, are provided in Appendix I as well as on the interactive Joint Planning Environment (JPE) available at www.jpdo.gov.

Trajectory Management - Arrival/Departure Operational Improvements	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
OI-0318: Arrival Time-Based Metering - Controller Advisories	O 2008																	
OI-0319: Time-Based Metering into En Route Streams	O 2008																	
OI-0309: Use Optimized Profile Descent			O 2010															
OI-0311: Increased Capacity and Efficiency Using RNAV and RNP			O 2010															
OI-0316: Enhanced Visual Separation for Successive Approaches					O 2012													
OI-0400: Wake Turbulence Mitigation: Departures - Wind-Based Wake Procedures						O 2013												
OI-0325: Time-Based Metering Using RNP and RNAV Route Assignments							O 2014											
OI-0326: Airborne Merging and Spacing - Single Runway							O 2014											
OI-0329: Airborne Merging and Spacing with OPD								O 2015										
OI-0401: Wake Turbulence Mitigation: Arrivals - Wind-Based Wake Procedures								O 2015										
OI-0330: Time-Based and Metered Routes with OPD									O 2016									
OI-0333: Improved Operations to Closely Spaced Parallel Runways									O 2016									
OI-0334: Independent Converging Approaches in IMC										O 2017								
OI-0381: GBAS Precision Approaches										O 2017								
OI-0331: Integrated Arrival/Departure and Surface Operations											O 2018							
OI-0338: Efficient Metroplex Merging and Spacing											O 2018							
OI-0402: Wake Turbulence Mitigation: Departures - Dynamic Wind Procedures											O 2018							
OI-0409: Net-Centric Virtual Facility											O 2018							
OI-0317: Near Zero Ceiling/Visibility Airport Access													O 2020					
OI-0341: Limited Simultaneous Runway Occupancy													O 2020					
OI-0403: Wake Turbulence Mitigation: Arrivals - Dynamic Wind Procedures													O 2020					
OI-0410: Automated Virtual Towers													O 2020					
OI-0339: Integrated Arrival/Departure and Surface Traffic Management for Metroplex															O 2022			

Trajectory Management - En Route/Multi-Domain Operational Improvements	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
OI-0304: Flexible Entry Times for Oceanic Tracks						O 2013												
OI-0305: Continuous Flight Day Evaluation							O 2014											
OI-0352: Automated Clearance Delivery and Frequency Changes							O 2014											
OI-0358: Trajectory Flight Data Management											O 2018							
OI-0360: Automation-Assisted Trajectory Negotiation													O 2020					
OI-0369: Automated Negotiation/Separation Management																	2024 O	
OI-0370: Trajectory-Based Management - Full Gate-To-Gate																		2025 O

Figure 2-1 Trajectory and Performance-Based OI Timetables

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Trajectory Management - Surface Operational Improvements																		
OI-0320: Initial Surface Traffic Management					O	2012												
OI-0321: Enhanced Surface Traffic Operations							O	2014										
OI-0332: Ground-Based and On-Board Runway Incursion Alerting									O	2016								
OI-0322: Low-Visibility Surface Operations										O	2017							
OI-0327: Surface Management - Arrivals/Winter Ops/Runway Configuration											O	2018						
OI-0340: Near-Zero-Visibility Surface Operations																	2025	O

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Separation Management Operational Improvements																		
OI-0344: Reduced Oceanic Separation - 30 Miles for Pair-Wise Maneuvers		O	2009															
OI-0347: Air Traffic Control Surveillance Service in Non-Radar Areas (ADS-B)				O	2011													
OI-0349: Automation Support for Mixed Environments							O	2014										
OI-0353: Reduced Oceanic Separation - Altitude Change Pair-Wise Maneuvers							O	2014										
OI-0356: Delegated Separation - Pair-Wise Maneuvers							O	2014										
OI-0354: Reduced Oceanic Separation - Co-Altitude Pair-Wise Maneuvers								O	2015									
OI-0355: Delegated Responsibility for Horizontal Separation								O	2015									
OI-0343: Reduced Separation - High Density En Route, 3-mile												O	2019					
OI-0359: Self-Separation Airspace - Oceanic															O	2022		
OI-0362: Self-Separation Airspace Operations															O	2022		
OI-0348: Reduce Separation - High Density Terminal, Less Than 3-miles																	2025	O
OI-0363: Delegated Separation - Complex Procedures																	2025	O

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Capacity Management Operational Improvements																		
OI-0346: Improved Management of Airspace for Special Use					O	2012												
OI-0310: Improved GA Access to Traverse Terminal Areas						O	2013											
OI-0307: Integrated Arrival/Departure Airspace Management								O	2015									
OI-0351: Flexible Airspace Management								O	2015									
OI-0361: Resource Planning								O	2015									
OI-0337: Flow Corridors - Level 1 Static										O	2017							
OI-0350: Flexible Routing												O	2019					
OI-0406: NAS Wide Sector Demand Prediction and Resource Planning												O	2019					
OI-0365: Advanced Management of Airspace for Special Use																O	2023	
OI-0366: Dynamic Airspace Reclassification																O	2023	
OI-0368: Flow Corridors - Level 2 Dynamic																2024	O	

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Flow Contingency Management Operational Improvements																		
OI-0408: Provide Full Flight Plan Constraint Evaluation with Feedback						O	2013											
OI-0303: TMI with Flight-Specific Trajectories							O	2014										
OI-0306: Provide Interactive Flight Planning from Anywhere											O	2018						

Figure 2-1 Trajectory and Performance-Based OI Timetables (continued)

2.2.1 Trajectory Management - Arrival/Departure Operational Improvements

Trajectory Management OIs support the NextGen transformation to the integrated management of aircraft movement using precise 4DTs in the most efficient, safe, secure, and environmentally-responsible manner possible. Trajectory Management OIs describe the evolution from today's processes where controllers guide an aircraft crew along rigidly-defined routes over inefficient and inflexible voice communication systems using a multitude of loosely integrated information systems with non-precise position information.

From this safe yet inefficient and inflexible system, Trajectory Management OIs describe the operational changes, the increasing levels of automation introduced for ANSP and aircraft support, the changing roles of humans and automation, and the eventual transformation to highly-efficient and flexible operations using advanced automation, communication, navigation, and surveillance (CNS) systems.

Trajectory Management involves managing individual aircraft movements to follow specific flight plans or trajectories using current practices as well as future techniques employing 4DTs, a precise description of an aircraft path in space and time. Trajectory Management is a shift from clearance-based control to trajectory-based management. Aircraft fly negotiated trajectories and control their movement in order to manage their own trajectory. To describe this fundamental yet complex area, Trajectory Management OIs are functionally grouped into three domains: Arrival/Departure, En Route/Multi-Domain, and Surface.

Figure 2-2 presents the planned evolution of the OIs that support the Arrival/Departure component of Trajectory Management. The Arrival/Departure component is the process by which aircraft trajectories are managed in terminal airspace and on the runway as they arrive at and depart from the airport. This is the most complex management function within the national airspace system (NAS), requiring the maneuvering and sequencing of aircraft to maximize airport capacity yet minimizing environmental impact in the safest possible manner.

As shown in Figure 2-2, OI-0318 and OI-0319 provide increased terminal throughput and capacity as well as efficient flight trajectories using time-based metering improvements. Time-based management is used for sequencing multiple departure streams over a single en-route fix and result in a reduction of "lost landing" opportunities at the runway threshold. The use of the most economical power setting from cruise to approach and the accompanying reductions in environmental impact is achieved by Optimized Profile Descent (OPD) improvements provided by OI-0309. These initial benefits of reduced fuel-burn, emission, and noise levels are limited and dependent upon the initial availability of advanced avionics, ground capabilities, and airspace redesigns. Broader benefits are available as the elements of OI-0309 are more widely implemented beyond the initial implementations at limited locations in 2010.

Also in the near term, improved arrival/departure operations are enabled by the use of Required Navigational Performance (RNP) and Area Navigation (RNAV) technologies, resulting in the increased capacity and efficiency described in OI-0311. RNP and RNAV, supported by the Enablers described in Chapters 2 and 9, allow flexible point-to-point operations including repeatable, predictable, and efficient navigation for departure procedures and approaches. Other improvements include efficient terminal and en-route spacing and complex operations that allow the use of curved path procedures that address terrain, noise sensitive, and/or special use airspace (SUA). As described in OI-0316, out-of window visual separation is enhanced by on-board traffic displays that improve situational awareness and allow successive visual approaches in marginal visual meteorological conditions (VMC). Interoperability standards address the flight crew's delegated responsibilities for maintaining visual contact with a leading aircraft, while the ANSP remains responsible for all other aircraft.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Trajectory Management - Arrival/Departure Operational Improvements																		
OI-0318: Arrival Time-Based Metering - Controller Advisories	O 2008																	
OI-0319: Time-Based Metering into En Route Streams	O 2008																	
OI-0309: Use Optimized Profile Descent			O 2010															
OI-0311: Increased Capacity and Efficiency Using RNAV and RNP			O 2010															
OI-0316: Enhanced Visual Separation for Successive Approaches					O 2012													
OI-0400: Wake Turbulence Mitigation: Departures - Wind-Based Wake Procedures						O 2013												
OI-0325: Time-Based Metering Using RNP and RNAV Route Assignments							O 2014											
OI-0326: Airborne Merging and Spacing - Single Runway							O 2014											
OI-0329: Airborne Merging and Spacing with OPD								O 2015										
OI-0401: Wake Turbulence Mitigation: Arrivals - Wind-Based Wake Procedures								O 2015										
OI-0330: Time-Based and Metered Routes with OPD									O 2016									
OI-0333: Improved Operations to Closely Spaced Parallel Runways									O 2016									
OI-0334: Independent Converging Approaches in IMC										O 2017								
OI-0381: GBAS Precision Approaches										O 2017								
OI-0331: Integrated Arrival/Departure and Surface Operations											O 2018							
OI-0338: Efficient Metroplex Merging and Spacing											O 2018							
OI-0402: Wake Turbulence Mitigation: Departures - Dynamic Wind Procedures											O 2018							
OI-0409: Net-Centric Virtual Facility											O 2018							
OI-0317: Near Zero Ceiling/Visibility Airport Access													O 2020					
OI-0341: Limited Simultaneous Runway Occupancy													O 2020					
OI-0403: Wake Turbulence Mitigation: Arrivals - Dynamic Wind Procedures													O 2020					
OI-0410: Automated Virtual Towers													O 2020					
OI-0339: Integrated Arrival/Departure and Surface Traffic Management for Metroplex															O 2022			

Figure 2-2 Trajectory Management - Arrival/Departure OI Timetable

The Arrival/Departure timetable includes initial improvements for wake turbulence management, airborne merging and spacing, coordinated runway operations, integrated surface management, and increased low-visibility operations. Staged implementation of procedures and standards for closely spaced arrivals, together with new technology, will maintain airport throughput and runway capacity during peak periods in favorable wind conditions. The impact of wake turbulence is mitigated using DSTs that support reduced wake separation rules that incorporate information on the aircraft type and prevailing wind conditions. Time-based metered routes are integrated with optimized profile and continuous descents as well as efficiently coordinated approaches in moderate/heavy traffic using DSTs that reduce inefficient aircraft maneuvers and improve environmental impact.

In the far-term, precision approaches, using the ground-based augmentation system (GBAS) provided in OI-0381, allow broader access at more airports as well as increased access to currently under-utilized regional airports. Access to airports with near-zero ceiling and visibility is increased by the use of enhanced technologies such as space-based navigation systems as presented in OI-0317. With the introduction of OI-0409 and OI-0410, virtual towers provide a broad range of ANSP services at remote airports without the need to provide a full tower infrastructure and local staff. Metroplex operations are enhanced by the full integration of trajectory, separation, and capacity management functions including surface and terminal airspace operations through the implementation of OI-0338 and OI-0339. By scheduling and managing all operations with full situational awareness, the ANSP and flight operators can efficiently collaborate to balance the demands of all users and maximize the utilization of the runway and airspace capacity.

NextGen arrival/departure aircraft operations, such as closely spaced parallel and/or convergent approaches, require:

- Increased precision and certainty of position and timing information to maximize runway throughput
- Precision navigation operations, cooperative surveillance, aircraft-based technology
- Procedures enabling the operations rates achievable in visual operations
- Mitigation of wake vortex constraints through prediction and real-time adaptation of applied separations
- Improved runway incursion prevention procedures and technologies
- Automatic distribution of runway braking action reports
- Delivery of taxi instructions before landing that can be automatically executed without waiting for a separate clearance.

Many Policy Issues as well as R&D Activities are needed to support the full implementation of these Arrival/Departure OIs. For example, PI-0008, PI-0014, and PI-0120 outline the avionics, aircraft equipment and performance requirements for RNP/RNAV, general aviation benefits, system flight prioritization, and certification for use of net centric information. Creating streamlined and coordinated processes for avionics certification to reduce safety-risk and implementation delays is also required. Performance standards and processes to achieve reliable systems for NextGen automation are addressed in PI-0004. A full listing of R&D Activities is presented in Section 2.4 with relevant Policy Issues presented in Section 2.5.

Complete information for Trajectory Management - Arrival/Departure OIs, including their integration with other IWP elements, can be found in Appendix I as well as on the interactive JPE available at www.jpdo.gov.

2.2.2 Trajectory Management - En Route/Multi-Domain Operational Improvements

Similar to the arrival/departure needs for terminal airspace, advanced trajectory management functions are needed to optimize the management of flights in en route, oceanic, and international airspace. Figure 2-3 presents the planned evolution of the OIs that support the En Route/Multi-Domain component of Trajectory Management.

As shown in Figure 2-3, the initial OI in this group supports the negotiation of entry times and track loading for oceanic operations using pre-determined alternatives, as detailed in OI-0304. As described in OI-0305, by 2014, ANSP and users continuously monitor flights and constraints and collaborate to develop strategies and trajectories that mitigate potential constraints. Also by 2014, OI-0352 provides the automated delivery of clearance and frequency information.

After 2018, NextGen En Route/Multi-Domain Trajectory Management allows aircraft and ANSP systems to negotiate and optimize trajectories in real-time with full awareness of user preferences and constraints such as weather, restricted airspace, and airport status, as presented in OI-0358 and OI-0360. The full realization of trajectory management for all phases of flight is described in OI-0369 and OI-0370. These OIs, enabled by automation and data exchange for trajectory negotiation and separation management, result in increased certainty of aircrafts' paths, increased overall capacity, and improved use of resources.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Trajectory Management - En Route/Multi-Domain Operational Improvements																		
OI-0304: Flexible Entry Times for Oceanic Tracks						O	2013											
OI-0305: Continuous Flight Day Evaluation							O	2014										
OI-0352: Automated Clearance Delivery and Frequency Changes							O	2014										
OI-0358: Trajectory Flight Data Management											O	2018						
OI-0360: Automation-Assisted Trajectory Negotiation													O	2020				
OI-0369: Automated Negotiation/Separation Management																2024	O	
OI-0370: Trajectory-Based Management - Full Gate-To-Gate																	2025	O

Figure 2-3 Trajectory Management - En Route/Multi-Domain OI Timetable

Many Policy Issues, as well as R&D Activities, must be completed to support the full implementation of these En Route/Multi-Domain OIs. For example, the Federal Aviation Administration (FAA) and NASA collaboration is needed to resolve issues within PI-0001, PI-0014, PI-0017, PI-0077, and PI-0082 which address oceanic airspace, high density operations, communication, aircraft equipage, and avionics certification. In addition PI-0006, which addresses the determination of appropriate roles and responsibilities allocated between humans/automation and air/ground, needs to be completed. R&D Activities for operator personnel training and procedures and allocation of operational responsibility found within D-1200 are also required to enable flight crews and dispatch personnel to achieve proficiency in trajectory-based airspace operations more efficiently.

Complete information for Trajectory Management - En Route/Multi-Domain OIs, including their integration with other IWP elements, can be found in Appendix I as well as on the interactive JPE available at www.jpdo.gov.

2.2.3 Trajectory Management - Surface Operational Improvements

The surface component of Trajectory Management increases the efficiency of surface operations and supports the safe surface movement of aircraft and other ground vehicles. Surface Trajectory Management supports flexible surface operations, expedites the execution of surface traffic movements, reduces departure queues, and supports the safe crossing of active runways. Within Surface Trajectory Management, ANSP and airport stakeholders use technologies, such as advanced surface management systems, for surface movement decision support to minimize the movement and operating time of aircraft while on the surface as well as to optimize the use of gates, taxiways, and runways in all operating conditions, thereby increasing airport efficiencies and decreasing environmental impacts.

Figure 2-4 presents the planned evolution of OIs that support the surface component of Trajectory Management. As shown in Figure 2-4, initial improvements for departure sequencing are provided by OI-0320 and advanced taxi movement scheduling provided by OI-0321. Net-centric infrastructure (NCI), such as air-ground data exchange, digitally transmits taxi instructions and airport information to equipped aircraft on arrival and prior to pushback. Implementation of these surface management OIs increases airport throughput, controller efficiency, and safety as well as reduces fuel-burn and emissions.

Surface safety is increased by the use of ground-based and on-board runway incursion alerting provided by OI-0332 in 2016. By 2017, the surface automation provided in OI-0322 allows ANSP and airport operators to use integrated surveillance data and efficiently coordinate and prioritize surface movement of aircraft and vehicles, even in low-visibility operations. Aircraft and ground vehicle movement is supported, through OI-0327, by a combination of advanced displays, alert mechanisms, and other ground and aircraft-based automation systems that incorporate weather information, to optimize winter surface operations. In the far-term, OI-0340 provides for aircraft and ground vehicle movement during near-zero visibility conditions, guided by full cooperative surveillance (Automatic Dependent Surveillance-Broadcast (ADS-B) out) and other technologies, such as moving map and cockpit traffic displays, and enhanced and synthetic vision, thus increasing the safety of surface operations as well as maximizing airport capacity. A cost/benefit analysis is required to establish the level of visibility to support.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Trajectory Management - Surface Operational Improvements																		
OI-0320: Initial Surface Traffic Management					O	2012												
OI-0321: Enhanced Surface Traffic Operations							O	2014										
OI-0332: Ground-Based and On-Board Runway Incursion Alerting									O	2016								
OI-0322: Low-Visibility Surface Operations										O	2017							
OI-0327: Surface Management - Arrivals/Winter Ops/Runway Configuration											O	2018						
OI-0340: Near-Zero-Visibility Surface Operations																	2025	O

Figure 2-4 Trajectory Management - Surface OI Timetable

Many Policy Issues as well as R&D Activities must be completed to support the full implementation of these Surface OIs. For example, the near-term policies, described in PI-0017 and PI-0021, address the need to certify the use of net-centric information, and secure information exchange found in PI-0024 needs to be resolved. Policy issues within PI-0120, regarding critical components of the aviation infrastructure, also need to be determined. FAA, NASA, and industry stakeholders need to address policies and procedures found in PI-0006, which concern the appropriate balance between human ANSP/operators and automation; rules of the road as described in PI-0007; and flight prioritization needed to implement NextGen aircraft equipment requirements, which can be found in PI-0077. Finally, close collaboration between FAA and NASA is required to capture the benefits of Trajectory-based surface operations in near-zero visibility.

Complete information for Trajectory Management - Surface OIs, including their integration with other IWP elements, can be found in Appendix I as well as on the interactive JPE available at www.jpdo.gov.

2.2.4 Separation Management Operational Improvements

To achieve the NextGen goals for improved capacity, the separation between aircraft in all airspace environments must be safely reduced and effectively managed for simple as well as complex operations. Separation Management OIs describe the evolution from today's processes, where controllers manage separation from other aircraft applying a limited set of separation standards and using position information from radar-based systems, to future operations where separation is managed with a wide range of standards using precise and timely aircraft position information. Using increasingly sophisticated ANSP separation management systems and processes, aircraft separation is closely managed, tailored to the unique needs of an aircraft and airspace, and reduced to the safest minimum levels from hazards such as wake turbulence, terrain, severe weather, and obstacles, as well as other aircraft. As aircraft separation capabilities increase, and to improve efficiency and flexibility, the responsibility for separation is increasingly delegated from ANSP to capable aircraft.

Figure 2-5 presents the planned evolution of the OIs that support Separation Management functions. As shown in Figure 2-5, the timetable begins with oceanic airspace separation improvements. User-preferred oceanic profiles, through the reduction of horizontal and longitudinal spacing to 30 miles for pair-wise maneuvers between capable aircraft, are enabled by OI-0344. This is a near-term OI that provides increased capacity and improved operational flexibility. The use of RNP and satellite-based voice and data communications are prerequisites, and industry stakeholders' and the FAA's collaboration is a key factor for implementation.

Separation Management Operational Improvements	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
OI-0344: Reduced Oceanic Separation - 30 Miles for Pair-Wise Maneuvers		O	2009															
OI-0347: Air Traffic Control Surveillance Service in Non-Radar Areas (ADS-B)				O	2011													
OI-0349: Automation Support for Mixed Environments							O	2014										
OI-0353: Reduced Oceanic Separation - Altitude Change Pair-Wise Maneuvers							O	2014										
OI-0356: Delegated Separation - Pair-Wise Maneuvers							O	2014										
OI-0354: Reduced Oceanic Separation - Co-Altitude Pair-Wise Maneuvers								O	2015									
OI-0355: Delegated Responsibility for Horizontal Separation								O	2015									
OI-0343: Reduced Separation - High Density En Route, 3-mile												O	2019					
OI-0359: Self-Separation Airspace - Oceanic															O	2022		
OI-0362: Self-Separation Airspace Operations															O	2022		
OI-0348: Reduce Separation - High Density Terminal, Less Than 3-miles																	2025	O
OI-0363: Delegated Separation - Complex Procedures																	2025	O

Figure 2-5 Separation Management OI Timetable

Aircraft-to-aircraft separation through enhanced surveillance is delegated by ANSP and facilitated by new procedures and data provided from on-board displays. Digital communications is used to reduce controller and aircraft crew workload. Maneuvers, such as en route merging and spacing found in OI-0355, are increasingly delegated to the aircraft, and trajectories are constantly modified to meet projected capacity demand. As aircraft separation capabilities increase, separation responsibility is also increasingly delegated from ANSP control to capable aircraft, thus improving efficiency and flexibility. By 2014, OI-0353 provides for reduced oceanic separation for altitude change pair-wise maneuvers and co-altitude pair-wise maneuvers through OI-0354. By 2022, OI-0359 provides self-separation operations in designated oceanic airspace for properly equipped aircraft. Aircraft-to-aircraft separation is delegated to the flight deck for aircraft equipped with ADS-B and onboard conflict detection and alerting.

Delegated separation improvements are also achieved in other ANSP-managed airspace. By 2019, three-mile separation procedures are applied in new high-density en route airspace, based on Required Surveillance Performance by means of OI-0343. By 2022, OI-0356 supports ANSP delegation of pair-wise separation responsibilities to capable aircraft. These OIs improve operator routing, enhance operational efficiency, and increase ANSP productivity. The ANSP delegates separation responsibility to capable aircraft with onboard displays to perform specific separation operations including passing, crossing, turn-behind, and other simple maneuvers. This does not include separation for complex situations that would require onboard conflict alerting.

By 2022, OI-0362 provides self-separation airspace in which capable aircraft are responsible for maintaining their own separation from other aircraft, weather, terrain, and other obstacles, without ANSP separation services in this airspace. This far-term OI enables operator-preferred routing with increased ANSP productivity. Finally, by 2025, based upon concept exploration and a feasibility research cost/benefit analysis, NextGen is envisioned to support delegated separation involving the more complex procedures found in OI-0363.

Complete information for Separation Management OIs, including their integration with other IWP elements, can be found in Appendix I as well as on the interactive JPE available at www.jpdo.gov.

2.2.5 Capacity Management Operational Improvements

The capacity of the national airspace must be actively managed to effectively balance the demands of multiple users with the constraints and operating conditions in all locations. Capacity Management OIs describe the evolution from today's operational model, where capacity is managed at a macro level using a limited set of inflexible rules, to a future state where capacity is dynamically adjusted on a micro level with a wide range of rules that safely accommodate demands and constraints with full situational awareness. NextGen Capacity Management may begin years before day-of-flight and continues through the day of operation.

Starting with OIs that allow for the improved scheduling and access to special use and terminal airspace, Capacity Management is improved by increasing airspace flexibility and allocation of ANSP resources. Using increasingly sophisticated decision support systems, the ANSP can adjust airspace configurations and resources to meet the unique needs and environmental conditions for specific locations. From an initial ability to adjust to specific configurations, the Capacity Management OIs describe the ability to dynamically adjust airspace configurations and classifications in full collaboration with airports, capable aircraft, and aircraft operators. To support increased capacity, OIs also define the use of improvements, such as flow corridors and advanced management of SUA.

Figure 2-6 presents the planned evolution of the OIs that support Capacity Management functions. As shown in Figure 2-6, near-term capacity improvements include OI-0346 that provides increased access to SUA, by 2012, through the use of real-time management and scheduling decision support tools and enhanced automation-to-automation communications. Through OI-0310, general aviation operators equipped with advanced surveillance capabilities are able to access busy terminal airspace in 2013 and operate with more direct routing.

Capacity Management Operational Improvements	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
OI-0346: Improved Management of Airspace for Special Use					O	2012												
OI-0310: Improved GA Access to Traverse Terminal Areas						O	2013											
OI-0307: Integrated Arrival/Departure Airspace Management								O	2015									
OI-0351: Flexible Airspace Management								O	2015									
OI-0361: Resource Planning								O	2015									
OI-0337: Flow Corridors - Level 1 Static										O	2017							
OI-0350: Flexible Routing												O	2019					
OI-0406: NAS Wide Sector Demand Prediction and Resource Planning												O	2019					
OI-0365: Advanced Management of Airspace for Special Use																O	2023	
OI-0366: Dynamic Airspace Reclassification																O	2023	
OI-0368: Flow Corridors - Level 2 Dynamic																2024	O	

Figure 2-6 Capacity Management OI Timetable

By 2015, through OI-0307, new airspace designs are integrated with terminal procedures and separation standards, particularly in major metro areas supporting multiple airports. This increases available routings, decreases delays, and provides more efficient throughput. ANSP decision support tools facilitate improved scheduling for arrival and departure aircraft based on airport demand, aircraft capabilities, and gate assignments. Terminal transition areas extend into current en route airspace to allow reduced separation standards, permitting aircraft to use RNAV and RNP procedures for increased throughput. These improvements also allow greater flexibility for aircraft reroutes around severe weather or other disruptions.

By implementing OI-0351 and OI-0361, ANSP resources and capacity are able to be adjusted and reallocated to meet traffic demands. To increase capacity, NextGen includes the staged implementation of Flow Corridors as described in OI-0337 and OI-0368. Flow Corridors support aircraft traveling on similar routes, using well-defined procedures to keep aircraft separated from aircraft outside the corridor, resulting in high traffic densities and increased throughput. To accommodate user demand, flexible routing is provided by OI-0350.

In the far term, OI-0365 provides real-time airspace management and scheduling of SUA, including daily negotiations using advanced automation that updates airspace status. These improvements facilitate increased access to the NAS, providing the maximum flexibility to all users and minimizing the impact on traffic flows. Through OI-0366, airspace is dynamically reclassified, for example from "Classic" to "Trajectory Based", to meet operational demand as well as to minimize the impact of adverse weather. Changes in airspace classification would be scheduled or dynamically implemented, depending on demand, using rules and procedures needed to execute airspace classifications. Significant Policy Issues as well as R&D Activities need to be completed to support the strategic changes described in the Capacity Management OI timetable.

Complete information for Capacity Management OIs, including their integration with other IWP elements, can be found in Appendix I as well as on the interactive JPE available at www.jpdo.gov.

2.2.6 Flow Contingency Management Operational Improvements

In support of the active management of separation, trajectories, and capacity, there is always a need to modify plans to accommodate special or changing conditions. To optimize the overall flow and capacity of the national airspace, the Flow Contingency Management OIs describe how today's mostly manual processes, using limited decision support tools, evolve to highly-integrated and collaborative processes, using automated decision support tools with full situational awareness. Using increasing levels of collaboration and integration among ANSP, aircraft operators, and aircraft, flights are adjusted to accommodate changing conditions. Initially adjusted and rerouted during pre-flight planning, flight plans and trajectories are eventually dynamically adjusted during flight, using integrated processes and digital communication between the flight deck and ANSP automation. Rather than global traffic management initiatives (TMIs) that broadly apply to multiple flights, flight plans are uniquely tailored to accommodate and balance the needs of each user with NAS demands, capacities, and constraints.

Flow Contingency Management is the process that identifies potential flow problems, such as large demand-capacity imbalances, congestion, high degrees of complexity, blocked or constrained airspace, or other off-nominal conditions. It is a collaborative process, between ANSP personnel and airspace users, to develop flow strategies to resolve the problems. Examples of flow strategies include establishing alternate routing to reduce complexity, restructuring airspace, and allocating access to airspace or runways. Flow Contingency Management strategies can include establishing multiple trajectories and/or flow corridors to reduce complexity, restructuring the airspace to provide more system capacity, or allocating time-of-arrival and departure slots to runways or airspace. Operators with multiple aircraft involved in an initiative have the flexibility to adjust individual aircraft schedules and trajectories within those allocations to accommodate their own priorities.

Figure 2-7 presents the planned evolution of OIs that support Flow Contingency Management functions. As shown in Figure 2-7, these Flow Contingency Management OIs begin with OI-0408, in 2013, that supports the collaboration between the ANSP and flight operators for the evaluation and adjustment of flight plans to accommodate constraints. The user has the ability to adjust or re-file the flight plan as additional information is received. In 2014, OI-0303 uses automation to disseminate TMIs that are appropriate to the situation at the flight-specific level.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Flow Contingency Management Operational Improvements																		
OI-0408: Provide Full Flight Plan Constraint Evaluation with Feedback						O 2013												
OI-0303: TMI with Flight-Specific Trajectories							O 2014											
OI-0306: Provide Interactive Flight Planning from Anywhere											O 2018							

Figure 2-7 Flow Contingency Management OI Timetable

Finally, by 2018, NextGen provides interactive flight planning from any location by means of OI-0306. ANSP automation allows the user to enter the flight plan incrementally, with feedback on conditions for each segment, enabling the user to quickly reach a flight plan agreement, thus optimizing their business objectives. Rather than global TMIs that broadly apply to multiple flights, flight plans are uniquely tailored to accommodate and balance the needs of each user with the overall demands, capacities, and constraints of the national airspace.

These NextGen Flow Contingency Management OIs are dependent on the resolution of key Policy Issues including: PI-0077, which addresses flight prioritization in high density operations; PI-0024, secure information exchange; and PI-0108, which concerns the certification of net-centric information.

Complete information for Flow Contingency Management OIs, including their integration with other IWP elements, can be found in Appendix I as well as on the interactive JPE available at www.jpdo.gov.

2.3 TRAJECTORY AND PERFORMANCE-BASED ENABLERS

Trajectory and Performance-Based Operations and Support requires a comprehensive set of integrated Enablers that support the active management and operation of aircraft. These Enablers include a suite of integrated ANSP information systems that provide the following functions:

- Surface Management
- Separation Management
- Capacity and Flow Contingency Management
- Aeronautical Information Management
- Virtual Tower
- Separation Management
- Trajectory Management
- Flight Planning
- Wake Management
- Oceanic Operations

Trajectory and Performance-Based Operations and Support also requires core infrastructure Enablers that provide CNS services as defined in their respective functional areas. In coordination with and supported by these core infrastructure Enablers described in other chapters of the Integrated Work Plan (IWP), the NextGen ANSP information systems provide more flexible, robust, and efficient decision support for all phases of flight. They provide enhanced functionality, broader integration, and full situational awareness using a secure NCI. Trajectory and Performance-Based Operations and Support also require aircraft and aircraft operator investments that support distributed separation and Trajectory Management functions as well as requirements for safety, security, and environmental management. Aircraft operators need a range of new CNS and flight management avionics as well as flight planning and management systems. These new or enhanced information systems and avionics require coordinated and significant investments, representing one of the greatest risks to the success of NextGen.

Enablers must be researched, developed, and implemented in a certain sequence and timing to effectively meet the needs of the OIs they support. Enablers also can support the implementation of other Enablers. To describe these broad needs, the Trajectory and Performance-Based Operations and Support Enablers have been aligned into 12 functional groups as shown, in summary, in Figure 2-8. The Enabler functional groups are described in the following sections with full descriptions of each Enabler, including their integration with other IWP elements, provided in Appendix II as well as on the interactive JPE available at www.jpdo.gov.

Oceanic Operations Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-0160: Oceanic Web Enabled Collaborative Trajectory Planning		E 2009																
EN-0161: Oceanic Trajectory - 4DT En Route		E 2009																
EN-0162: Development of Flexible Oceanic Entry Points				E 2011														

Trajectory Management Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-0008: Trajectory Negotiation - Level 1 Controlled Time of Arrival (CTA)						E 2013												
EN-0034: Trajectory Management Decision Support - Level 1						E 2013												
EN-0110: Trajectory Negotiation - Level 2 En Route Time-Based Metering						E 2013												
EN-0017: Trajectory Negotiation - Level 3 Automation-Assisted 4DTs											E 2018							
EN-0037: Trajectory Management Decision Support - Level 2											E 2018							
EN-0018: Trajectory Negotiation - Level 4 Automated 4DTs													E 2020					

Surface Movement Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-0023: Surface Movement - Detail Operational Concept				E 2011														
EN-0100: Surface Movement Decision Support - Level 1 Initial				E 2011														
EN-0026: Surface Movement Decision Support - Level 2 Mid Term								E 2015										

Integrated Operation Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-0007: High-Density Arrival/Departure Detail Operational Concept				E 2011														
EN-0027: Metroplex Flow Management Decision Support											E 2018							
EN-0009: Integrated Trajectory/Separation Management - Terminal															E 2022			

Separation Management Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-0016: Separation/Trajectory Management Detail Operational Concept			E 2010															
EN-0039: UAS Detail Operation Concept					E 2012													
EN-0301: Performance-Based Separation Standards and Procedures					E 2012													
EN-0035: Separation Management Decision Support - Level 1						E 2013												
EN-0212: Parameter Driven Aircraft Separation Standards and Procedures						E 2013												
EN-0168: In-Trail Oceanic Separation Using ADS-C							E 2014											
EN-0169: In-Trail Oceanic Separation Using ADS-B							E 2014											
EN-0038: Separation Management Decision Support - Level 2											E 2018							

Wake Management Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-0150: Wake Vortex Configuration Advisory Decision Support - Level 1 Static Drift Only					E 2012													
EN-0029: Wake Detection/Prediction w/Dynamic Wake Spacing - Level 1 Wake Drift							E 2014											
EN-0151: Wake Vortex Configuration Advisory Decision Support - Level 2 Dynamic Drift							E 2014											
EN-0030: Wake Detection/Prediction w/Dynamic Wake Spacing - Level 2 Wake Drift/Decay									E 2016									
EN-0152: Wake Vortex Configuration Advisory Decision Support - Level 3 Dynamic Drift/Decay									E 2016									

Figure 2-8 Trajectory and Performance-Based Enabler Timetables

Flight Planning and Data Management Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-0210: Flexible Routing Flight Plan Automation - Operator				E 2011														
EN-0004: 4D Flight Plan Automation - ANSP							E 2014											
EN-0005: 4D Flight Plan Automation - Operator							E 2014											
EN-0006: 4D Flight Plan Management Decision Support - Level 1							E 2014											
EN-0003: 4D Flight Plan Management Decision Support - Level 2											E 2018							

Aeronautical Information Management Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-0206: Consolidated Aeronautical Information - Level 1 Network-Enabled Legacy				E 2011														
EN-1270: Flow Information Services - FAA Group 1				E 2011														
EN-1271: Flight and Surveillance Information Services - FAA Group 1				E 2011														
EN-1272: Aeronautical Information Services (AIS) - FAA Group 1				E 2011														
EN-0207: Consolidated Aeronautical Information - Level 2 Integrated Status						E 2013												
EN-0002: Network-Enabled Flight Object Information							E 2014											

Virtual Tower Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-0019: Virtual Tower - Detail Operational Concept				E 2011														
EN-0020: Staffed Virtual Tower Capability								E 2015										
EN-0021: Automated Virtual Tower - Level 1 Single Runway Airport								E 2015										
EN-0022: Automated Virtual Tower - Level 2 Multiple Runway Airport									E 2016									

Avionics Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-0202: Avionics - Traffic Display Level 1 Cockpit Display of Traffic Information (CDTI)	E 2008																	
EN-0203: Avionics - Traffic Collision and Avoidance System - Level 1	E 2008																	
EN-0201: Avionics - RNP		E 2009																
EN-0028: Avionics - Access to Airspace Boundary Information				E 2011														
EN-0102: Avionics - Moving Map Display				E 2011														
EN-0200: Avionics - Traffic Display Level 2				E 2011														
EN-0204: Avionics - Traffic Collision and Avoidance System - Level 2				E 2011														
EN-1007: Avionics - Trajectory Management - Advanced Surface Operations					E 2012													
EN-0031: Avionics - Airborne Merging and Spacing						E 2013												
EN-0106: Avionics - Delegated Separation Acknowledgement Information							E 2014											
EN-0103: Avionics - Trajectory Management - Arrival/Departure								E 2015										
EN-0109: Avionics - Surface Conflict Management									E 2016									
EN-0101: Avionics - Enhanced Obstacle Detection										E 2017								
EN-0032: Avionics - Airborne Self-Separation															E 2022			

Figure 2-8 Trajectory and Performance-Based Enabler Timetables (continued)

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Aircraft Weather-Related System Enablers																		
EN-5015: Aircraft Systems - Runway Friction Sensors and Technology							E	2014										
EN-2810: Aircraft Systems - Turbulence Mitigation											E	2018						
EN-2820: Aircraft Systems - Icing Alleviation											E	2018						
EN-2830: Aircraft Systems - Low Visibility Alleviation											E	2018						
EN-2840: Aircraft Systems - Vortex Avoidance Alleviation											E	2018						
EN-2850: Aircraft Systems - Radiation Alleviation											E	2018						
EN-2860: Aircraft Systems - Volcanic Ash Alleviation											E	2018						
EN-2870: Aircraft Systems - Weather Mitigation Requirements											E	2018						
EN-5019: Aircraft Systems - Ground Icing Detection													E	2020				
EN-5018: Aircraft Systems - De-Ice/Anti-Ice Technology																2024	E	

Figure 2-8 Trajectory and Performance-Based Enabler Timetables (continued)

2.3.1 Oceanic Operations Enablers

The NextGen plan envisions early adoption of OIs that improve oceanic operations. These OIs require Enablers that increase the availability of user-preferred oceanic profiles. The increased availability of user-preferred oceanic profiles requires additional Enablers that provide for the negotiation of track entry times and track loading to improve oceanic route efficiency. Figure 2-9 presents the planned evolution of the Enablers that support Oceanic Operations functions within NextGen.

Figure 2-9 shows that by 2009, EN-0160 provides oceanic web-enabled collaborative trajectory planning, allowing aircraft operators and ANSP traffic flow managers to collaborate on oceanic trajectory scheduling prior to departure. EN-0161 allows aircraft operators to send their desired oceanic 4DT profile adjustments in real-time. By 2011, EN-0162 provides dispatchers and traffic flow managers the flexibility to adjust oceanic entry points.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Oceanic Operations Enablers																		
EN-0160: Oceanic Web Enabled Collaborative Trajectory Planning		E	2009															
EN-0161: Oceanic Trajectory - 4DT En Route		E	2009															
EN-0162: Development of Flexible Oceanic Entry Points				E	2011													

Figure 2-9 Oceanic Operations Enabler Timetable

Achieving the Enablers described in this timetable requires overcoming many challenges including:

- Timely completing the development of 4DT data exchange for flexible routing and issuing flight clearances
- Requirements for determining optimal flight profile information to support alternatives selection for altitude changes and co-altitude pair-wise maneuvers at reduced separation in oceanic airspace.

Complete information on Oceanic Operations Enablers, including their integration with other IWP elements, can be found in Appendix II as well as on the interactive JPE available at www.jpdo.gov.

2.3.2 Trajectory Management Enablers

NextGen requires OIs that enable flexible airspace management, flexible resource allocation, integrated arrival/departure and surface operations, time-based and metered routes with Optimized Profile Descent (OPD), efficient metroplex merging and spacing, and a host of other improvements. These OIs require Enablers that support integrated arrival/departure airspace; improved independent operations to parallel runways; automation-assisted trajectory negotiation; reduced separation in high-density terminal areas; advanced management of SUA; dynamic flow corridors; and NAS-wide airspace demand prediction and resource planning. Accomplishing these improvements requires Enablers that support trajectory management, trajectory negotiation, and Trajectory Management decision support at various levels through the waterfall development and deployment. The FAA, in collaboration with industry and partner agencies, will lead the implementation of these Enablers. NASA and the Department of Defense (DOD) will lead the research, development, and evaluation of the required technology, as well as procedures to make this a reality.

Figure 2-10 presents the planned evolution of the Enablers that support trajectory negotiation and management functions within NextGen. Four levels of trajectory negotiation ANSP decision support tools and functions are envisioned, as described by EN-0008, EN-0110, EN-0017 and EN-0018. Two levels of Trajectory Management ANSP decision support tools and functions are envisioned, as described by EN-0034 and EN-0037.

Trajectory Management Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-0008: Trajectory Negotiation - Level 1 Controlled Time of Arrival (CTA)						E	2013											
EN-0034: Trajectory Management Decision Support - Level 1						E	2013											
EN-0110: Trajectory Negotiation - Level 2 En Route Time-Based Metering						E	2013											
EN-0017: Trajectory Negotiation - Level 3 Automation-Assisted 4DTs											E	2018						
EN-0037: Trajectory Management Decision Support - Level 2											E	2018						
EN-0018: Trajectory Negotiation - Level 4 Automated 4DTs													E	2020				

Figure 2-10 Trajectory Management Enabler Timetable

The first level of trajectory negotiation, described by EN-0008, provides ANSP decision support tools to facilitate negotiation, between ANSP/Controllers and flight operators/crews, of Controlled Time of Arrivals (CTAs) for time-based metering into high-density terminal areas. The second level of trajectory negotiation is described by EN-0110 that includes negotiated time-based metered 4DTs in en route airspace. 4DT negotiation defines the agreed-upon position and timing of aircraft through a given airspace. Demand is projected from filed flight plans and demand forecasts. Capacity is projected from probabilistic weather forecasts, SUA, infrastructure status, planned capacity, and flow strategies. Consideration of aircraft capabilities, including appropriate speed/altitude profiles, is factored in negotiating trajectories. CTA and 4DTs may be communicated to the cockpit by voice or data. CTA negotiations may be conducted as early as an hour prior to departure, whereas 4DTs are most likely negotiated while the aircraft is airborne.

In parallel with the first two levels of trajectory negotiation and available by 2013 is the first level of trajectory management decision support as described by EN-0034. EN-0034 is part of the initial integrated suite of ANSP automation tools that support the overall management of real-time 4DTs for all aircraft movements in en route and terminal domains. These tools incorporate demand, capacity, and flow contingency strategies received from the integrated suite of ANSP tools with precise, real-time aircraft position and intent received from ground-based and airborne systems. These tools enhance the ANSP's ability to actively manage specific aircraft movements and the ANSP’s ability to manage the overall flow of all aircraft. This initial suite of integrated Trajectory Management tools is enhanced to a second level as described by EN-0037, available by 2018. These enhancements include the addition of algorithms, data collection, and communication abilities that support Trajectory Management of: complex merging and spacing in en route and metroplex environments, dynamic airspace reconfiguration, flow corridors, and full trajectory management from gate to gate.

In coordination with availability of the second level of Trajectory Management, the third and forth levels of trajectory negotiation are provided by EN-0017 and EN-0018 in 2018 and 2020 respectively. These Enablers facilitate trajectory negotiation of flexible 4DTs through a given airspace by the use of enhanced ANSP decision support tools & automation which no longer requires, but may still use, named waypoints. This mid- to far-term automation improves trajectory optimization using automatic consideration of other traffic and aircraft capabilities and the ability of ANSP systems to perform separation management as trajectories are generated. ANSP automation must consider all real-time traffic, airspace constraints, aircraft capabilities, and other factors. This does not include automation of such extent, quality, and immediacy to relieve controllers of any separation management responsibilities. Final acceptance of a trajectory requires the participation of pilots and controllers on each end of the negotiation. Flight crews are responsible for final acceptance of a negotiated trajectory for crewed aircraft. Explicit acceptance by a human controller is not necessarily required. Air-ground data exchange is necessary to efficiently convey 4DTs to and from cockpit systems.

Achieving the Enablers described in this timetable requires overcoming many challenges including:

- Completing the research on NextGen team size optimization, common NextGen automation platform, weather and wake impacts for en route operations, and spacing management in congested en route airspace
- Development of trajectory negotiation protocols for air and ground information architectures
- Resolution of policy issues including public acceptance of automation, international commercial space operation, Global Positioning System (GPS) policy to support civil NextGen Positioning Navigation Timing (PNT) requirements, and the balance of human vs. automation.

Complete information on Trajectory Management Enablers, including their integration with other IWP elements, can be found in Appendix II as well as on the interactive JPE available at www.jpdo.gov.

2.3.3 Surface Movement Enablers

NextGen requires OIs that allow for increased efficiency and improved effectiveness of congested surface operations. These OIs require Enablers that support low-visibility surface operations, wake turbulence mitigation, enhanced surface traffic operations, ground-based and on-board runway incursion alerting, and surface management. These OIs also require Enablers that address a detailed operational concept for surface movement and surface movement decision support.

Figure 2-11 presents the planned evolution of the Enablers that support Surface Movement functions within NextGen. The first Enabler within the Surface Movement group is EN-0023, which provides the detailed operational concept for surface movement. This Enabler addresses the policies regarding appropriate roles and responsibilities for humans vs. automation and for flight operators vs. ANSPs in supporting safe and efficient low-visibility surface movement at high-density airports by 2011.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Surface Movement Enablers																		
EN-0023: Surface Movement - Detail Operational Concept				E	2011													
EN-0100: Surface Movement Decision Support - Level 1 Initial				E	2011													
EN-0026: Surface Movement Decision Support - Level 2 Mid Term								E	2015									

Figure 2-11 Surface Movement Enabler Timetable

The next core component of this Enabler group is EN-0100, which provides automation to enable safe and efficient flow of aircraft on the surface. This Enabler includes decision support automation for efficient flow management. Next in the sequence would be EN-0026, which provides automation to enable safe and efficient flow of aircraft and ground equipment on the surface. This Enabler includes decision support automation for efficient flow management, real-time information distribution, such as runway braking action reports, and ground-based runway incursion detection and alerting. The benefits include enhanced airport throughput, controller efficiency, enhanced safety, and reduced fuel-burn and emissions.

Achieving the Enablers described in this timetable requires overcoming many challenges including:

- A cooperative research effort throughout the aviation community led primarily by the FAA and NASA
- Completion of the terminal and surface low-visibility concept of operations
- Resolution of policy issues like Air Traffic Management (ATM) automation development and performance and interoperability standards.

Full information on Surface Movement Enablers, including their integration with other IWP elements, can be found in Appendix II as well as on the interactive JPE available at www.jpdo.gov.

2.3.4 Integrated Operation Enablers

NextGen requires new and dynamic procedures for operations, with significant integration at all levels and in all forms, to include integrated arrival/departure and surface operations, reduced separation, delegated separation, efficient metroplex merging and spacing, time-based metering, independent converging approaches in Instrument Meteorological Conditions (IMC), dependent multiple approaches in IMC, and wake turbulence mitigation. These OIs require Enablers that support the integration of decision making automation across the NAS for high-density operations, metroplex flow management, separation management, and trajectory management.

Figure 2-12 presents the planned evolution of the Enablers that focus on Integrated Operations functions within NextGen. The first Enabler within the Integrated Operation group is EN-0007 which addresses the operational concept that is needed by 2011 to guide the overall development of integrated operations for NextGen. This Enabler defines the operational concept for high-throughput and high-efficiency operations for high-density terminal areas as well as defines an effective operational concept for the combination of time-based metering, management by 4DT, and sequence-based pair-wise spacing.

The Integrated Operation functional group also includes EN-0027 which provides midterm metroplex airspace planning and traffic flow management (TFM) automation. The evolution of procedures for the use of reduced separation standards and technologies in various airspace environments includes planning systems to optimize arrival and departure flow strategies for current and forecast weather conditions as well as scheduling automation to manage individual aircraft in flows, such as assigning each arriving or departing aircraft to an appropriate runway, arrival or departure stream, and place in sequence.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Integrated Operation Enablers																		
EN-0007: High-Density Arrival/Departure Detail Operational Concept				E	2011													
EN-0027: Metroplex Flow Management Decision Support											E	2018						
EN-0009: Integrated Trajectory/Separation Management - Terminal															E	2022		

Figure 2-12 Integrated Operation Enabler Timetable

In the far term, EN-0009 provides an ANSP automated decision support tool which integrates the management of arrival/departure and surface operations as well as trajectory management with separation management to include wake turbulence separation requirements. This Enabler provides safe and efficient management of flow and capacity in terminal airspace.

Achieving the Enablers described in this timetable requires overcoming many challenges including:

- Development of a terminal and surface low visibility concept of operations
- NASA's applied research on optimizing performance-based trajectories in transition airspace through the metroplex environment and on integrating arrival/departure flow management with surface operations
- Development of air/ground separation management architectures that can satisfy NextGen's increased capacity and safety requirements
- Development of traffic spacing management components to support high-throughput delivery of aircraft to the runway threshold and departure operations
- Public acceptance of automation which involves considerable industry promotion and support
- The establishment of FAA ATM automation development, performance, and interoperability standards.

Full information on Integrated Operation Enablers, including their integration with other IWP elements, can be found in Appendix II as well as on the interactive JPE available at www.jpdo.gov.

2.3.5 Separation Management Enablers

NextGen requires OIs that provide reduced separation between aircraft as well as operations involving self-separation and delegated separation. These OIs require Enablers that support the reduction or tailoring of aircraft separation to specific parameters as well as the safe, secure, and efficient management of separation across all airspace. Reducing or tailoring aircraft separation requires many Enablers that provide precise on-board avionics for positioning and navigation, advanced surveillance information systems to share position information, as well as management systems that incorporate precise surveillance and trajectory information to safely and effectively manage separation.

Figure 2-13 presents the planned evolution of the Enablers that support Separation Management functions within NextGen. The first Enabler within the Separation Management group is EN-0016, which by 2010 provides the operational concept to guide the overall development of Separation Management within NextGen. The Separation Management Enabler group also includes the evolution of procedures for the use of reduced separation standards and technologies in various airspace environments. In 2012, EN-0301 provides performance-based separation procedures and standards that allow the ANSP and flight operators to conduct reduced oceanic, en route, and terminal separation operations. Also by 2012, EN-0039 provides the operational concept to guide the overall development of how Unmanned Aircraft System (UAS) operations are incorporated in the NAS. This operational concept includes standards for separation of UASs from other aircraft, procedures for UAS operations, and requirements for onboard equipment.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Separation Management Enablers																		
EN-0016: Separation/Trajectory Management Detail Operational Concept			E	2010														
EN-0039: UAS Detail Operation Concept					E	2012												
EN-0301: Performance-Based Separation Standards and Procedures					E	2012												
EN-0035: Separation Management Decision Support - Level 1						E	2013											
EN-0212: Parameter Driven Aircraft Separation Standards and Procedures						E	2013											
EN-0168: In-Trail Oceanic Separation Using ADS-C							E	2014										
EN-0169: In-Trail Oceanic Separation Using ADS-B							E	2014										
EN-0038: Separation Management Decision Support - Level 2											E	2018						

Figure 2-13 Separation Management Enabler Timetable

Two levels of Separation Management decision support tools and functions are envisioned for NextGen. The first level described by EN-0035, available in 2013, is the initial suite of integrated ANSP automated decision support tools that support the safe management and execution of separation procedures and standards in en route airspace. These tools incorporate real-time information from ground-based and aircraft systems that provide precise aircraft positions and trajectories. These tools are integrated with trajectory management tools and enhance a controller's ability to ensure that aircraft are safely separated from potentially hazardous conflicts, including other aircraft, wake turbulence, terrain, severe weather, restricted airspace, and obstacles. This first level of integrated Separation Management decision support coincides with EN-0212 that provides parameter-driven separation standards. Safe separation standards and procedures will reflect aircraft capabilities, wake turbulence characteristics, operational geometries, and environmental conditions

The second level of integrated Separation Management decision support, described by EN-0038 and available in 2018, provides enhancements including support of more complex dynamic wake management, delegated separation, self-separation, and integrated trajectory management procedures and standards. The enhancements also include the extension of advanced Separation Management support for all airspace domains including terminal and oceanic. The Separation Management decision support tools are enhanced to integrate with the full suite of trajectory, capacity, and flow contingency management support tools using a NCI and system wide information management (SWIM) providing full situational awareness of aircraft, airspace, weather, and all elements needed for comprehensive Separation Management.

By 2014, EN-0168 and EN-0169 support enhanced oceanic operations by managing in-trail separation using ADS-B or Automatic Dependent Surveillance - Contract (ADS-C) technologies. Achieving the Enablers described in this timetable requires overcoming many challenges including applied research on:

- Spacing management in congested en route airspace
- Common NextGen automation platform
- Weather and wake impacts for en route operations
- The roles of humans and automation in the safe application of multiple separation standards.

It also requires the development of:

- ATM automation development and performance and interoperability standards
- Policies to support civil NextGen PNT requirements in 2010
- Public acceptance of automation providing air traffic control and critical safety-monitoring tasks
- Understanding of the appropriate balance of human vs. automation
- Operational concepts and detailed procedures for complex Separation Management
- Coordination between the FAA and the aviation industry to agree upon the new operational concepts by 2010, so that development of new automation decision support systems can begin.

Full information on Separation Management Enablers, including their integration with other IWP elements, can be found in Appendix II as well as on the interactive JPE available at www.jpdo.gov.

2.3.6 Wake Management Enablers

NextGen requires OIs that reduce the wake turbulence effects on aircraft operations both in the terminal and en route environments, resulting in reduced spacing and increased capacity which directly contribute to the ability to achieve NextGen capabilities. These OIs require Enablers that support the reduction of wake-based separation requirements using improved, new or modified procedures; aircraft structural configurations to reduce wake turbulence; development of ANSP decision support tools; and ground-based wake vortex advisory systems.

Figure 2-14 presents the planned evolution of the Enablers that support Wake Management functions within NextGen. Wake Management is envisioned to be supported by three levels of wake vortex configuration decision support tools and functions as well as two levels of wake detection and prediction.

Wake Management Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-0150: Wake Vortex Configuration Advisory Decision Support - Level 1 Static Drift Only					E 2012													
EN-0029: Wake Detection/Prediction w/Dynamic Wake Spacing - Level 1 Wake Drift							E 2014											
EN-0151: Wake Vortex Configuration Advisory Decision Support - Level 2 Dynamic Drift							E 2014											
EN-0030: Wake Detection/Prediction w/Dynamic Wake Spacing - Level 2 Wake Drift/Decay									E 2016									
EN-0152: Wake Vortex Configuration Advisory Decision Support - Level 3 Dynamic Drift/Decay									E 2016									

Figure 2-14 Wake Management Enabler Timetable

The wake vortex configuration decision support tools and functions are described by EN-0150, EN-0151, and EN-0152. EN-0150 provides the first level by 2012 and utilizes current and predicted weather information to determine whether persistently favorable conditions are forecast, allowing the possible periodic reduction in wake-based spacing requirements within NextGen. EN-0151 utilizes current and predicted weather information to determine dynamic adjustments to longitudinal spacing, based on wake drift prediction. EN-0152 incorporates wake drift and decay prediction to determine dynamic adjustments to longitudinal spacing.

Wake detection and prediction is described by EN-0029 and EN-0030. EN-0029 provides the first level ground-based wake vortex advisory system based solely on wake transport in 2014. EN-0030 provides the second-level of this system incorporating wake drift into the overall management of wake. Developed standards enable safe wake spacing for various meteorological conditions.

Achieving the Enablers described in this timetable requires overcoming many challenges including:

- Development of advanced wake sensing capabilities to support dynamic wake spacing
- Development of a wake vortex arrival and departure capability incorporating weather measurement and wake predictions to support dynamic wake separation procedures
- Coordination between the FAA and the Department of Commerce (DOC) as well as the entire aviation community.

Full information on Wake Management Enablers, including their integration with other IWP elements, can be found in Appendix II as well as on the interactive JPE available at www.jpdo.gov.

2.3.7 Capacity/Flow Contingency Management Enablers

NextGen requires OIs enabling safe, efficient, and secure execution of both Capacity Management and Flow Contingency Management. NextGen also requires improved management of SUA, continuous flight day evaluation, NAS-wide sector demand prediction and resource planning, trajectory-based management, integrated arrival/departure airspace management, flexible resource allocation and routing, dynamic airspace reclassification, and TMIs with flight-specific trajectories. These OIs require Enablers that support effective scheduling and management of SUA and security airspaces, provide airspace/capacity/flow contingency management decision support tools, as well as support networked ANSP facilities.

Figure 2-15 presents the planned evolution of the Enablers that support Capacity and Flow Contingency Management functions within NextGen. The plan envisions two levels of SUA management decision support as well as three levels of airspace capacity and flow contingency decision support.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Capacity/Flow Contingency Management Enablers																		
EN-0170: SUA Management Decision Support - Level 1		E 2009																
EN-0033: Airspace/Capacity/Flow Contingency Management Decision Support - Level 1						E 2013												
EN-0171: SUA Management Decision Support - Level 2						E 2013												
EN-0300: Networked Air Navigation Support Facilities								E 2015										
EN-0036: Airspace/Capacity/Flow Contingency Management Decision Support - Level 2 Limited											E 2018							
EN-0180: Airspace/Capacity/Flow Contingency Management Decision Support - Level 3 Dynamic															E 2022			

Figure 2-15 Capacity/Flow Contingency Management Enabler Timetable

The first level of SUA management decision support is EN-0170 that provides automated decision support tools and procedures to improve the scheduling and management of SUA by 2009. These tools integrate the required SUA utilization, demand, capacity, and system constraint information, allowing collaboration between stakeholders to exchange airspace demands, capacities, and constraints, providing real-time scheduling functions of SUA that increase access for non-military users, improve system efficiency, and meet military operational needs. EN-0171 provides the second level of SUA management in 2013, by adding dynamic scheduling, incorporating probabilistic weather information, and other features. The improved automation supports rapid processing of requests and allocation of airspace to minimize disruptions to civil aviation while continuing to meet military operational needs.

Airspace/capacity and flow contingency management decision support tools and functions are envisioned in three levels described by EN-0033, EN-0036, and EN-0180. EN-0033 provides the first level in 2013.

This corresponds with the targeted release of the integrated suite of ANSP tools, including EN-0034 that provides separation management decision support and EN-0035 that provides trajectory management decision support. EN-0033 provides the ability to identify demand and capacity imbalances as well as define resource allocation and flow structuring strategies. The second level, defined by EN-0036 and available in 2018, provides more dynamic management capabilities, including strategies to take advantage of aircraft equipage to maximize efficient use of airspace. These tools support strategic and tactical collaboration between ANSP and airspace operators. The third and final level, defined by EN-0180 and available in 2022, provides a broad range of dynamic management capabilities to support the full functions of TBO, the dynamic management of airspace classification and configuration, as well as the planning and management of restricted airspace and flow corridors.

Achieving the Enablers described in this timetable requires overcoming many challenges including applied research on:

- Spacing management in congested en route airspace
- NextGen team size optimization
- Common NextGen automation platform
- Methodologies for dynamically allocating NAS resources
- ANSP roles and responsibilities
- Airspace assignment methods
- Flow corridor operational concepts.

It also requires the development of:

- Coordination and dissemination requirements for SUAs
- Mixed equipage trajectory-based routes and advanced OPD operations
- Technologies and procedures for dynamically adjusting airspace structures
- Business continuity requirements for networked facilities
- NAS-wide aggregate flow models
- Aircraft Operations Center (AOC) equipage implementation policy.

Full information on Capacity/Flow Contingency Management Enablers, including their integration with other IWP elements, can be found in Appendix II as well as on the interactive JPE available at www.jpdo.gov.

2.3.8 Flight Planning and Data Management Enablers

NextGen requires OIs in the areas of Flight Planning and Data Management. These OIs require Enablers that support flexible routing and interactive flight planning from anywhere as well as Enablers that provide airborne and ground-based automation to process flight plan information.

Figure 2-16 shows the planned evolution of the Enablers that provide Flight Planning and Data Management functions within NextGen. The first Enabler within the Flight Planning and Data Management group is EN-0210, which permits flight operators to file multiple flight plan intent messages from which the ANSP selects the one that most efficiently meets flow management and flight operator goals.

From 2014-2018, significant improvements in Flight Planning Automation and Data Management are implemented. EN-0004 provides ANSP 4DT flight management without requiring operators to file 4DTs or negotiate 4DTs between operator and ANSP. EN-0005 provides flight operators the means to file flight plans, as requested, through Flight Operations Centers (FOCs) or private services, while EN-0006 proceeds further, enabling flight operators the means to analyze 4D flight trajectories with respect to TFM initiatives and weather prediction through flow analysis tools common with ANSP. With the release of EN-0003, ANSP has decision support automation allowing the pre- and in-flight collaboration with FOCs and other flight schedulers to optimize flight plans via a collaborative ATM process. This process is based on a common understanding of current and projected airspace status and constraints, including demand, weather, and planned capacity management, flow contingency management, and trajectory management strategies and initiatives.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Flight Planning and Data Management Enablers																		
EN-0210: Flexible Routing Flight Plan Automation - Operator				E 2011														
EN-0004: 4D Flight Plan Automation - ANSP							E 2014											
EN-0005: 4D Flight Plan Automation - Operator							E 2014											
EN-0006: 4D Flight Plan Management Decision Support - Level 1							E 2014											
EN-0003: 4D Flight Plan Management Decision Support - Level 2											E 2018							

Figure 2-16 Flight Planning and Data Management Enabler Timetable

Achieving the Enablers described in this timetable requires overcoming many challenges including:

- Consolidation of air navigation information with network-enabled weather information
- Development and incorporation of methodologies and algorithms for weather assimilation into decision-making
- Policy resolution of:
  - AOC equipage implementation
  - Certifying use of net-centric information
  - Secure information exchange.

Full information on Flight Planning and Data Management Enablers, including their integration with other IWP elements, can be found in Appendix II as well as on the interactive JPE available at www.jpdo.gov.

2.3.9 Aeronautical Information Management Enablers

NextGen requires OIs across many areas of flight operations that require broad situational awareness, including current, consistent, and accurate aeronautical information, such as airport status, airspace status, and flight status. The efficient and effective collection, dissemination, and management of this aeronautical information is an important component of NextGen.

Figure 2-17 presents the planned evolution of the Enablers that support Aeronautical Information Management functions within NextGen. The timetable shows initial benefit with EN-0206, which capitalizes on minor improvements to legacy systems to gain immediate benefits to scheduled use of SUA, Temporary Flight Restrictions (TFRs), and flow restricted airspace. These systems allow improved civilian flight planning and airspace utilization while assisting ANSPs to more efficiently manage the airspace and help resolve en route flow problems.

Aeronautical Information Management Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-0206: Consolidated Aeronautical Information - Level 1 Network-Enabled Legacy				E 2011														
EN-1270: Flow Information Services - FAA Group 1				E 2011														
EN-1271: Flight and Surveillance Information Services - FAA Group 1				E 2011														
EN-1272: Aeronautical Information Services (AIS) - FAA Group 1				E 2011														
EN-0207: Consolidated Aeronautical Information - Level 2 Integrated Status						E 2013												
EN-0002: Network-Enabled Flight Object Information							E 2014											

Figure 2-17 Aeronautical Information Management Enabler Timetable

Also in the near term, EN-1270 provides the initial group of services for FAA delivery of flow information, including route status, traffic flow, and runway visual range information. EN-1271 presents the initial group of services that provide flight and surveillance information. Clearance delivery and taxi status information is also available on the FAA's enterprise network and can be accessed by outside users (other agencies, third parties) via authorized gateways/portals. Also by 2011, EN-1272 provides the initial group of services for the delivery of aeronautical information including SUA status and configuration.

Automated, real-time net-centric systems through EN-0207 provides aeronautical information, including SUA, TFRs, flow restricted airspace, and weather data from the initial 4D Weather Cube capability, as well as demand and capacity predictions, to a variety of government, military, and civilian agencies, including general and commercial aviation. By 2014, EN-0002 furnishes representations of the information concerning a particular flight, including approved and alternate preferred flight plans, aircraft and flight crew capabilities, and position and intent information.

Achieving the Enablers described in this timetable requires overcoming many challenges including:

- Coordination of FAA and DOD as well as other agencies and industry
- Secure information exchange
- AOC equipage implementation policy.

Full information on Aeronautical Information Management Enablers, including their integration with other IWP elements, can be found in Appendix II as well as on the interactive JPE available at www.jpdo.gov.

2.3.10 Virtual Tower Enablers

NextGen requires OIs that provide increased access and services at low to moderate volume or remote airports without the need to provide a full tower infrastructure and local staff. These OIs require Automated Virtual Tower (AVT) or Staffed Virtual Tower (SVT) Enablers that provide a range of sequencing, separation, spacing, and surface management functions. AVTs are expected to provide services for low-volume airports currently uncontrolled or non-towered. SVTs are expected to provide services to moderate to large terminals. The enhanced air traffic advisory service and air traffic services at moderate to large terminals increase IMC throughput and provide basic Visual Flight Rules (VFR) services. At moderate to busy airports, SVTs increase IMC throughput with remote personnel providing needed services similar to those provided by current Air Traffic Control Towers (ATCT), but with enhanced capabilities in severe weather and low-visibility conditions.

Figure 2-18 presents the planned evolution of the Enablers that support Virtual Tower functions within NextGen. The first requirement in the creation of Virtual Towers is to develop a detailed operational concept, including appropriate roles and responsibilities for humans vs. automation and for flight operators vs. ANSPs. This is achieved by EN-0019 in 2011. By 2015, EN-0020 provides a more cost-effective way to offer tower services to moderate and large terminals. Staffing is more flexible and efficient, avoiding the cost of building a tower. Also in 2015, EN-0021 provides enhanced air traffic advisory service in one of two implementation alternatives: separation functions provided by ground automation, or sequencing provided by ground automation and separation functions provided by aircraft operators. Finally, in 2016, EN-0022 provides tower services for multiple-runway airports and during low-traffic operation periods at towered or SVT airports, including surface movement provided through AVTs.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Virtual Tower Enablers																		
EN-0019: Virtual Tower - Detail Operational Concept				E	2011													
EN-0020: Staffed Virtual Tower Capability								E	2015									
EN-0021: Automated Virtual Tower - Level 1 Single Runway Airport								E	2015									
EN-0022: Automated Virtual Tower - Level 2 Multiple Runway Airport									E	2016								

Figure 2-18 Virtual Tower Enabler Timetable

Achieving the Enablers described in this timetable requires overcoming many challenges including developing policies and completing research on:

- Virtual tower capability
- Facility and networking alternatives
- Balance of human vs. automation
- Public acceptance of automation providing air traffic control and critical safety-monitoring tasks
- ATM automation development and performance and interoperability standards.

Full information on Virtual Tower Enablers, including their integration with other IWP elements, can be found in Appendix II as well as on the interactive JPE available at www.jpdo.gov.

2.3.11 Avionics Enablers

Aircraft avionics are a critical component of almost every OI in the Trajectory and Performance-Based Operations and Support Functional Area. Avionics provide a vital operational function and link between the aircraft and ANSP-provided automation and CNS systems, as well as aircraft operator systems. NextGen requires Enablers that support functions, such as conflict detection and resolution, self-separation, delegated separation, trajectory management, airborne merging and spacing, RNP/RNAV, cooperative surveillance, and data communications. The implementation of these Enablers result in improved aircraft and operator efficiency and performance, reduced aircraft operational spacing, increased capacity, and reduced ANSP workload.

Figure 2-19 presents the planned evolution of the Avionics Enablers that are needed to support NextGen operations. The first Enablers within the Avionics group are EN-0202, EN-0203, and EN-0211. EN-0202 refers to flight crew knowledge of nearby traffic depicted on cockpit traffic display systems. There is no change of separation tasks or responsibility within this Enabler. EN-0203 is a computerized avionics device that is designed to reduce the danger of mid-air collisions between aircraft. It monitors the airspace around an aircraft, independent of Air Traffic Control (ATC), and warns pilots of the presence of other aircraft which may present a threat of mid-air collision.

Avionics Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-0202: Avionics - Traffic Display Level 1 Cockpit Display of Traffic Information (CDTI)	E 2008																	
EN-0203: Avionics - Traffic Collision and Avoidance System - Level 1	E 2008																	
EN-0201: Avionics - RNP		E 2009																
EN-0028: Avionics - Access to Airspace Boundary Information				E 2011														
EN-0102: Avionics - Moving Map Display				E 2011														
EN-0200: Avionics - Traffic Display Level 2				E 2011														
EN-0204: Avionics - Traffic Collision and Avoidance System - Level 2				E 2011														
EN-1007: Avionics - Trajectory Management - Advanced Surface Operations					E 2012													
EN-0031: Avionics - Airborne Merging and Spacing						E 2013												
EN-0106: Avionics - Delegated Separation Acknowledgement Information							E 2014											
EN-0103: Avionics - Trajectory Management - Arrival/Departure								E 2015										
EN-0109: Avionics - Surface Conflict Management									E 2016									
EN-0101: Avionics - Enhanced Obstacle Detection										E 2017								
EN-0032: Avionics - Airborne Self-Separation															E 2022			

Figure 2-19 Avionics Enabler Timetable

Existing trajectory management avionics within EN-0211 evolves by 2012 into avionics that support advanced surface operations, and by 2015 into avionics that assist in the coordination and execution of trajectory management using precision navigation, cooperative surveillance, and onboard algorithms, allowing reduction of lateral separation requirements. As early as 2009, avionics may include specific combinations of flight management systems, navigation sensors, flight guidance systems, and cockpit displays that are necessary to navigate routes and flight paths with specific RNP standards.

By 2011, moving map display avionics provided by EN-0102 present airport ramps, taxiways, and runways in real-time including own-ship and cooperative surface traffic and ground vehicles. By 2013, EN-0031supports airborne merging and spacing functions in the en route and terminal areas. Delegated separation avionics, defined by EN-0106, are expected by 2014 and allow the ANSP and the aircraft automation to manage delegated responsibility. By 2016, EN-0109 provides surface conflict management functions enabling trajectory-based procedures at high-density airports to expedite traffic and to schedule active runway crossings. It also allows aircraft to perform low-visibility delegated separation procedures. Finally, in 2022, EN-0032 provides avionics that support airborne self-separation procedures.

Achieving the NextGen vision and the full range of benefits envisioned through the use of advanced avionics is a complex undertaking. It requires balanced approaches and policies concerning the cost and benefits that will drive aircraft equipage. It requires a streamlined avionics certification process, globally harmonized standards, synchronized ANSP investments, and PBO. Research into the cost, benefits, and standards is needed, and intense coordination and collaboration with industry partners is essential.

Future versions of the IWP will address avionics in more detail with input from a broader range of stakeholders. In particular, information from the Avionics Roadmap being developed by a consortium led by the Joint Planning Development Office (JPDO) Aircraft Working Group will be included. This Avionics Roadmap provides valuable insights into the requirements, research, development, and policies needed for NextGen Avionics.

Full information on Avionics Enablers, including their integration with other IWP elements, can be found in Appendix II as well as on the interactive JPE available at www.jpdo.gov.

2.3.12 Aircraft Weather-Related System Enablers

NextGen requires a range of aircraft systems that support the mitigation and avoidance of weather and weather related phenomena. Figure 2-20 presents the planned evolution of the Enablers that provide Aircraft Weather-Related Systems needed to meet NextGen operations.

The first of these Aircraft Weather-Related Systems is EN-5015 that provides aircraft sensors that measure runway friction. The sensors transmit the friction data via net-centric and aircraft-based datalinks. This information is used by aircraft operators to estimate runway landing distance to ensure safe operations. The information is also used by airport operators to define the need to treat the runways for snow and/or ice accumulation.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Aircraft Weather-Related System Enablers																		
EN-5015: Aircraft Systems - Runway Friction Sensors and Technology							E	2014										
EN-2810: Aircraft Systems - Turbulence Mitigation											E	2018						
EN-2820: Aircraft Systems - Icing Alleviation											E	2018						
EN-2830: Aircraft Systems - Low Visibility Alleviation											E	2018						
EN-2840: Aircraft Systems - Vortex Avoidance Alleviation											E	2018						
EN-2850: Aircraft Systems - Radiation Alleviation											E	2018						
EN-2860: Aircraft Systems - Volcanic Ash Alleviation											E	2018						
EN-2870: Aircraft Systems - Weather Mitigation Requirements											E	2018						
EN-5019: Aircraft Systems - Ground Icing Detection													E	2020				
EN-5018: Aircraft Systems - De-Ice/Anti-Ice Technology																2024	E	

Figure 2-20 Aircraft Weather-Related System Enabler Timetable

New aircraft systems that support weather mitigation are dependent upon developing requirements and standards that are accepted by industry stakeholders. D-2123 supports the development of these requirements that are then endorsed through EN-2870 in 2018. Using these endorsed requirements, many aircraft systems can be implemented, including EN-2820, EN-2830, EN-2850, and EN-2860 expected in 2018. These Enablers support the mitigation of aircraft impacts from icing on aircraft surfaces, low visibility conditions, radiation, and volcanic ash. Also by 2018, EN-2810 and EN-2840 are expected to support mitigation of aircraft impacts from wake vortex and turbulence.

By 2020, EN-5019 is expected to provide aircraft detection and evaluation of ground icing conditions. This Enablers provides information to pilots on the status of icing conditions, enhancing safety by providing direct measurement of icing, rather than the visual inspections and estimated anti-icing fluid holdover times that are used today. By 2024, EN-5018 is expected to provide aircraft surfaces that are resistant to ground icing, with both de-ice and anti-ice capabilities. The materials provide for effective icing protection and are lightweight and energy-efficient. This would significantly reduce airport de-icing/anti-icing requirements

Achieving the Enablers described in this timetable requires overcoming many challenges including

- Developing aircraft systems weather mitigation requirements
- Broad industry and government coordination.

Full information on Aircraft Weather-Related System Enablers, including their integration with other IWP elements, can be found in Appendix II as well as on the interactive JPE available at www.jpdo.gov.

2.4 RESEARCH AND DEVELOPMENT ACTIVITIES

NextGen Trajectory and Performance-Based Operations and Support requires OIs and Enablers that have not been fully researched or supported by developments allowing them to begin implementation. This section presents the R&D Activities needed to refine conceptual alternatives and resolve technical challenges that will shape the implementation of NextGen. These activities are drawn from the NextGen R&D Plan for FY 2009 - FY 2013 with a strong emphasis on near-term R&D needs. Additional R&D detail is expected in subsequent versions of the IWP.

Figure 2-21 presents the R&D Activities needed to support the air navigation operations areas, including Trajectory Management and Separation Management. Figure 2-22 presents the R&D Activities needed to support the air navigation support areas of Capacity Management and Flow Contingency Management. These R&D Activities are listed in their chronological order by the first required output of Research Activities and then by the first required output of Development Activities. Full descriptions of the R&D Activities, including their integration with other IWP elements, can be found in Appendix III as well as on the interactive JPE available at www.jpdo.gov.

The R&D Activities are aligned with OIs and Enablers to describe the dependencies and sequencing necessary to achieve the overall IWP in a timely and efficient manner. The use and extent of dynamic allocation between ANSP facilities with the creation of dynamic airspace structures is the most significant research area for defining the support environment. Flexible allocation of ATM resources will drive the networking of systems for information sharing and backup. Research will conclude the methods for dynamic allocation of ATM resources and designation of airspace structures, such as self-separation airspace. Also, research will identify facility needs for flexible airspace design and techniques for exploiting performance-based trajectories with shifts in ANSP team sizes and skill sets.

At the same time, research into the effects of workload allocation and facility configuration, based on capacity, will result in tools for matching capacity to the demand, including projected weather impacts. A key technical challenge is finding a means to account for the uncertainties in future available capacity arising from weather, flight emergencies, and security events. The method must not only forecast potential imbalances but also translate the mismatch into airspace allocations to facilities and renegotiations of the specific agreements that constitute the 4DT. Research on automated capacity problem detection, notification, coordination, and resolution will result in procedures to account for real-time assessments of the accuracy and reliability of probabilistic weather forecasts. Another significant trade-off to consider in managing uncertainty is the allocation of airspace between classes of users, between airports in a metro area, and between military and civil purposes when there is a capacity gap. Research on airspace structures and collaborative planning steps will contribute to defining a 4DT allocation scheme for collaborative planning. This decision, in turn, will drive the research to define what specific airspace structures (e.g. flow corridors and self-separation, SUA) are needed in a trajectory-based operation. This will allow development of ATM -wide applicable procedures and common automation, as well as specific solutions such as virtual towers.

With potentially significant negotiations and separation management functions involving the cockpit, modular or incrementally upgradeable avionics are needed to allow accelerated certification throughout the transition in operations. Research will establish the basis for the methods for development and certification of elements of system-of-systems in a piecewise fashion to enable more routine upgrades. Such a capability is useful in implementing the avionics suites to meet performance-based separation procedures.

Air Navigation Operations R&D Activities	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
R-1580: Applied Research on an Airborne Collision Avoidance System	◆																	
R-1590: Applied Research for Required Oceanic Flight Profile Information	◆																	
R-0610: Applied Research on Safe Taxi Operations in Low Visibility Conditions	◆	◆																
R-0910: Applied Research on Optimizing Overlapping Runway Occupancies	◆	◆																
R-1430: Applied Research on Human/Automation Roles in High-Density Surface Operations	◆	◆																
R-0120: Applied Research on Low-Visibility and Surface Operation Technologies	◆																	
R-0340: Applied Research on 3D RNAV/RNP Procedures	◆																	
R-0510: Applied Research on Air and Ground Separation Management Architectures	◆	◆																
R-0630: Applied Research on Effective Surface Management in Various Weather Conditions	◆																	
R-0930: Applied Research on Low Visibility Independent Parallel and Converging Approach	◆	◆																
R-1230: Applied Research on Weather and Wake Impacts for En Route Operations	◆	◆		◆					◆									
R-1240: Applied Research on Low Visibility Dependent Multiple Approach Procedures	◆	◆																
R-0590: Applied Research on Optimizing Visual Flight Rule (VFR) Operations	◆																	
R-1620: Applied Research on Spacing Management in Congested En Route Airspace	◆			◆					◆				◆					
R-0040: Applied Research on Critical NextGen Aircraft Capabilities		◆																
R-0350: Applied Research on Air and Ground-Based Runway Incursion Detection Technologies		◆																
R-0530: Applied Research on Automated Air and Ground Separation Management Alternatives		◆																
R-0600: Applied Research on Assessing and Predicting Wake Severity		◆		◆														
R-1630: Applied Research on Flow Corridor Operational Concepts		◆							◆				◆					
R-2126: Applied Research on Airframe Designs to Accelerate Wake Vortex Decay		◆		◆														
R-1190: Applied Research on Certification Methods, Requirements, and Standards for UASs			◆			◆										◆		
R-1370: Applied Research on the Operational Concept for UASs in Trajectory-Based Airspace			◆															
R-0500: Applied Research on Variable Separation Standards				◆														
R-0820: Applied Research for Required Aircraft 4DT Intent Data						◆												
R-1600: Applied Research on Aircraft-Based CNS Technologies in Self-Separation Airspace											◆							
D-2131: Required Oceanic Flight Profile Information	◆																	
D-1200: Guidance for Trajectory-Based Procedures	◆			◆					◆									
D-0870: Mixed Equipage Trajectory-Based Routes and Advanced OPD Operations		◆		◆														
D-0880: Terminal and Surface Low Visibility ConOps		◆				◆												
D-2125: Situational Awareness Technologies in Low-Visibility and Surface Operations		◆	◆					◆										
D-0360: Requirements for Taxi Instructions Submission			◆															
D-0480: Reduced Oceanic Separation Standards and Procedures			◆															
D-0490: 5nm Non-Radar Separation Standards and Procedures			◆															
D-0520: Trajectory Prediction Methodologies for New Vehicle Classes			◆						◆									
D-0830: Trajectory Negotiation Protocols for Air and Ground Information Architectures			◆	◆					◆		◆							
D-1250: Safe Taxi Operations in Low Visibility Conditions			◆															
D-1640: Wind-Dependent Wake Vortex Arrival Procedures and Tools			◆	◆	◆		◆											
D-2127: 3D RNAV/RNP Procedures			◆															
D-0330: Aircraft-Based Precision Approach Capability				◆	◆	◆												
D-0890: Dynamic Wake Management for Single Runway Operations				◆	◆		◆											
D-1680: Advanced Wake Sensing Capabilities				◆	◆		◆											
D-2133: Air and Ground-based Runway Incursion Detection Technology				◆			◆	◆										
D-2135: Air and Ground Separation Management Architecture				◆					◆				◆					
D-2129: Required Aircraft 4DT Intent Data								◆	◆				◆					
D-2137: Performance Requirements for Aircraft-Based CNS Technologies in Self Separation													◆					

Figure 2-21 Air Navigation Operations R&D Activities Timetable

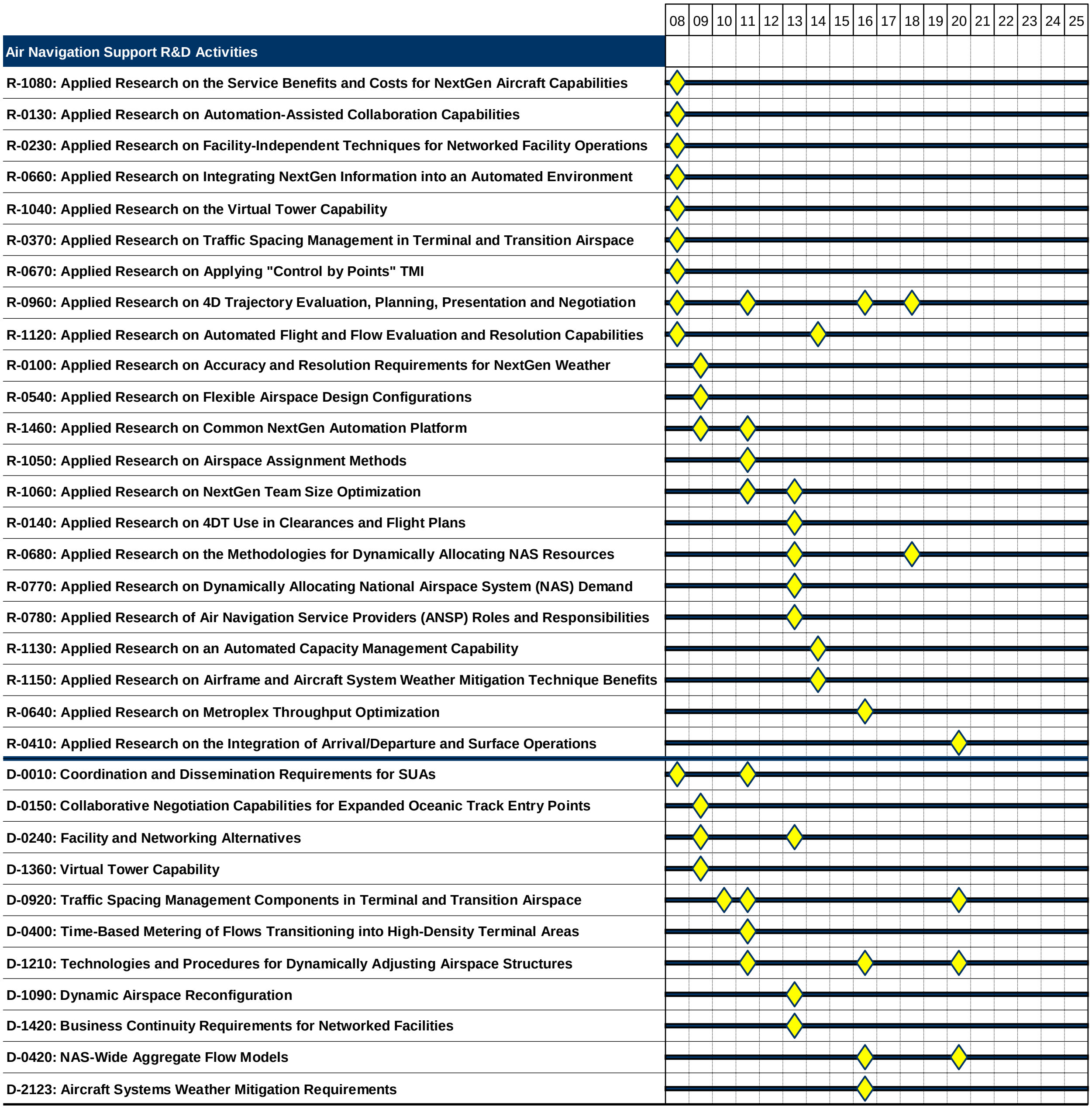


Figure 2-22 Air Navigation Support R&D Activities Timetable

Research into the role given the aircraft in separation assurance, in conjunction with or in lieu of TBO, will define the avionics implications for coordinating the trajectory, navigating in adherence to the trajectory, management of wake, and the visualization requirements for achieving performance similar to category II/III. Research will address cockpit technologies and procedures for very closely-spaced parallel, triple, and quadruple runway procedures. Development of a second round of tools and network facility capabilities will allow capacity to be expanded and complexity to be managed in high-density environments through means such as 4DT for separation assurance, and performance-based separation standards.

2.5 POLICY ISSUES

The Policy Issues associated with Trajectory and Performance-Based Operations are shown in Figure 2-23 and include four major thrusts. First, it is necessary to address changing roles and responsibilities inherent in NextGen. When the appropriate allocation of functions between automation and humans is determined, policies and mechanisms must be developed and implemented to achieve operator and public acceptance of those new roles and responsibilities and to adapt to outcomes of those decisions. Right-sizing and facility reconfiguration, and workforce development challenges, such as training for new roles and responsibilities, are among the issues associated with changing roles and responsibilities.

Second, policies must be developed and implemented to achieve timely equipage of aircraft and deployment of CNS / ATM with NextGen technologies. This ensures that operator capabilities are synchronized with air traffic system improvements and support a proper balance of avionics and ATM infrastructure that ensures adequate performance and safety, provides cost-effective solutions, and optimizes system wide benefits. These policies may enable the full range of options, from early implementation of capabilities that offer highest-value to users to preferential operating opportunities for NextGen equipped aircraft, relegating non-equipped aircraft to separate airspace, or financial incentives, and mandates for technologies whose primary value is safety and system efficiency rather than individual operator benefits.

Third, a methodology or mechanism must be determined for prioritizing flights in congested operating environments that provides the most efficient use of resources. The outcome of this policy should reflect values stated in the NextGen ConOps and be employable as "rules of the road." These policies need to guide development of automation and decision support tools to ensure the smooth and efficient flow of traffic for NextGen TBO. Regulatory, market-based, and collaborative approaches should be considered.

And fourth, all NextGen trajectory and performance-based capabilities must be harmonized internationally so operational differences in oceanic, U.S., and non-U.S. airspace are transparent to users. This involves the full range of bi- and multilateral (e.g., International Civil Aviation Organization) negotiations with partner nations and around the world. International discussions should address enabling international commercial space operations, including landing rights for U.S. operators at spaceports around the world. Details of each Policy Issue, including their integration with other IWP elements, can be found in Appendix IV as well as on the interactive JPE available at www.jpdo.gov.

Trajectory and Performance-Based Policy Issues	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
PI-0014: Aircraft Equipage Implementation Policy		P 2009																
PI-0005: Public Acceptance of Automation			P 2010															
PI-0006: Balance of Human vs. Automation			P 2010															
PI-0008: General Aviation Benefits			P 2010															
PI-0110: International Commercial Space Operations				P 2011														
PI-0001: Airport Operation Centers (AOC) Equipage Implementation Policy						P 2013												
PI-0004: ATM Automation Development, Performance and Interoperability Standards						P 2013												
PI-0065: Airspace Regulatory Changes - Global Harmonization						P 2013												
PI-0082: Oceanic Airspace Policy						P 2013												
PI-0077: High Density Operations - Flight Prioritization							P 2014											
PI-0002: NextGen Facilities								P 2015										
PI-0007: Rules of the Road											P 2018							

Figure 2-23 Trajectory and Performance-Based Policy Issues Timetable

2.6 SUMMARY - TRAJECTORY AND PERFORMANCE-BASED OPERATIONS AND SUPPORT

NextGen requires a fundamental shift to trajectory and performance-based operations with full situational awareness and integration of weather, safety, security, and environmental information. TBO uses precise 4DTs that are actively managed to optimize an individual flight, as well as the overall operations of the NAS. TBO requires the use of precise and timely surveillance, navigation, and weather information that is distributed and shared over a secure national integrated network. It requires new policies, processes, procedures, standards, and rules to guide TBO functions. TBO will also require the ANSP, the aircraft operator, the airport, and the aircraft to use new and advanced information systems to support active management of flights. PBO incorporate an aircraft's performance capabilities into the management of flights and the air transportation system. NextGen will provide varying levels of service and operating flexibility, depending on the performance capability of the aircraft. Specific operations and airspace will be allocated to aircraft that meet required CNS performance thresholds, enabling increased capacity.

Operational Improvements: To achieve the TBO and PBO concepts defined in the NextGen vision, many OIs must be executed across multiple organizational structures, types of airspace, phases of flight, aircraft types, operating conditions, and locations. OIs must be implemented to support the direct management of flights by the ANSP and the aircraft crew. In addition, OIs will address the support functions performed by the ANSP, the aircraft operator, and many other organizations. To describe this rich diversity, the IWP presents TBO and PBO OIs in the following functional groups:

- **Trajectory Management:** Trajectory Management OIs support the NextGen transformation to the integrated management of aircraft movement on the surface and during all phases of flight, using precise 4DTs in the most efficient, safe, secure, and environmentally responsible manner possible. Trajectory Management OIs describe the evolution from today's processes where controllers guide an aircraft crew along rigidly-defined routes over inefficient and constrained voice communication systems using a multitude of loosely integrated information systems with imprecise position information. From this safe, yet inefficient and capacity-limited system, Trajectory Management OIs describe: the improvements in the surface, arrival/departure, and en route domains; the increasing levels of DSTs introduced for ANSP and aircraft support; the changing roles of humans and automation; and the eventual transformation to highly efficient and flexible operations using advanced and integrated DSTs, and CNS systems.
- **Separation Management:** To achieve the NextGen goals for improved capacity, the separation between aircraft in all airspace environments must be safely reduced and effectively managed for simple as well as complex operations. Separation Management OIs describe the evolution from today's processes where controllers manage aircraft separation using a static set of separation standards and position information from radar-based systems, to future operations where separation is managed with a wide range of standards using precise and timely aircraft position information. Using increasingly sophisticated DSTs and processes, aircraft separations are closely managed and tailored to the unique needs of an aircraft and airspace to achieve the safest minimum separation from hazards such as wake turbulence, terrain, severe weather, as well as other aircraft. As separation capabilities improve, the responsibility for separation is increasingly delegated from the ANSP to properly equipped aircraft to improve efficiency and flexibility.
- **Capacity Management:** The capacity of the national airspace must be actively managed to effectively balance the demands of users with the constraints and operating conditions in all locations. Capacity Management OIs describe the evolution from today's operational models where capacity is managed at a macro level using a limited set of inflexible rules, to a future state where capacity is dynamically adjusted on a micro level with a wide range of rules that safely support demands and constraints with full situational awareness. Starting with OIs that allow for

the improved scheduling and access to special use and terminal airspace, Capacity Management is improved by increasing airspace flexibility and allocation of ANSP resources. Using increasingly sophisticated DSTs, the ANSP is able to adjust airspace configurations and resources to meet the unique needs and environmental conditions for specific locations. From the initial ability to adjust specific configurations, the Capacity Management OIs describe the ability to dynamically adjust airspace configurations and classifications in full collaboration with airports, capable aircraft, and aircraft operators. To provide increased capacity, OIs also define improvements such as flow corridors and advanced SUA management.

- **Flow Contingency Management:** In support of the active airspace management, there will always be a need to modify plans to accommodate special or changing conditions. To optimize the overall flow and capacity of the national airspace, the Flow Contingency Management OIs describe how today's mostly manual processes, using limited DSTs, evolve to highly integrated and collaborative processes, using automated DSTs with full situational awareness. Using increasing levels of collaboration and integration between ANSP, aircraft operators, and aircraft, flights are adjusted to accommodate changing conditions. Initially adjusted and rerouted during pre-flight planning, flight plans and trajectories will eventually be dynamically adjusted during flight, using integrated processes and digital communication between the flight deck and ANSP automation. Rather than TMIs that broadly apply to multiple flights, flight plans will be uniquely tailored to accommodate the needs of each user, yet balanced with the overall demands, capacities, and constraints of the national airspace.

Enablers: TBO and PBO require a comprehensive set of integrated Enablers that support the active management of aircraft. These Enablers include a suite of advanced and integrated ANSP DSTs that support the following functions:

- Surface Management
- Separation Management
- Capacity and Flow Contingency Management
- Aeronautical Information Management
- Virtual Tower
- Separation Management
- Trajectory Management
- Flight Planning
- Wake Management
- Oceanic Operations

TBO and PBO also require core infrastructure Enablers that provide CNS services as defined in their respective functional areas. In coordination with, and supported by, these core infrastructure Enablers, the NextGen ANSP DSTs will provide more flexible, robust, and efficient decision support for all phases of flight. They will provide enhanced functionality, broader integration, and full situational awareness using a secure NCI. TBO and PBO also require aircraft and aircraft operator investments that support distributed separation and trajectory management functions, as well as requirements for safety, security, and environmental management. Aircraft and aircraft operators will need a range of new or enhanced navigation, surveillance, communication and flight management avionics, as well as flight planning and management systems. These new or enhanced DSTs and avionics require coordinated and significant investments, representing one of the greatest challenges to the success of NextGen.

Research and Development Activities: Some of the TBO and PBO concepts require further R&D to guide the overall NextGen effort. Some of the more challenging areas include:

- The integration of safety-critical digital data exchange of information, such as 4DT and flight clearances, into the operational processes and systems used for flight management and control
- Algorithms for dynamic, real-time trajectory management, incorporating conflict management, flow optimization, and incorporation of multiple user preferences

- The allocation of roles and responsibilities between automation and humans, as well as the allocation between controllers and flight crews
- Performance-based separation standards including wake turbulence factors
- Automation-assisted en route flight plan negotiation that accommodates changing conditions, such as weather and non-routine operations
- Aircraft equipment, such as displays and alerting systems, that support independent parallel or converging runway approach procedures
- An integrated simulation and modeling environment for the National Airspace System (NAS) that incorporates elements, such as airport demand and capacity, airspace allocation, aircraft performance capabilities, as well as environmental and safety performance management.

Policy Issues: TBO and PBO are significant changes to the current operations of the air transportation system. To guide and support the development of OIs and Enablers, many policies are needed that establish governance, require standards, define roles and responsibilities, and more. Some of the most difficult, yet important, policies needed in the near term will help to define the "rules of the road" for priority access to airspace and runways, the prioritization of flights in congested airspace, the standardization of equipment, the use of incentives or mandates for equipage, and the optimum configuration of ANSP facilities.

3 Airport Operations and Support

Airports serve as the integrative space between ground and air transportation systems. Airports enable aircraft to arrive and depart in a safe, efficient, and secure manner, while also facilitating the movement of people and cargo, on and off aircraft. As a central link in the air transportation chain of operations, airports are a determining factor in the total capacity of the air transportation system. Accordingly, airports are critical to the overall transformation to the Next Generation Air Transportation System (NextGen) .

Achieving the capacity growth needed to meet future demand for aircraft operations and passenger and cargo movements at airports will be a significant challenge. NextGen seeks substantial improvements in the utilization of existing infrastructure, as well as the development of new infrastructure, at both commercial service and general aviation (GA) airports. NextGen will benefit the passenger, cargo, and GA aircraft operators that use the nation's airports.

Airport Operations and Support functions are aligned to the NextGen Capability to *Provide Flexible Airport Facility and Surface Operations*. In support of this capability, the airport operational improvements (OIs) seek to increase the overall capacity of the airport system through the implementation of transformational concepts that enable the optimum and balanced utilization of airside and landside infrastructure. For airports, achieving NextGen requires coordinated improvements across many domains, including safety, security, environmental, and Air Traffic Management (ATM) elements. As such, the NextGen vision for growth of the airport system incorporates elements for environmental, economic, and regional sustainability.

3.1 INTRODUCTION

This chapter presents the results, timing, and dependencies of work efforts necessary to achieve the NextGen vision for Airport Operations and Support. Airport needs are highly specific to each location and therefore require unique plans for each airport and/or metropolitan area. Rather than defining location specific plans, the IWP focuses on national OIs to develop functional capabilities that can be used as components of an airport specific plan. Follow-on efforts, such as the Federal Aviation Administration's (FAA) Future Airport Capacity Task-2 (FACT-2) Next Steps study will identify congested airports and metropolitan regions that have capacity constraints or need specific OIs. These efforts will identify solution sets and action plans that utilize NextGen capabilities for the purpose of coordinating Federal action with airport operators.

This chapter focuses on airport concepts and initiatives needed to improve airport operations that are distinct from ATM OIs. Advanced ATM procedures and technologies will improve the operational capacity of existing airport runways and the efficiency of surface operations. This includes, for example, performance-based navigation to provide Visual Flight Rules (VFR)-equivalent operations during Instrument Meteorological Conditions (IMC) on closely-spaced parallel runways. On the airport surface, synthetic vision, moving maps, and automated alert and de-confliction systems will provide for safe navigation of aircraft and ground support equipment (GSE) during low-visibility conditions. Additional information on ATM capabilities is provided in Chapter 2.

Unlike other components of the air transportation system that are directly managed by the Federal government, airport decisions are primarily made at the local level. The development or transformation of an airport hinges on the efforts and decisions of the communities and users that it serves. The factors that drive many airport investment decisions are primarily market and user driven, rather than falling under the jurisdiction of the Federal government. Even as airports seek to be responsive to the needs of the aircraft operators and traveling public, these particular users are responding to market factors. Trends and factors that are expected to drive airport development and operations through 2025 and beyond include the following:

- Significant capacity gains can be achieved from maximizing the use of existing infrastructure, increasing the utilization of GA and reliever airports, and implementing new ATM procedures that increase airport efficiency. Additional capacity gains may also be achieved by developing new infrastructure at commercial service and GA airports.
- Some commercial service hub airports that are approaching capacity today may not be able to reasonably expand to support unconstrained demand in aircraft operations or passenger movements. In these cases, the re-development of other existing airports in the congested area may be necessary to augment regional capacity.
- Congestion and the "hassle factor" can drive some passenger choices as to whether to travel on scheduled carriers with connections through large hub airports or seek transportation via 'regional' airports with (scheduled or non-scheduled) nonstop service.
- Small hub, non-hub, and non-primary commercial service and GA airports can expand by promoting higher levels of service to both aircraft operators and passengers. Concurrently, new aircraft technology can allow aircraft operators to efficiently serve these airports with competitive non-stop, long-range flights by medium seating capacity aircraft.
- People and cargo will need to get to and from the airport in a predictable and efficient manner. Therefore, efficient intermodal transportation networks and information systems will be needed to link airports with population and business centers.
- Collaboration among Federal, state, and local agencies is needed to support the effective governance of NextGen airport operations and regional considerations, given the many stakeholders who have vital interests in a successful airport system.

In recognition of these trends, the OIs and Enablers described in the following sections provide available services that can be adopted by airports, as dictated by their needs and missions. The Joint Planning Development Office (JPDO) recognizes that there are no "one size fits all" solutions for airports. For example, the busiest commercial service hub airports may need systems to actively manage ramp operations to reduce congestion. However, a small hub airport is not likely to have sufficient ramp congestion to warrant this investment. Some commercial service hub airports that cannot easily expand their terminal buildings may have a need for off-airport passenger processing capabilities, while other airports will choose to build expansive, flexible terminals. GA and reliever airports may seek facility improvements and instrument approach access that will serve the needs of their GA aircraft operators, including support for the expansion of on-demand air taxi service with very light jets. Following the tradition of airport development in the United States, the actual implementation of these concepts will be done through local decision making in cooperation with the airport operator, users, and neighboring communities, along with support from local, state and Federal governments.

3.2 AIRPORT OPERATIONAL IMPROVEMENTS

The NextGen vision for airports requires the implementation of a broad range of improvements across the airport environment, including the implementation of new technologies, policies, and approaches. To describe these broad transformations, the Airport OIs have been aligned into two functional groups, as shown in summary in Figure 3-1. The OI functional groups are described in the following sections. Full descriptions of each OI, including their integration with other IWP elements, are provided in Appendix I as well as on the interactive Joint Planning Environment (JPE) available at www.jpdo.gov.

Airport Operations Operational Improvements	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
OI-5006: Coordinated Ramp Operations Management							O	2014										
OI-5009: Improved Tactical Management of Airport Operations								O	2015									
OI-5010: Advanced Winter Weather Operations - Level 1								O	2015									
OI-5012: Airport Intermodal Ground Access								O	2015									
OI-5014: Efficient Passenger Flows In Terminal Buildings										O	2017							
OI-5015: Off-Airport Passenger and Baggage Processing										O	2017							
OI-5110: Advanced Winter Weather Operations - Level 2													O	2020				
OI-5008: Advanced Weather Capability for Airside Facilities															O	2022		
OI-5111: Advanced Winter Weather Operations - Level 3																	2025	O

Airport Support Operational Improvements	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
OI-5000: Airport Preservation								O	2015									
OI-5002: Improved Strategic Management of Existing Infrastructure (Airside)													O	2020				
OI-5003: Improved Strategic Management of Existing Infrastructure (Landside)													O	2020				
OI-5004: New Airside Airport Infrastructure																	2025	O
OI-5005: New Landside Airport Infrastructure																	2025	O

Figure 3-1 Airport Operations and Support OI Timetables

3.2.1 Operational Improvements for Airport Operations

Operational elements at airports include both airside and landside components. Airside components include activities on the ramp, apron, taxiways, and runways. Landside components include passenger flows through the security checkpoint to/from the gates, as well as baggage screening/handling and ground transportation. In order to support NextGen, the operation of both airside and landside components must be balanced and enhanced through new technology, management procedures, and programs to optimize the use of airport infrastructure.

Figure 3-2 presents the planned evolution of OIs that support airport operations. As shown in Figure 3-2, these OIs support airside and landside operations. Airside operations will benefit from NextGen technologies. At busy airports, coordination of GSE, de-icing operations, and maintenance activities are needed to enable efficient, secure, and safe surface operations during all-weather conditions and to support high-density aircraft operations. This is a key near-term feature of the timetable, with OI-5006 providing coordinated ramp operations management. Resource management tools are also intended to optimize day-to-day tactical operations such as clearing the airport surface and aircraft deicing during winter weather events. OI-5009 provides improved tactical management of airport operations, while OI-5010 provides the first level of advanced winter weather operations.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Airport Operations Operational Improvements																		
OI-5006: Coordinated Ramp Operations Management							O	2014										
OI-5009: Improved Tactical Management of Airport Operations								O	2015									
OI-5010: Advanced Winter Weather Operations - Level 1								O	2015									
OI-5012: Airport Intermodal Ground Access								O	2015									
OI-5014: Efficient Passenger Flows In Terminal Buildings										O	2017							
OI-5015: Off-Airport Passenger and Baggage Processing										O	2017							
OI-5110: Advanced Winter Weather Operations - Level 2													O	2020				
OI-5008: Advanced Weather Capability for Airside Facilities															O	2022		
OI-5111: Advanced Winter Weather Operations - Level 3																	2025	O

Figure 3-2 Airport Operations OI Timetable

Landside operations will also be improved with NextGen. OI-5014 seeks to provide efficient passenger flows in terminal buildings. This will include new passenger, baggage, and security-screening technologies that help passenger flows inside the terminal building become more efficient and predictable, with a corresponding reduction in time from curb to gate. The trend for passenger check-in at locations outside the airport, such as at home, via mobile phone, and at hotels, will expand as remote terminals support off-airport passenger and baggage processing. OI-5015 supports this trend with advances in off-airport passenger and baggage processing to reduce the need for passenger processing in the terminal building, thus mitigating passenger crowding and delay. OI-5012 seeks to enhance the efficiency of intermodal ground access so that passengers and cargo can get to/from the airport with reasonable trip times and costs.

3.2.2 Operational Improvements for Airport Support

Airport Support functions include many of the activities that are needed to plan for the strategic direction of the airport system; that is, the long-term planning that will enable the national airport system to accommodate substantial increases in aircraft operations, passenger movements, and cargo while maintaining an acceptable level of service.

Figure 3-3 presents the planned evolution of OIs that have airport support functions. These OIs focus on strategic management and new airside and landside infrastructure. To foster long-term sustainability, airports and local governments must collaborate to protect airport and community resources, including consideration of off-airport environmental and community planning issues as well as regional mobility. A diverse network of airports must be preserved throughout the nation in the best interest of an efficient national air transportation system. A key feature of the timetable is the development of programs and policies that are intended to benefit airport preservation, as discussed in OI-5000.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Airport Support Operational Improvements																		
OI-5000: Airport Preservation								O	2015									
OI-5002: Improved Strategic Management of Existing Infrastructure (Airside)													O	2020				
OI-5003: Improved Strategic Management of Existing Infrastructure (Landside)													O	2020				
OI-5004: New Airside Airport Infrastructure																	2025	O
OI-5005: New Landside Airport Infrastructure																	2025	O

Figure 3-3 Airport Support OI Timetable

Comprehensive, integrated, regional airport system planning is also critical to achieving preservation, mobility, and sustainability objectives, as well as building additional airport capacity where needed. At some airports, NextGen technologies alone may provide sufficient new capacity, avoiding the need for land acquisition and/or major construction projects. Airport operators will need to better develop their strategic plans to enhance the utilization of existing infrastructure and to identify necessary capital investments. OI-5002 and OI-5003 incorporate mechanisms to improve the strategic management of existing airside and landside infrastructure, while OI-5004 and OI-5005 provide for the development of new airport infrastructure to boost capacity. With further refinement and development of the supporting Enablers that are discussed in Section 3.3, these OIs will be more fully developed.

3.3 AIRPORT ENABLERS

The transformation of Airport Operations and Support requires the implementation of many Enablers. These Enablers will provide the foundation for the realization of OIs and the overall NextGen vision. Enablers must be researched, developed and implemented in a certain sequence and timing to effectively meet the needs of the OIs they support. Enablers can also support the implementation of other Enablers. To describe these broad needs, the Airport Operations and Support Enablers have been aligned into four functional groups, as shown in summary in Figure 3-4. The Enabler functional groups are described in the following sections. Full descriptions of each Enabler, including their integration with other IWP elements, are provided in Appendix II as well as on the interactive JPE available at www.jpdo.gov.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Airside Operations Enablers																		
EN-5007: Zero or Low-Emissions Ground Support Equipment			E 2010															
EN-5012: Airport Rescue Fire Fighting					E 2012													
EN-5004: Airport GSE Surface Management System						E 2013												
EN-5014: Runway Friction - Ground-Based Sensors and Technology						E 2013												
EN-5008: Ground Congestion Data Feed to Airport Acceptance Rate								E 2015										
EN-5013: Runway Friction - Integrated Condition Reporting								E 2015										
EN-5021: Ground Based Non-Fluid De-Icing Technology								E 2015										
EN-5022: Deicing/Anti-Icing Holdover Time Input to Flight Object								E 2015										
EN-5052: Ramp Lightning Detection and Deflection								E 2015										
EN-5023: Advanced De-Icing/Anti-Icing Fluid Recovery									E 2016									
EN-5024: Water Quality Management									E 2016									
EN-5016: Ice-Resistant Pavement Surfaces											E 2018							
EN-5020: Advanced De-Icing/Anti-Ice Fluids											E 2018							

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Landside Function Enablers																		
EN-5029: Intermodal Ground Transportation Information System						E 2013												
EN-5030: Remote Check-In Processing Systems						E 2013												
EN-5053: Airport Intermodal Ground Access Mobility Systems							E 2014											
EN-5026: Design Guidelines for NextGen Airport Passenger Terminal Buildings								E 2015										

Figure 3-4 Airport Operations and Support Enabler Timetables

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Resource Management Enablers																		
EN-5009: Airside Resource Management System - Level 1						E	2013											
EN-5010: Landside Resource Management System - Level 1						E	2013											
EN-5017: Airport Winter Operations Resource Management System - Level 1						E	2013											
EN-5011: Airport Resource Management System - Level 1							E	2014										
EN-5217: Airport Winter Operations Resource Management System - Level 2											E	2018						
EN-5209: Airside Resource Management System - Level 2													E	2020				
EN-5210: Landside Resource Management System - Level 2													E	2020				
EN-5211: Airport Resource Management System - Level 2													E	2020				

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Airport Advocacy and System Planning Enablers																		
EN-5033: Identification of Constrained Airports and Regions			E	2010														
EN-5041: Regional Planning Processes					E	2012												
EN-5000: Airport Advocacy Program						E	2013											
EN-5001: Airport-Compatible Land Use						E	2013											
EN-5045: Airport Protection Surfaces						E	2013											
EN-5003: Obstruction Measurement and Evaluation Process							E	2014										
EN-5043: Parallel Runway Separation Distance Standards									E	2016								
EN-5047: Airfield Design Standards										E	2017							
EN-5032: Streamlined Airport Development Processes													E	2020				
EN-5035: Post-Implementation Evaluations of Airport Development Actions													E	2020				

Figure 3-4 Airport Operations and Support Enabler Timetables (continued)

3.3.1 Airside Operations Enablers

As described in Section 3.2.1, efficient operations of aircraft and vehicles on the airport surface will be important for maintaining the smooth flow of operations envisioned with NextGen. Given the high numbers of aircraft operations that are projected to occur at the busiest airports in the future, airport ramp areas will become more complex and crowded. NextGen incorporates Enablers to facilitate the orderly flow of GSE and maintain safety on airport ramps. In addition, the active management of ramp operations is needed to mitigate ground congestion during inclement weather events. Weather substantially and frequently impacts airport operations. For example, winter weather impacts runway availability, freezing rain and snow require de-icing of aircraft, lightning halts ramp operations, and low visibility affects the mobility of GSE. However, these impacts can be significantly reduced by integrating weather information directly into decision-making. Therefore, an important objective of airport Enablers is to reduce the impact of weather on airside operations.

Figure 3-5 shows the planned evolution of the Enablers that will support Airside Operations within NextGen. A key feature of the timetable involves surveillance and management of GSE on the airport surface through EN-5004 that provides an airport GSE surface management system. The system is needed to support low-visibility aircraft taxi operations so that pilots will have information on the location and movement of GSE via flight deck situational displays. In addition to helping to avoid collisions and runway incursions, the system may also help GSE with navigation, security, and situational awareness.

Airside Operations Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-5007: Zero or Low-Emissions Ground Support Equipment			E 2010															
EN-5012: Airport Rescue Fire Fighting					E 2012													
EN-5004: Airport GSE Surface Management System						E 2013												
EN-5014: Runway Friction - Ground-Based Sensors and Technology						E 2013												
EN-5008: Ground Congestion Data Feed to Airport Acceptance Rate								E 2015										
EN-5013: Runway Friction - Integrated Condition Reporting								E 2015										
EN-5021: Ground Based Non-Fluid De-Icing Technology								E 2015										
EN-5022: Deicing/Anti-Icing Holdover Time Input to Flight Object								E 2015										
EN-5052: Ramp Lightning Detection and Deflection								E 2015										
EN-5023: Advanced De-Icing/Anti-Icing Fluid Recovery									E 2016									
EN-5024: Water Quality Management									E 2016									
EN-5016: Ice-Resistant Pavement Surfaces											E 2018							
EN-5020: Advanced De-Icing/Anti-Ice Fluids											E 2018							

Figure 3-5 Airside Operations Enabler Timetable

Another key feature of the timetable is the grouping of Enablers that are intended to advance winter operations at airports, including both snow and ice clearing on the airport surface and de-ice/anti-ice treatment of aircraft. Measuring runway friction is an important component of this, as accurate friction information will be needed to support aircraft landing distance calculations during high-density runway operations. The runway friction data is also used by airport operators to define the need to treat the runways for rubber removal or snow/ice accumulation. To this end, EN-5014 provides ground-based sensors and technology that measure and report runway friction information, while EN-5015, discussed in Chapter 2, addresses aircraft-based systems for friction reporting. EN-5013 provides integrated condition reporting of runway friction information to users, depending on which system(s) is/are in use at an airport, at a given time. Both options are included in the IWP, pending evaluation of their viability. Potentially, one or both systems could be used at an airport.

As discussed in Section 2.2.3, surface trajectory management is planned at the busiest airports. During winter weather, specific aircraft de-icing and anti-icing needs will be factored into an aircraft's planned trajectory. For this reason, EN-5022 addresses the integration of operator-determined aircraft holdover times into the Flight Object to facilitate effective management of the departure queue and taxi paths so that holdover times are not exceeded.

Other Enablers, such as EN-5012 that provides airport rescue and fire fighting and EN-5052 that provides ramp lightning detection and deflection, are intended to address challenges in emergency response with the next generation of composite and very large aircraft (such as the Boeing 787 and Airbus A380), and mitigate the duration of ramp closures for safety during thunderstorms.

Achieving the Enablers described in this timetable will require overcoming several challenges:

- Ongoing research has not been able to adequately correlate ground friction measurements with aircraft braking performance.
- Today, many vendors are developing systems for surveillance of GSE. The interoperability of these systems with NextGen and aircraft systems will need to be determined. Understanding the scalability of these systems to track the many GSE vehicles on busy airports also needs to be addressed.

3.3.2 Landside Function Enablers

As described in Section 3.2, more people and cargo will be moving through landside areas at airports, including passenger terminal buildings and ground access to get to and from an airport. Accordingly, Enablers are needed to provide for new terminal building layouts that are conducive to higher passenger flows, as well as providing for efficient connections to intermodal ground transportation modes. Figure 3-6 shows the planned evolution of the Enablers that will support Landside Functions within NextGen.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Landside Function Enablers																		
EN-5029: Intermodal Ground Transportation Information System						E	2013											
EN-5030: Remote Check-In Processing Systems						E	2013											
EN-5053: Airport Intermodal Ground Access Mobility Systems							E	2014										
EN-5026: Design Guidelines for NextGen Airport Passenger Terminal Buildings								E	2015									

Figure 3-6 Landside Function Enabler Timetable

A key feature of the timetable is the incorporation of NextGen technologies into design guidance for airport passenger terminal buildings, as provided in EN-5026. This includes the integration of advanced passenger and baggage processing systems as well as remote check-in capabilities. This Enabler will build from applied research on real-time gate assignments and the optimization of terminal design to facilitate passenger movement between gates and intermodal ground access modes. An important consideration is that not all of these capabilities will be needed at all airports. Remote check-in, for example, is of primary interest in airports with constraints on expanding their terminal facilities and/or located in cities with substantial origin/destination traffic.

Intermodal ground access is another important component of the timetable, since new initiatives are needed so that air services will connect with intermodal transportation, as appropriate, within each regional transportation system in order to provide efficient ground access. Passengers have a variety of options with intermodal ground access transportation, including public rail and bus transit, taxicabs, shuttle services, and even private automobiles. With high quality, readily available information on intermodal ground access that is integrated into their itinerary, as envisioned in EN-5029, passengers will be able to make informed decisions about travel to and from the airport. The development of intermodal transportation systems that connect with airport ground access is also identified in EN-5053 as an important component to support NextGen. Standards and interoperability of remote check-in processing systems are also addressed as part of the timetable.

Achieving the Enablers described in this timetable will require overcoming several challenges:

- Airports are generally prohibited from funding non-aviation, off-airport projects due to concerns over airport revenue diversion. Therefore, new and innovative public finance mechanisms will be needed to fund large-scale intermodal initiatives and infrastructure.
- The initiatives in the timetable are primarily airport operator and industry driven, given the focus on technology integration. Several companies and research teams are currently working on development of comparable systems for intermodal transportation information and remote processing; however, industry leadership, standards, and technology integration have not been fully addressed.

3.3.3 Resource Management Enablers

As aircraft operations and the flow of passengers and cargo grow with NextGen, today's practices of information sharing at airports will need to evolve to support this increased operational demand. With the aid of net-centric infrastructure (NCI) and services, airport resource management systems will assist airport operators in the synthesis of real-time information and the proactive management of resources in anticipation of near-term events, typically in an hourly or daily timeframe. Figure 3-7 shows the planned evolution of the Enablers that will support Resource Management functions for airports within NextGen.

Resource Management Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-5009: Airside Resource Management System - Level 1						E 2013												
EN-5010: Landside Resource Management System - Level 1						E 2013												
EN-5017: Airport Winter Operations Resource Management System - Level 1						E 2013												
EN-5011: Airport Resource Management System - Level 1							E 2014											
EN-5217: Airport Winter Operations Resource Management System - Level 2											E 2018							
EN-5209: Airside Resource Management System - Level 2													E 2020					
EN-5210: Landside Resource Management System - Level 2													E 2020					
EN-5211: Airport Resource Management System - Level 2													E 2020					

Figure 3-7 Resource Management Enabler Timetable

A key feature of the timetable is the incorporation of Enablers specific to both airside and landside functions at the airport. Airside functions include airfield inspections and maintenance, safety procedures, emergency response services, security inspections, winter operational activities, and gate and ramp management. This includes many of the activities that are required under 14 CFR Part 139 certification for airports with scheduled air carrier service. At airports with significant winter operations, the resource management systems will provide guidance for scheduling, prioritization, and active management of de-icing/anti-icing operations for both aircraft and airport movement surfaces during winter weather operations. In consideration of weather information, resources will be aligned with operational demand in order to reduce delays. Landside functions will also benefit, including terminal passenger flows, security screening status, parking, and airport curb status.

Achieving the Enablers described in this timetable will require overcoming several challenges:

- The initiatives in the timetable are primarily industry and airport operator driven, given the focus on technology integration. Several companies and research teams are currently working on development of comparable systems for airport resource management; however, industry leadership, standards, and technology integration have not been fully addressed.

- Airport operators will ultimately determine the success of this timetable, since implementation and use is at the airport level. Airport operators and users will need to understand the benefit of resource management in order to incentivize widespread implementation.

3.3.4 Airport Advocacy and System Planning Enablers

As described in Section 3.2.2, long-term planning is needed to develop the facilities and infrastructure at airports that will be needed to accommodate future demand. NextGen will need to incorporate Enablers so that airport operators have the tools needed to advance their facilities, including mechanisms to further airport advocacy and design standards that incorporate NextGen capabilities. Importantly, many of the challenges in the current airport system will require integrated, regional solutions on a substantially larger scale than is typically done today. Figure 3-8 shows the planned evolution of the Enablers that will support Airport Advocacy and System Planning functions within NextGen.

Airport Advocacy and System Planning Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-5033: Identification of Constrained Airports and Regions			E 2010															
EN-5041: Regional Planning Processes					E 2012													
EN-5000: Airport Advocacy Program						E 2013												
EN-5001: Airport-Compatible Land Use						E 2013												
EN-5045: Airport Protection Surfaces						E 2013												
EN-5003: Obstruction Measurement and Evaluation Process							E 2014											
EN-5043: Parallel Runway Separation Distance Standards									E 2016									
EN-5047: Airfield Design Standards										E 2017								
EN-5032: Streamlined Airport Development Processes													E 2020					
EN-5035: Post-Implementation Evaluations of Airport Development Actions													E 2020					

Figure 3-8 Airport Advocacy and System Planning Enabler Timetable

A key feature of this timetable is guidance to airports on design standards for NextGen. As NextGen requirements evolve and become more detailed, airfield design standards will be revised through EN-5047. For example, new sensors on the airport for weather monitoring or wake turbulence may need specific locations and/or clearance areas, while the removal of certain ground-based NAVAIDS may add flexibility to airport layouts. Parallel runway separation standards are also expected to change, as shown in EN-5043, so that independent aircraft operations can be conducted on parallel runways with less separation than is required today. This enables construction of new runways with potentially less land acquisition, and at airports where runway expansion might not otherwise be possible.

Airport operators will also benefit from an increased emphasis on advocacy and regional planning. Community support for airports is important to the success of NextGen. Recognizing this, EN-5000 seeks to develop tools, best management practices, and policies to facilitate local efforts for airport advocacy, including Federal support for airport preservation and critical capacity projects.

Regional transportation solutions will also be needed to meet the mobility needs of certain congested mega-regions. In NextGen, regional planning will be needed to provide a comprehensive, strategic perspective on the enhancements needed for the airport system to meet regional demand through the identification of priority improvements that are needed to grow the capacity. EN–5041 focuses on enhancing the regional planning process as part of NextGen.

Achieving the Enablers described in this timetable will require overcoming several challenges:

- NextGen is progressing with work on ATM procedures, technologies, and sensors, with requirements that will affect airport design standards. However, many of these requirements will not be defined for several more years. Because major airport infrastructure projects are often complex, multi-year projects with long lead times, the implementation of new design standards at airports may not occur in time to meet NextGen objectives.

- Parallel runway separation standards are a particular need for airports, so that future standards can be incorporated into development decisions that are made in the near-term. Timing of these standards is a critical component to NextGen, given the 10 years that is typically needed to build a new runway. New parallel runway separation standards could change the scope and improve the viability of some airport capacity projects.

- Tools and policies advancing airport advocacy goals involve a complex balancing of intricate local land use regulations with an appropriate federal role.
- Although effective governance and funding for regional transportation solutions is critical to addressing mobility needs, building consensus has been an ongoing challenge.

3.4 RESEARCH AND DEVELOPMENT ACTIVITIES

NextGen will require significant Research and Development (R&D) Activities to guide the implementation requirements and decisions needed for Airport Operations and Support. This section presents the R&D Activities that have been identified as necessary to further the development of the Enabler timetables described in Section 3.3. Detailed information describing each R&D Activity, including their integration with other IWP elements, can be found in Appendix III as well as on the interactive JPE available at www.jpdo.gov.

Figure 3-9 shows the planned evolution of the R&D Activities needed to support NextGen airport Enablers. Key themes of the R&D Activities include travel mode choice in congested mega-regions, information standards to promote information dissemination, and solutions for better integrating airports into regional transportation systems. Another key R&D Activity seeks to guide passenger terminal design in recognition of the high numbers of passengers that are expected to use airports in the future, so that landside congestion does not impede operational growth. Finally, the potential viability and benefits of dynamic, real-time gate management will be evaluated for consideration by stakeholders.

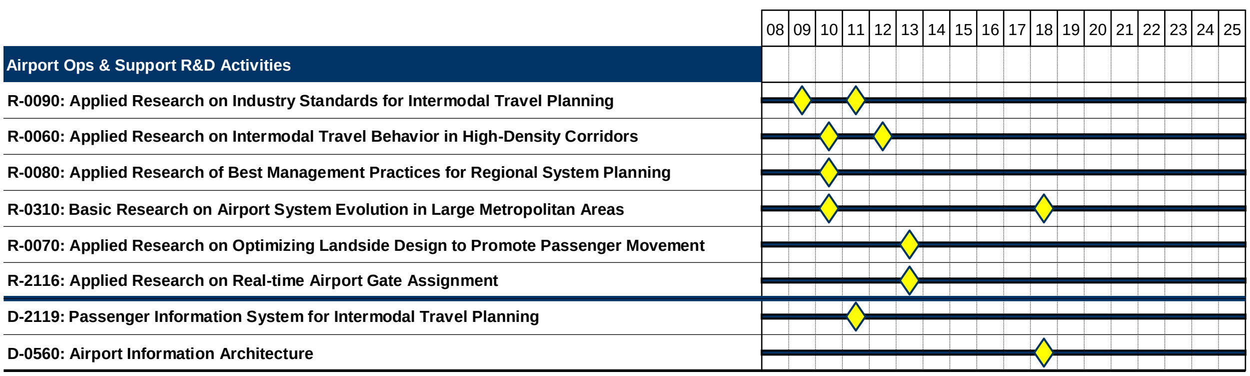


Figure 3-9 Airport Operations and Support R&D Activity Timetable

Many of the airport R&D Activities are being conducted under the Transportation Research Board's (TRB) Airport Cooperative Research Program (ACRP), which is funded by an annual appropriation from the FAA's Airport Improvement Program. Additional information on ACRP research activities, including research updates, is available at http://trb.org/CRP/ACRP/ACRP.asp. Similarly, NASA's AirPortal program is conducting airport research that is aligned with the NextGen ConOps.

As NextGen moves forward, several challenges will exist in the identified research activities:

- The scope of future R&D Activities must be evaluated so that the research direction and findings will be applicable to NextGen needs.
- R&D Activity sponsorship that is not undertaken by ACRP or NASA will need to be identified.
- Substantial airport research is undertaken by ACRP, the AirPortal program, National Center of Excellence for Aviation Operations Research (NEXTOR), and other groups that will be applicable to NextGen. As research results become available, a systematic method is needed to integrate these results into the Enabler timetables.

3.5 POLICY ISSUES

Many of the Airport OIs and Enablers will require a strategic decision and/or resolution of certain Policy Issues. Following research and evaluation, policy decisions will be needed to help shape, guide, and support the realization of the NextGen vision. This section describes the current Policy Issues relevant to airports. These are presented as options requiring further evaluation and research, with follow-up consideration by the Senior Policy Council (SPC) for strategic issues and by various JPDO stakeholders for tactical issues. Figure 3-10 shows the planned evolution of the Policy Issues that will support NextGen airport Enablers. Further information concerning specific Policy Issues, including their integration with other IWP elements, can be found in Appendix IV as well as on the interactive JPE available at www.jpdo.gov.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Airport Ops & Support Policy Issues																		
PI-0044: Airport Land Banking				P 2011														
PI-0045: Airport Ground Transportation Access				P 2011														
PI-0038: Small-Hub, Non-Hub, Non-Primary, General Aviation and Reliever Airport Finance					P 2012													
PI-0039: Hazards to Air Navigation Enforcement Policy					P 2012													
PI-0046: Role of the Federal Government in Airport Capacity Enhancements					P 2012													
PI-0047: Role of Federal Government in Conversion of Former Military Air Bases to Civil Aviation					P 2012													
PI-0048: Airport Preservation					P 2012													
PI-0097: Airport Emergency Response					P 2012													
PI-0036: Airport Advocacy Program						P 2013												
PI-0037: Airport-Compatible Land Use						P 2013												
PI-0069: Congestion Management Program						P 2013												

Figure 3-10 Airport Operations and Support Policy Issues Timetable

A fundamental Policy Issue is to determine if the Federal government's current limited role in airport capacity decisions is sufficient to provide the long-term capacity necessary for the efficient operation of the national aviation system. NextGen needs to ensure that increases in airspace capacity will be matched by a comparable increase in airport system capacity. Published in May 2007, the FAA's FACT 2 study indicates that 14 airports and eight metropolitan regions are likely to be capacity constrained in 2025, even with planned NextGen ATM improvements. Today, a decision to build a new airport or expand an existing one is primarily a local decision. Although the law under 49 USC 40104(c) directs the FAA to "encourage" the construction of airport capacity enhancement projects at congested airports, any action beyond the FAA's current activities, including airport advocacy, may be controversial. Accordingly, PI-0046 examines policy options to augment the role of the Federal government in enhancing airport capacity.

In addition to expansion of airport capacity, the preservation of existing airport capabilities is important to the success of NextGen. To do this, PI-0036 and PI-0048 explore policy options for developing a robust Federal airport advocacy and sponsorship program aimed at helping airport operators, local government, businesses, users, and the community to understand the importance of long-term airport preservation and capacity enhancement. Similarly, PI-0047 researches policy options that would allow the Federal government to have a more active role in utilizing closed or existing military bases to expand airport capacity, where needed. Policy issues on land use and enforcement of obstacle standards complement this effort, as discussed in PI-0037 and PI-0039.

As NextGen moves forward, several challenges exist in the identified policy research:

- While there is substantial interest in airport advocacy and preservation, substantial research and analysis will be needed to identify effective policy options.
- Given concerns over airport revenue diversion, non-aviation funding sources will need to be identified if substantial improvements to intermodal infrastructure are to be made.
- While the FAA has been progressing with national level planning to identify solution sets specific to airports for further coordinating action, identifying effective policy options to augment the FAA's role in encouraging airport sponsors and communities to build new capacity could be complex.

3.6 SUMMARY - AIRPORT OPERATIONS AND SUPPORT

Innovative, capacity-enhancing solutions are needed to manage expected increases in aircraft operations, passenger flow, and cargo movements. NextGen seeks to increase the overall airport capacity through transformational concepts that enable the optimum and balanced utilization of runways, ramps/aprons, gates, and passenger terminal buildings. The Airport Operations and Support functional area addresses the complex factors affecting airport functions not directly involved with ATM.

Operational Improvements: NextGen advancements will seek to optimize the use of existing facilities and achieve the best possible throughput of aircraft, passengers, and cargo. For example, new airport facilities will be developed using NextGen design standards for runway layout. Airside operations will be improved through better coordination of ramp operations, use of advanced winter weather capabilities such as coordinated deicing activities, and improved situational awareness of airport demand/capacity and operational issues. Landside operations will be improved, as applicable to the needs of specific airports, through more efficient passenger flow management, expanded and coordinated intermodal ground transportation access, and off-airport passenger and baggage processing.

Challenges: While work is progressing on NextGen ATM procedures and sensors that will benefit airports, detailed requirements and follow-on airport design standards will not be available for several more years. Because major airport infrastructure projects are often complex, multi-year projects with long lead times, the publication of new design standards for airports may not occur in time to meet NextGen objectives. This could delay airport development projects and/or result in new facilities that are not optimized for use with NextGen. Parallel runway separation standards are a specific example of this risk. New parallel runway separation standards could change the scope and improve the viability of some airport runway projects. However, given the 10 years that are typically needed to build a new runway, projects that are currently in planning and design today, with commissioning during the next decade, will be built to legacy standards. Airports cannot begin to integrate NextGen capabilities into their future infrastructure plans without guidance on new design standards. Mechanisms to manage this risk in timing need to be considered and integrated into NextGen.

Many of the airport initiatives described in this chapter are primarily industry and airport operator driven, given the focus on technology integration. Several companies and research teams are currently working on development of comparable systems for airport surveillance, information dissemination, and resource management; however, industry leadership, standards, and technology integration have not been fully addressed.

Enablers: Airside and landside operations must be balanced and enhanced through new technology, management procedures, and programs to optimize airport capacity. Surveillance of airport vehicles will be integrated into NextGen capabilities, so that pilots and ground crews have situational awareness of the airport surface during low-visibility conditions. This will improve safety and reduce runway incursions, a critical need as more aircraft and ground vehicles operate on the airport surface. Because inclement weather can substantially impact surface operations, the resource systems used by airports, the ANSP and aircraft operators will integrate weather information directly into decision-making. Airports will be able to better respond to lightning that can stop ramp operations, as well as proactively manage winter operations at airports for clearing snow from runways and deicing aircraft. NextGen will also collaborate with airports and industry to integrate remote check-in systems, intermodal transportation information systems, and advanced terminal designs to improve the overall passenger experience and reduce landside congestion.

Research and Development Activities: To guide the most effective use of airports, research is needed on travel patterns and modal choice in congested metropolitan areas, effective techniques for real-time gate management, optimized passenger movement patterns within terminals, and use of information systems for optimum airport resource management.

Policy Issues: Airports require effective collaboration of local, state, and Federal governments, as well as private organizations. Policies are needed that provide for the effective governance and collaboration among these varied interests as NextGen becomes a reality for the airport system. Near-term policy challenges include evaluating options for enhancing the federal role in airport preservation and capacity enhancements. Advocacy is envisioned as an important element to this, so that airport operators have the tools, resources, and Federal support necessary to help local governments, businesses, users, and communities understand the importance of long-term airport sustainability and capacity enhancement.

4 Weather Information Services

The primary role of the Next Generation Air Transportation System's (NextGen) Weather Information Services is to provide all Air Navigation Service Providers (ANSPs) and aviation users with a common weather picture for integration into automated and human air traffic decision making, enabling the safe, timely, and efficient operation of the air transportation system. Weather Information Services strategically aligns to the NextGen Capability to *Provide Effective Information Sharing Environment*. Weather Information Services supports this capability by providing timely and accurate weather information in a distributed and coordinated environment through trusted aviation stakeholder partnerships using data policies and standards. This major paradigm change to information sharing means weather is no longer just an end product viewed in a stand-alone display, requiring cognitive interpretation and impact assessment, and having little ability to significantly impact weather-related delays. Instead, weather information is designed to integrate with and support NextGen decision-oriented automation capabilities and human decision-making processes.

The Operational Improvements (OIs), Enablers, Research & Development (R&D) Activities, and Policy Issues within this chapter reflect the collaborative planning of all Joint Planning Development Office (JPDO) Partners to achieve the NextGen Weather Information Services vision. Figure 4-1 describes the multi-agency approach to transforming today's diverse weather systems into unified Weather Information Services with direct integration of common weather information into decision support tools (DSTs).

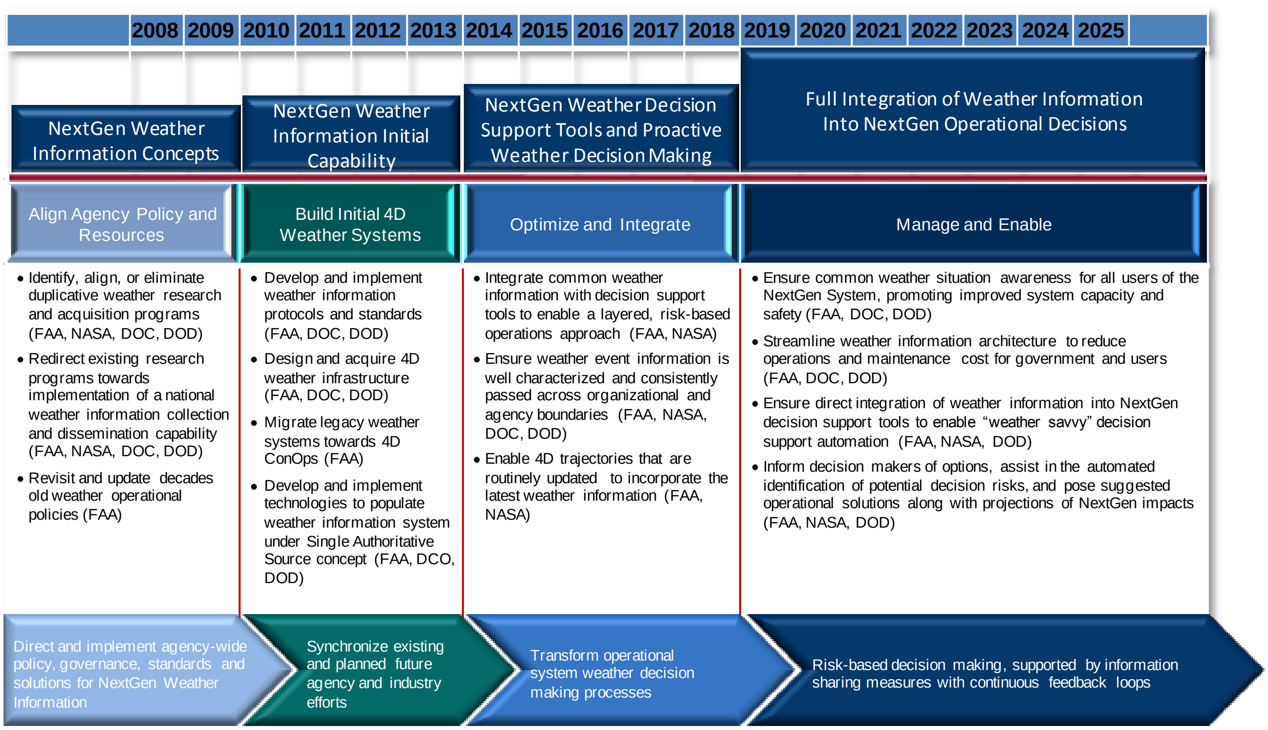


Figure 4-1 Weather Information Services High-Level Timetable

4.1 INTRODUCTION

This chapter presents the results, timing, and dependencies of work efforts necessary to achieve the NextGen vision for Weather Information Services. Today, aviation weather information is drawn from numerous competing and conflicting products provided by government and commercial service providers. These multiple sources require users to cognitively interpret weather in order to determine its impact, leading to inefficient collaboration and delayed and reactive decisions. The NextGen vision is for a "common weather picture" for all stakeholders, with standardized tools to interpret the impact of weather on air transportation operations.

Figure 4-2 details NextGen Weather Information Services, showing how observational data from a variety of sources, along with forecast data from a variety of processes, is compiled, via network-enabled operations, into a 4D Weather Cube. From within this cube, these numerous sources are arbitrated and fused into a Single Authoritative Source (SAS) of weather information used in joint government/user NextGen decision-making processes. This SAS provides the consistent and continuous "common weather picture" that is distributed to all stakeholders through the NextGen net-enabled "virtual" 4D Weather Cube.

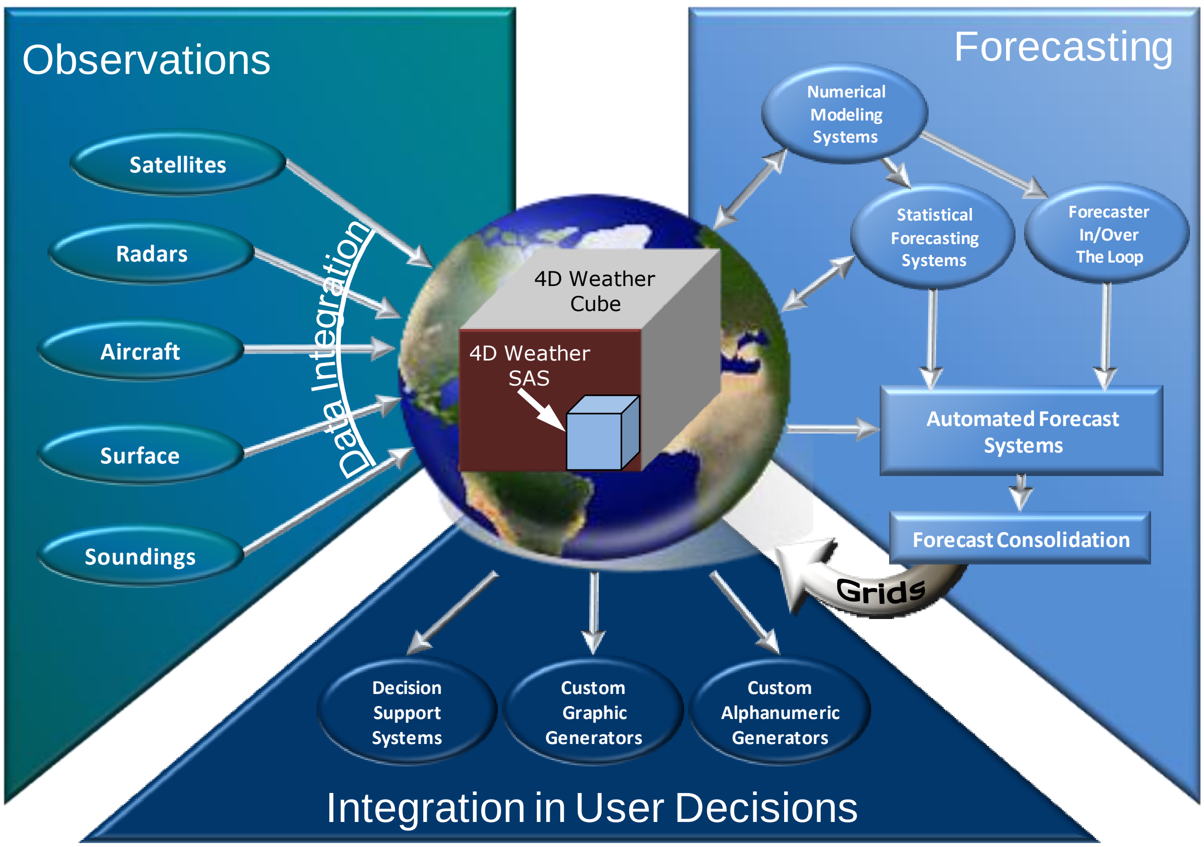


Figure 4-2 4D Weather Information Services

To eliminate the need for stakeholders to individually interpret and manually integrate weather into their decisions, and to set the stage for more collaborative decision making, weather information, in the form of observed or forecasted meteorological variables (e.g., storm intensity, echo tops), must be translated into information that is directly relevant to NextGen users and service providers. This includes information such as the likelihood of a flight deviation, airspace permeability, and capacity. This translation is done outside the 4D Weather Cube by Air Traffic Management (ATM) automation systems, using standardized translation algorithms. The update frequency of NextGen weather information is commensurate with the needs dictated by operational requirements and capabilities. Additionally, the 4D Weather Cube allows rapid automation-to-automation notification of changing weather situations to NextGen decision makers. As with enhanced communication of weather information to ground-based automation systems and human users, weather data communications to the flight deck involves both “publish/subscribe” and "broadcast" dissemination of information. Aircraft may request or subscribe to receive specific weather information impacting their flight. Area weather advisories and warnings are also broadcast to all impacted aircraft whenever potentially hazardous conditions occur.

Under NextGen, network-enabled aircraft also become active participants in collection and transmission of weather information. Airborne observations are transmitted to ground-based systems for integration with other weather sources and to other nearby aircraft to alert them of hazardous conditions (e.g., turbulence, microbursts). Unmanned Aircraft Systems (UASs) are also used for making in-situ observations, performing weather reconnaissance missions such as scouting for favorable routes and collecting critical observations where and when needed.

In summary, this NextGen weather capability is integral to achieving NextGen’s vision, goals, and objectives. Achieving these objectives will significantly reduce weather delays, thus saving operators billions of dollars, reducing passenger inconvenience, and lowering the environmental footprint of aviation. The common weather picture, enabled by the SAS capability, facilitates achieving these objectives through improved shared situational awareness. Direct integration of this common weather picture into users' weather-savvy DSTs ensures NextGen decision makers understand the full range of options for dealing with anticipated and unanticipated adverse weather; assists in identifying potential risks; and offers suggested strategies and actions that minimize disruptions to air transportation users.

4.2 WEATHER INFORMATION SERVICES OPERATIONAL IMPROVEMENTS

NextGen poses a new way of looking at the role of weather information. The focus is no longer on the weather as a standalone product, but rather as an enabler of improved ATM decisions. The weather OIs fostered by this new concept support:

- Seamless integration of weather information into ATM operations
- Collaboration via a common, shared, probabilistic weather picture
- Multi-organizational weather information sharing through net-centric operations.

This combination better informs decision makers of options, assists in the identification of potential risks, and offers suggested operational solutions along with projections of airspace impacts. This streamlined operational architecture for information access also reduces operations and maintenance costs for both the government and users. Today’s complex maze of point-to-point interfaces will be a thing of the past. The transformation to the NextGen vision for Weather Information Services requires the implementation of weather-specific OIs presented in Figure 4-3. It also requires the implementation of domain specific OIs that incorporate weather into operational changes as described in other Integrated Work Plan (IWP) chapters.

Weather Information Services Operational Improvements	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
OI-2010: Net-Enabled Common Weather Information Infrastructure						O 2013												
OI-2020: Net-Enabled Common Weather Information - Level 1 Initial Capability						O 2013												
OI-2021: Net-Enabled Common Weather Information - Level 2 Adaptive Control/Enhanced Forecast											O 2018							
OI-2022: Net-Enabled Common Weather Information - Level 3 Full NextGen															O 2022			

Figure 4-3 Weather Information Services OI Timetable

The weather-specific OIs begin in 2013 with OI-2010 that provides the net-enabled common weather information infrastructure needed to foster the concepts of collaboration, integration, and data sharing. The 4D Weather Cube is developed and implemented in three levels as described in OI-2020, OI-2021, and OI-2022. These three time-phased levels are synchronized with the NextGen capabilities they support. Level 1 is considered "initial"; Level 2 is "intermediate"; and Level 3 is considered "fully operational." In Level 1 and Level 2, weather information will be increasingly accessed by net-centric means, but legacy point-to-point access will remain available. As NextGen spirals towards increased capability and net-centric services, legacy applications will transition to network-based operations, and new applications will be built to use net-centric data. When Level 3 is achieved, point-to-point communications functionality and infrastructures will complete the migration to net-centric constructs.

These OIs support a wide range of NextGen OIs requiring the integration of weather information and are in turn supported by weather Enablers providing prerequisite weather observation, forecast, dissemination, and integration components. Spiral development will be used to increase forecasting and sensing capabilities based upon prioritized user needs and available funding. Level 1 weather information includes both very high-priority weather parameters, as well as those that are easy to transition to a data-tagged net-centric environment. Level 2 and 3 capabilities will include additional weather parameters, increased forecast area coverage, and additional long-term forecasts. They will also provide increased accuracy, resolution, and refresh rates as required to meet NextGen's transitional and end-state needs.

There are numerous challenges and issues that must be addressed to bring this vision into fruition:

- The system must be researched, designed, built, tested, and operated by multiple partner agencies
- Operational guidance and policies (that have yet to be fully defined) for airman and ANSPs must be updated to address the new net-centric SAS paradigm
- Operational systems must transform to accept information from Weather Information Services
- Requirements for new systems must be defined by multiple integrated organizations and modeled to determine measurable benefit.

Detailed information for each Weather Information Services OI, including their integration with other IWP elements, can be found in Appendix I, as well as on the interactive Joint Planning Environment (JPE) available at www.jpdo.gov.

4.3 WEATHER INFORMATION SERVICES ENABLERS

The transformation of Weather Information Services requires the implementation of many Enablers. These Enablers will provide the foundation for the realization of OIs and the overall NextGen vision. Enablers must be researched, developed, and implemented according to a particular sequence and schedule to effectively meet the needs of the OIs they support. Enablers also can support the implementation of other Enablers. The weather information provided by these Enablers must also be translated into impact by DSTs that support service provider and aircraft operator needs. To more specifically define the Enablers that support Weather Information Services, they have been aligned into five functional groups as summarized in Figure 4-4. Full descriptions of Weather Information Services Enablers, including their integration with other IWP elements, are provided in Appendix II as well as on the interactive JPE available at www.jpdo.gov.

Similar to the Weather Information Services OIs, many Enablers have three time-phased levels synchronized with the NextGen capabilities they support. Level 1 is considered "initial"; Level 2 is "intermediate"; and Level 3 is considered "fully operational." In Level 1 and Level 2, weather information will be increasingly accessed by net-centric means, but legacy point-to-point access will remain available. As NextGen spirals towards increased capability and net-centric services, legacy applications will transition to network based operations, and new applications will be built to use net-centric data. When Level 3 is achieved, point-to-point communications functionality and infrastructures will complete the migration to net-centric constructs. The central elements of these Enabler timetables are the 4D Weather Cube Enablers, as provided by EN-2010, EN-2020, and EN-2030 within the Weather Information and Dissemination functional group. These three levels of the 4D Weather Cube are planned for initial availability in 2013, 2018, and 2022 respectively.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Governance and Standards Enablers																		
EN-2040: NextGen Net-Enabled Virtual 4D Weather Cube Governance Structure		E 2009																
EN-2700: Weather Information Regulatory Structure		E 2009																
EN-2710: NextGen Net-Enabled Virtual Four-Dimensional (4D) Weather Cube Governance Model		E 2009																
	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Weather Observation Enablers																		
EN-2210: Network-Enabled Weather Observation Strategy		E 2009																
EN-2270: Integrated Observation Governance Structure			E 2010															
EN-2220: Network-Enabled Weather Observation System - Ground-Based Level 1					E 2012													
EN-2230: Network-Enabled Weather Observation System - Airborne Level 1 - Major Carriers					E 2012													
EN-2240: Network-Enabled Weather Observation System - Satellites Level 1					E 2012													
EN-2260: Network-Enabled Weather Observation System - Integrated Level 1					E 2012													
EN-2250: Network-Enabled Weather Observation System - Adaptive Control								E 2015										
EN-2221: Network-Enabled Weather Observation System - Ground-Based Level 2									E 2016									
EN-2231: Network-Enabled Weather Observation System - Airborne Level 2 - High-End Aircraft									E 2016									
EN-2241: Network-Enabled Weather Observation System - Satellites Level 2									E 2016									
EN-2261: Network-Enabled Weather Observation System - Integrated Level 2									E 2016									
EN-2222: Network-Enabled Weather Observation System - Ground-Based Level 3													E 2020					
EN-2232: Network-Enabled Weather Observation System - Airborne Level 3 - UAS													E 2020					
EN-2242: Network-Enabled Weather Observation System - Satellites Level 3													E 2020					
EN-2262: Network-Enabled Weather Observation System - Integrated Level 3													E 2020					
	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Weather Information and Dissemination Enablers																		
EN-2080: Network-Enabled User-Defined Weather Information Request Function			E 2010															
EN-1273: NextGen Weather Information Services - FAA Group 1				E 2011														
EN-2680: Methodologies and Algorithms for Weather Assimilation into Decision-Making - Level 1				E 2011														
EN-2010: NextGen 4D Weather Cube Information - Level 1 Initial Operating Capability						E 2013												
EN-2060: Legacy Weather Applications Integrated with Network-enabled Weather Information						E 2013												
EN-2681: Methodologies and Algorithms for Weather Assimilation into Decision-Making - Level 2										E 2017								
EN-2020: NextGen 4D Weather Cube Information - Level 2 Adaptive Control/Enhanced Forecasts											E 2018							
EN-2070: Aircraft Systems - Aircraft-Aircraft Hazardous Weather Information Sharing												E 2019						
EN-2682: Methodologies and Algorithms for Weather Assimilation into Decision-Making - Level 3														E 2021				
EN-2030: NextGen 4D Weather Cube Information - Level 3 Full NextGen															E 2022			

Figure 4-4 Weather Information Services Enabler Timetables

Weather Forecasting Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-2410: Weather Forecasts - Consolidated Convective Storm - Level 1					E 2012													
EN-2420: Weather Forecasts - Consolidated Icing - Level 1					E 2012													
EN-2430: Weather Forecasts - Consolidated Turbulence - Level 1					E 2012													
EN-2440: Weather Forecasts - Consolidated Ceiling and Visibility - Level 1					E 2012													
EN-2470: Weather Information - Wake Vortex - Level 1					E 2012													
EN-2520: Weather Forecasts - Consolidated Winter Storm - Level 1					E 2012													
EN-2500: Improve Weather Models - Level 1						E 2013												
EN-2411: Weather Forecasts - Consolidated Convective Storm - Level 2									E 2016									
EN-2421: Weather Forecasts - Consolidated Icing - Level 2									E 2016									
EN-2431: Weather Forecasts - Consolidated Turbulence - Level 2									E 2016									
EN-2441: Weather Forecasts - Consolidated Ceiling and Visibility - Level 2									E 2016									
EN-2451: Weather Forecasts - Volcanic Ash - Level 2									E 2016									
EN-2461: Weather Forecasts - Environment - Level 2									E 2016									
EN-2471: Weather Information - Wake Vortex - Level 2									E 2016									
EN-2481: Weather Forecasts - Space - Level 2									E 2016									
EN-2521: Weather Forecasts - Consolidated Winter Storm - Level 2									E 2016									
EN-2501: Improve Weather Models - Level 2										E 2017								
EN-2412: Weather Forecasts - Consolidated Convective Storm - Level 3													E 2020					
EN-2422: Weather Forecasts - Consolidated Icing - Level 3													E 2020					
EN-2432: Weather Forecasts - Consolidated Turbulence - Level 3													E 2020					
EN-2442: Weather Forecasts - Consolidated Ceiling and Visibility - Level 3													E 2020					
EN-2452: Weather Forecasts - Volcanic Ash - Level 3													E 2020					
EN-2462: Weather Forecasts - Environment - Level 3													E 2020					
EN-2472: Weather Information - Wake Vortex - Level 3													E 2020					
EN-2482: Weather Forecasts - Space - Level 3													E 2020					
EN-2522: Weather Forecasts - Consolidated Winter Storm - Level 3													E 2020					

Figure 4-4 Weather Information Services Enabler Timetables (continued)

4.3.1 Governance and Standards Enablers

The operational use of NextGen common weather information will require a transformation of the weather governance and standards currently in place. For example, weather standards must transform from a focus on products to a focus on information. As these standards transform, NextGen Weather Information Services must be capable of taking observation and forecast information and transforming it into today's regulatory weather products such as METARs, AIRMETS, and SIGMETS.

Figure 4-5 shows the planned evolution of the Enablers that will support weather governance and standards needed with NextGen. Over the next few years, these governance and standards Enablers will create the structure needed to build the NextGen Weather Information Services. These transformational Enablers are EN-2710 that establishes the 4D Weather Cube governance model, EN-2040 that uses this model to establish the governance structure for the 4D Weather Cube, and EN-2700 that establishes the regulatory structure for weather information. Efforts are currently underway by JPDO Partners to plan for and implement these transformational Enablers. NextGen information sharing and data standards are discussed in Chapter 8, including EN-2050 that provides weather information standards.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Governance and Standards Enablers																		
EN-2040: NextGen Net-Enabled Virtual 4D Weather Cube Governance Structure		E	2009															
EN-2700: Weather Information Regulatory Structure		E	2009															
EN-2710: NextGen Net-Enabled Virtual Four-Dimensional (4D) Weather Cube Governance Model		E	2009															

Figure 4-5 Governance and Standards Enabler Timetable

Challenges must be addressed for these Enablers to become a reality. The first challenge is identifying the roles and responsibilities of the partner agencies and industry in fielding a system that will ensure access to data by all the partner agencies and non-government participants. Equally important is ensuring that industry has opportunities to provide weather information to system users. Finally, transforming how weather information, rather than products, is assimilated into air traffic operations must be expedited so that the initial 4D Weather Cube of EN-2010 can be implemented by the target date of 2013.

4.3.2 Weather Observation Enablers

NextGen Weather Information Services includes the transition of the currently disjointed, point-to-point weather observation system to an integrated net-centric operational environment of surface, airborne, and satellite observation systems. This will lower communications costs and increase the use of weather information. Figure 4-6 shows the planned evolution of the Enablers that will provide this integrated weather observation capability needed for NextGen.

In the next five to seven years, the focus will be on net-enabling and integrating the current observation systems to make them available to users via the 4D Weather Cube. Guiding this transformation is EN-2210 that provides the overall strategy for network-enabled weather observation, and EN-2270 that provides an integrated governance structure for weather observations. The first level of enhanced and network-enabled weather observations is planned for 2012 and includes: EN-2220 that supports ground-based observations; EN-2230 that supports airborne observations from major commercial carriers; EN-2240 that supports satellite observations; and EN-2260 that supports the integration of these various sources. Second and third levels of these observation Enablers are planned for 2016 and 2020.

Fielding this net-centric observation system has many challenges. In the near-term, determining the most efficient and effective process to transform from point-to-point communications to a network-enabled observation system is vital to successfully achieving initial availability. It will be important to determine which elements of the current observation system should be retained and which elements should be enhanced with net-centric capabilities. Research must also be accomplished to determine how the system will analyze and assimilate inputs from the multiple sensors needed to develop the SAS of current conditions. In the mid- to long-term, the operation and control of integrated sensor systems by partner agencies and industry will require further discussion. Lastly, multi-agency perspectives must be used to develop answers for questions such as how sensors are retained or retired, what new sensors are needed, and how those new sensors are fielded.

Weather Observation Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-2210: Network-Enabled Weather Observation Strategy		E 2009																
EN-2270: Integrated Observation Governance Structure			E 2010															
EN-2220: Network-Enabled Weather Observation System - Ground-Based Level 1					E 2012													
EN-2230: Network-Enabled Weather Observation System - Airborne Level 1 - Major Carriers					E 2012													
EN-2240: Network-Enabled Weather Observation System - Satellites Level 1					E 2012													
EN-2260: Network-Enabled Weather Observation System - Integrated Level 1					E 2012													
EN-2250: Network-Enabled Weather Observation System - Adaptive Control								E 2015										
EN-2221: Network-Enabled Weather Observation System - Ground-Based Level 2									E 2016									
EN-2231: Network-Enabled Weather Observation System - Airborne Level 2 - High-End Aircraft									E 2016									
EN-2241: Network-Enabled Weather Observation System - Satellites Level 2									E 2016									
EN-2261: Network-Enabled Weather Observation System - Integrated Level 2									E 2016									
EN-2222: Network-Enabled Weather Observation System - Ground-Based Level 3													E 2020					
EN-2232: Network-Enabled Weather Observation System - Airborne Level 3 - UAS													E 2020					
EN-2242: Network-Enabled Weather Observation System - Satellites Level 3													E 2020					
EN-2262: Network-Enabled Weather Observation System - Integrated Level 3													E 2020					

Figure 4-6 Weather Observation Enabler Timetable

4.3.3 Weather Forecasting Enablers

Developing accurate, consistent, and timely forecasts is one of the most challenging aspects of Weather Information Services. NextGen operations will require a transition from the current, fragmented forecasting environment with numerous competing and conflicting forecast products, to a net-centric system, providing a common weather picture that meets the needs of NextGen users. This transition will allow NextGen Partners to better focus their weather forecasting research and available resources.

Figure 4-7 shows the planned evolution of the Enablers that will provide the consolidated weather forecasts needed for NextGen. When integrated with DSTs, the forecasts resulting from this timetable will enable improved air traffic decision making and collaboration.

Deterministic and probabilistic weather forecast information is developed and incorporated into the three levels of the 4D Weather Cube as provided by three sets of weather forecasting Enablers. The first set of Level 1 forecast Enablers includes EN-2410 that provides consolidated convective storm forecasts, EN-2520 that provides consolidated winter storm forecasts, EN-2420 that provides consolidated icing forecasts, EN-2430 that provides consolidated turbulence forecasts, EN-2440 that provides consolidated ceiling and visibility forecasts, and EN-2470 that provides wake vortex forecasts. These Level 1 forecasts are planned for 2012. Level 2 and 3 forecasts are planned for 2016 and 2020, respectively, to allow time for certification and implementation prior to the planned availability dates for the 4D Weather Cube. To support the development of these forecast Enablers, improved weather models, provided by EN-2500 and EN-2501, will include the development of enhanced algorithms and techniques for developing consolidated probabilistic forecasts.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Weather Forecasting Enablers																		
EN-2410: Weather Forecasts - Consolidated Convective Storm - Level 1					E	2012												
EN-2420: Weather Forecasts - Consolidated Icing - Level 1					E	2012												
EN-2430: Weather Forecasts - Consolidated Turbulence - Level 1					E	2012												
EN-2440: Weather Forecasts - Consolidated Ceiling and Visibility - Level 1					E	2012												
EN-2470: Weather Information - Wake Vortex - Level 1					E	2012												
EN-2520: Weather Forecasts - Consolidated Winter Storm - Level 1					E	2012												
EN-2500: Improve Weather Models - Level 1						E	2013											
EN-2411: Weather Forecasts - Consolidated Convective Storm - Level 2									E	2016								
EN-2421: Weather Forecasts - Consolidated Icing - Level 2									E	2016								
EN-2431: Weather Forecasts - Consolidated Turbulence - Level 2									E	2016								
EN-2441: Weather Forecasts - Consolidated Ceiling and Visibility - Level 2									E	2016								
EN-2451: Weather Forecasts - Volcanic Ash - Level 2									E	2016								
EN-2461: Weather Forecasts - Environment - Level 2									E	2016								
EN-2471: Weather Information - Wake Vortex - Level 2									E	2016								
EN-2481: Weather Forecasts - Space - Level 2									E	2016								
EN-2521: Weather Forecasts - Consolidated Winter Storm - Level 2									E	2016								
EN-2501: Improve Weather Models - Level 2										E	2017							
EN-2412: Weather Forecasts - Consolidated Convective Storm - Level 3													E	2020				
EN-2422: Weather Forecasts - Consolidated Icing - Level 3													E	2020				
EN-2432: Weather Forecasts - Consolidated Turbulence - Level 3													E	2020				
EN-2442: Weather Forecasts - Consolidated Ceiling and Visibility - Level 3													E	2020				
EN-2452: Weather Forecasts - Volcanic Ash - Level 3													E	2020				
EN-2462: Weather Forecasts - Environment - Level 3													E	2020				
EN-2472: Weather Information - Wake Vortex - Level 3													E	2020				
EN-2482: Weather Forecasts - Space - Level 3													E	2020				
EN-2522: Weather Forecasts - Consolidated Winter Storm - Level 3													E	2020				

Figure 4-7 Weather Forecasting Enabler Timetable

It should be noted that volcanic ash, environment, and space information forecasts are only provided in Level 2 and 3 forecasts since digital, 4D versions of this information will not be available in time for Level 1 forecasts. Please refer to Appendix II for information included in these forecast Enablers.

NextGen weather forecasting will encounter many challenges. First, new operational paradigms must be developed within the weather community, such as the evolving role for human forecasters, use of human over the loop versus human in the loop, and increased automated forecasting. Second, cross-agency research must be consolidated to more effectively support the needs of the aviation user community. Third, weather information policies that enable NextGen must be established quickly and updated frequently, so new forecasts can support NextGen capabilities in a timely manner as they come online. Today, it can take decades to establish or modify policies. Fourth, methodologies must be developed to identify the information sources that will be used to create the SAS. Initial methodologies will be relatively simple and static, making way for more complex and dynamic methodologies over time. Lastly, forecast uncertainty must be addressed in a way that can be readily translated into system impact by DSTs.

4.3.4 Weather Information and Dissemination Enablers

The weather observations and forecasts described in Section 4.3.2 and 4.3.3 will require an automation platform and mechanism to provide the common weather picture information to users. Figure 4-8 shows the planned evolution of the Enablers that will provide the weather information and dissemination needed for NextGen.

As shown in Figure 4-8, there are three time-phased levels synchronized with the NextGen capabilities they support. The Level 1 Enablers establish the initial capability to provide net-centric weather information and support the assimilation of weather information into DSTs. These include EN-2010 that provides the initial 4D Weather Cube, EN-2080 that provides a network-enabled user-defined weather information request function, EN-2060 that integrates legacy weather applications with the 4D Weather Cube, and EN-2680 that provides the methodologies and algorithms needed to assimilate weather information into DSTs and processes. These Enablers will lay the ground work for follow on methodologies and more advanced algorithm development that will field the full NextGen capability.

Weather Information and Dissemination Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-2080: Network-Enabled User-Defined Weather Information Request Function			E 2010															
EN-1273: NextGen Weather Information Services - FAA Group 1				E 2011														
EN-2680: Methodologies and Algorithms for Weather Assimilation into Decision-Making - Level 1				E 2011														
EN-2010: NextGen 4D Weather Cube Information - Level 1 Initial Operating Capability						E 2013												
EN-2060: Legacy Weather Applications Integrated with Network-enabled Weather Information						E 2013												
EN-2681: Methodologies and Algorithms for Weather Assimilation into Decision-Making - Level 2										E 2017								
EN-2020: NextGen 4D Weather Cube Information - Level 2 Adaptive Control/Enhanced Forecasts											E 2018							
EN-2070: Aircraft Systems - Aircraft-Aircraft Hazardous Weather Information Sharing												E 2019						
EN-2682: Methodologies and Algorithms for Weather Assimilation into Decision-Making - Level 3														E 2021				
EN-2030: NextGen 4D Weather Cube Information - Level 3 Full NextGen															E 2022			

Figure 4-8 Weather Information and Dissemination Enabler Timetable

Developing a net-centric weather information system and translating this weather information into aviation impact are challenging activities. Net-centric distribution challenges include: ensuring bandwidth availability to disseminate data in a timely manner, multi agency operation and data access, system security, data latency, archiving requirements, and getting data to/from aircraft. Today, service providers and aviation users cognitively translate displays of weather into aviation impact, each in their own unique way. Automating and standardizing this process is a difficult task, requiring algorithms that must replicate and unify largely undocumented human behavior, while also improving upon it.

4.4 RESEARCH AND DEVELOPMENT ACTIVITIES

This section presents a summary of the initial set of R&D Activities that have been identified to guide the implementation of Weather Information Services OIs and Enablers. The R&D Activities have primarily been drawn from the NextGen R&D Plan for FY 2009 – FY 2013 and, therefore, have a heavy emphasis on near-term R&D needs. Figure 4-9 shows the planned evolution of the R&D Activities needed to support NextGen Weather Information Services.

In 2013, the structure will be in place to manage the development, authorization, standards, policy, and certification of the virtual 4D Weather Cube to provide a common SAS of current and forecasted weather information. It will leverage net-enabled weather observations and probabilistic weather forecasts developed by 2012. By 2016, a second round of network-enabled observations and predictive model improvements will be developed, supporting more advanced flexible airspace and trajectory-based operations (TBO). It will make use of adaptive controls to direct observation sensors on aircraft and satellites in real time. This round will also enable aircraft to participate more fully in the observation network and receive information tailored to performance-based procedures, such as turbulence, wake, or icing data.

Longer-term, NextGen Weather Information Services will require ongoing development of sensors. D-2179 provides support for enhanced and expanded ground-based weather sensors. D-2191 provides support for enhanced and expanded airborne-based weather sensors. D-2193 provides support for enhanced and expanded space-based weather sensors. Challenges involved with program decisions concerning new sensor systems include separating the benefits associated with improved weather observation information from those of better forecasting techniques; establishing the appropriate relative mix of surface, airborne, and satellite weather sensors; and determining assessment techniques for probabilistic forecasts.

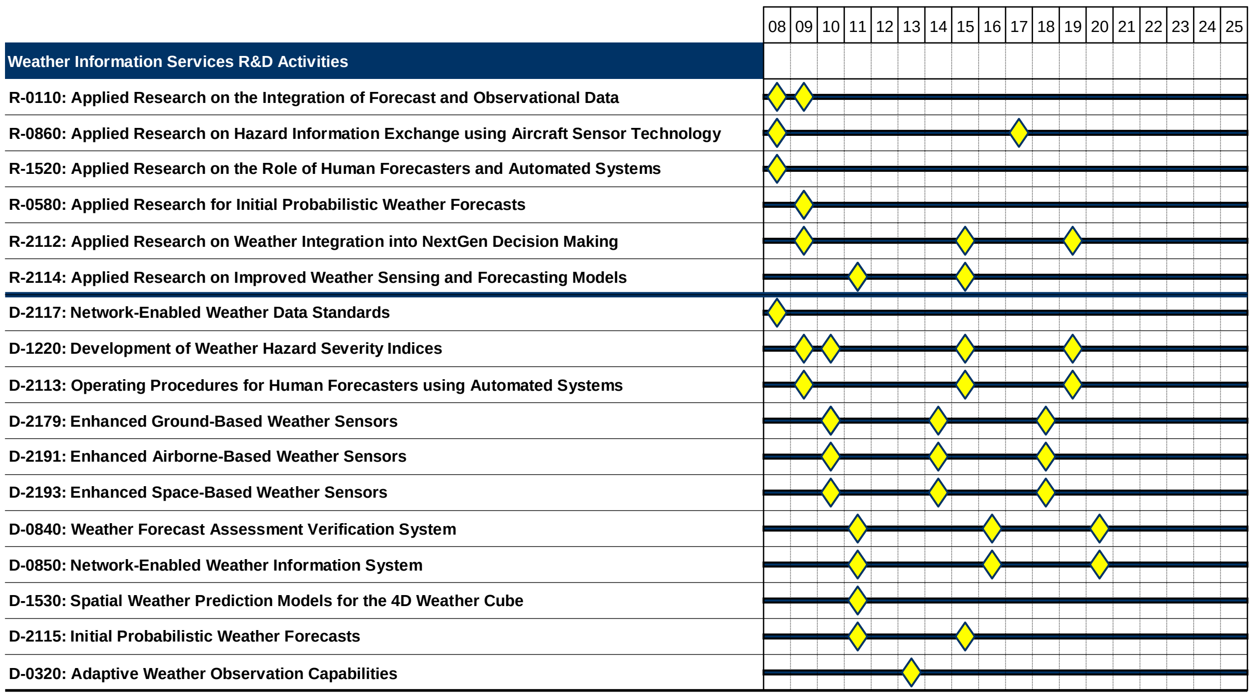


Figure 4-9 Weather Information Services R&D Activities Timetable

Detailed information describing each R&D Activity, including their integration with other IWP elements, can be found in Appendix III, as well as on the interactive JPE available at www.jpdo.gov.

4.5 POLICY ISSUES

NextGen envisions a SAS for weather information. This raises two basic Policy Issues. First, who will be responsible for gathering, forecasting, disseminating, and displaying weather information? Second, how will this information be used?

Currently, the Federal Aviation Administration (FAA), the National Oceanic and Atmospheric Administration (NOAA), Department of Defense (DOD), and the private sector all play a role in detecting, forecasting, disseminating, and displaying weather information, but the roles and responsibilities of each are not always clear. Although the private sector is playing an increasing role in disseminating weather information, meteorological services are still perceived by some as an inherently governmental function. As the roles of the public and private sectors evolve, any decision to clarify or change the roles and responsibilities in providing weather information is likely to have a far reaching impact on the FAA, NOAA, DOD, the private sector, and aviation users. Those who are impacted may feel they have been adversely affected. It would also affect legal liability in the event of a weather-related aviation accident.

With respect to the use of weather information, the Air Traffic Control (ATC) system now accounts for weather in improving system efficiency. Controllers disseminate weather information and collect pilot weather reports. The controller provides weather information to the pilot, and the FAA Air Traffic Control System Command Center (ATCSCC) uses weather information to manage aircraft flow. Also, FAA Flight Service Stations (FSS) provide weather briefings as a service to General Aviation (GA) pilots. However, weather and weather avoidance information is provided by the controller to the pilot on an advisory or “time available” basis. This stands in contrast to the hard tactical control role that the controller exercises in maintaining aircraft separation. The pilot in command is responsible for keeping clear of such weather.

Under NextGen, the authoritative source of weather information, coupled with a net-enabled operational capability, will enable pilot, dispatcher, and ANSP decision makers to have equal access to common weather information on which to base strategic and tactical weather avoidance decisions. Therefore, the roles and responsibilities of the ANSP, dispatcher, and pilot in providing, obtaining, and utilizing weather information should be clarified. Also, NextGen is moving in a direction that would place more responsibility on the ground automation system for tactical control of aircraft to avoid hazardous weather. This, in turn, will increase the responsibility (and liability) of the FAA as the service provider for weather separation. Thus, the underlying policy issue is determining the final authority for avoiding hazardous weather. Will pilots be willing to fly a four-dimensional trajectory (4DT) that they think is unsafe but which the automated ATC system considers safe and necessary for maximum efficiency? Will that ATC system allow a pilot to fly a route that the automation system deems unsafe or deviate from the assigned route if that would reduce efficiency? These issues require immediate interagency and stakeholder attention.

Figure 4-10 presents the Policy Issues that support Weather Information Services. These Policy Issues are intended to encourage targeted stakeholder engagement in solving policy challenges that may impede progress toward Weather Information Services OIs and Enablers. Depending on the maturity of a given issue, descriptions range from specific policy suggestions to recommendations for further analysis and open discussion. Further information concerning specific Policy Issues, including their integration with other IWP elements, can be found in Appendix IV, as well as on the interactive JPE available at www.jpdo.gov.

Weather Information Services Policy Issues	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
PI-0087: Weather Information Policy - Use of Single Authoritative Source in ATM Decisions		P	2009															
PI-0088: Federal vs. Private Role In Weather Services		P	2009															
PI-0089: Weather Avoidance Decision Making				P	2011													
PI-0086: Weather Information Policy - Global Harmonization					P	2012												

Figure 4-10 Weather Information Services Policy Issues Timetable

4.6 SUMMARY - WEATHER INFORMATION SERVICES

Weather plays a significant role in the majority of air transportation system delays. To reduce these delays, weather information needs to be assimilated into NextGen decision-making processes and integrated with NextGen decision support automation. The Weather Information Services functional area provides comprehensive four-dimensional aviation weather information called the 4D Weather Cube, which in-turn provides a SAS of current and forecasted weather. This common weather picture is translated into potential impacts and integrated into the full suite of NextGen information management systems, allowing decision makers to have full situational awareness and the ability to minimize air transportation user disruptions due to adverse weather. This major paradigm change means weather is no longer just an end product to be viewed in a stand-alone display, requiring cognitive interpretation and impact assessment, and having little ability to significantly impact weather-related delays. Instead, weather information is designed to integrate with and support NextGen decision-oriented automation capabilities and human decision-making processes.

Challenges: The first challenge is identifying the roles/responsibilities of NextGen Partner agencies and industry in fielding the 4D Weather Cube. Coupled with this is ensuring industry has an opportunity to provide weather information to users that differs from the Weather Cube's SAS. Other challenges include transforming air traffic and flight operations to use the SAS and updating federal regulations to allow its use by service providers and users in decision making.

Operational Improvements: NextGen requires the development and execution of a weather operational structure that includes governance, standards, and collaboration of multiple organizations to detect, collect, process, forecast, and disseminate the weather information required by the 4D Weather Cube.

Enablers: The 4D Weather Cube needs: data standards and a governance structure to guide and support the development process and operations; a broad range of integrated ground, airborne, and satellite observation sources and platforms; enhanced models and processing of convective and winter storms, icing, turbulence, ceiling and visibility, volcanic ash, and space weather forecasts; and the development of supporting information systems. The methodologies and algorithms to assimilate weather information into the trajectory, separation, and capacity management systems are also critical Enablers.

Research and Development Activities: Enhanced probabilistic forecasting models/techniques, improved understanding of the optimum roles of human forecasters and automation, integration of weather forecasts and observations into the SAS, and the techniques to integrate and tailor weather information into ATM decision making and procedures requires additional R&D.

Policy Issues: Policies are needed to define the operational use of the SAS, including its integration into decision making, as well as determining responsibilities for managing separation from weather.

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5 Safety Management

The Next Generation Air Transportation System (NextGen) vision for Safety Management is to ensure NextGen concepts are developed and implemented, while maintaining or improving safety. The risks, real or perceived, of safely implementing new operations and technologies may limit the ability to provide the air traffic system capacity needed to meet projected increases in demand. Achieving NextGen's goals requires a fundamental change in the way the air transportation community manages safety.

NextGen must proactively address all aspects of safety to achieve success. Safety considerations must be incorporated throughout the NextGen process, starting with initial planning, and continuing through the incorporation of safety requirements into the definition and performance estimates of Operational Improvements (OIs). NextGen requires safety-enhancing practices and systems that are deployed as part of an integrated design-to-implementation safety management process. NextGen concepts must address current safety issues and mitigate potential safety risks of new operational concepts, thereby enabling the unencumbered growth of the air transportation system. Addressing safety considerations, after NextGen concepts have been developed, will impose capacity constraints on the future air transportation system, ensuring NextGen's goals are not achieved.

As a key requirement for the overall success of NextGen, the Safety Management functional area supports all of the NextGen Capabilities with a strong alignment to the *Integrated Regulatory and Risk Management* Capability. This capability seeks to provide proactive risk identification and analysis, through improved automation, policies, procedures, and processes, using established standards, requirements, and responsibilities.

5.1 INTRODUCTION

This chapter presents the results, timing, and dependencies of work efforts necessary, to achieve the NextGen vision for Safety Management. NextGen Safety Management seeks to ensure that the safety of property and, more importantly, human life is maintained or improved, despite the anticipated growth of the air transportation system. Safety Management requires a continuous improvement approach that applies to all aspects of the aviation system, throughout all phases of its lifecycle. Due to constant vigilance and diligence, aviation has an excellent safety record of identifying and mitigating safety risks. This record must be maintained or improved as NextGen becomes a reality.

NextGen Safety Management uses a continuous improvement approach throughout the Integrated Work Plan (IWP) OIs and Enablers. This is reflected, with the use of far-term milestone dates, in data element descriptions and timetables. The far-term dates in the description and timetables should not be interpreted as indicating a lack of interim results before the milestone dates, or that safety will no longer be considered beyond the milestones. Rather, the Safety Management elements should be considered as providing continuous improvement for their specific area of the air transportation system.

The NextGen approach to Safety Management is more fully described in the products and policies produced by the Joint Planning Development Office (JPDO) Safety Working Group. These products include the *National Aviation Safety Strategic Plan*, the *National Safety Management System Standard*, the *Aviation Safety Information Analysis and Sharing Concept of Operations*, and the *Safety Culture Improvement Resource Guide*.

5.2 SAFETY MANAGEMENT OPERATIONAL IMPROVEMENTS

The NextGen vision for Safety Management requires the implementation of OIs that provide a continuous level of safety improvements, supporting the transformation to NextGen. To achieve this transformation and vision, NextGen requires a comprehensive, proactive safety management approach that incorporates safety throughout the aviation culture. The JPDO has developed the *National Aviation Safety Strategic Plan* (NASSP) that provides specific goals, objectives, and strategies, to support the transformation to NextGen and the achievement of its capacity-enhancement goals, while improving safety.

To describe these needs, the Safety Management OIs are aligned into functional groups, as shown in Figure 6-1, corresponding to the three major goals of the NASSP: Safer Practices; Safer Systems; and Safer Worldwide. The OI functional groups are described in the following sections. Full descriptions of each OI, including their integration with other IWP elements, are provided in Appendix I as well as on the interactive Joint Planning Environment (JPE), available at www.jpdo.gov.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Safer Practices Operational Improvements																		
OI-3004: Improved Operational Processes Using the Safety Management System (SMS)							O	2014										
OI-3101: Enhanced Safety Information Analysis and Sharing							O	2014										
OI-3102: Improved Safety for NextGen Evolution									O	2016								
OI-3108: Improved SMS Standards and Effectiveness													O	2020				
OI-3109: Increased Safety Information Sharing and Analysis Scope and Effectiveness													O	2020				
Safer Systems Operational Improvements																		
OI-3103: Improved Safety of Operational Decision Making																	2025	O
OI-3104: Enhanced Safety of Airborne Systems																	2025	O
OI-3105: Enhanced Safety of Ground-based Systems																	2025	O
Safer Worldwide Operational Improvements																		
OI-3106: Increased International Cooperation for Aviation Safety													O	2020				
OI-3107: Improved Safety Across Air Transportation System Boundaries													O	2020				

Figure 5-1 Safety Management OI Timetables

Safety Management OIs introduce safety-enhancing practices and systems, as well as build safety-enhancing requirements into the air transportation's operational systems and procedures. The safety management practices include safety data analysis capabilities that allow the identification and resolution of safety threats, at the precursor level, before an accident's occurrence. The safety management systems improve safety assurance, engaging all stakeholders in the air transportation system and fostering a safety-focused environment, where each person's role in safety is understood and put into action.

The Safety Management OIs describe the high-level operational changes envisioned to support the transformation to the NextGen vision. The OIs described in this section are the initial baseline to support discussions with JPDO stakeholders and a full vetting of each IWP element.

5.2.1 Safer Practices Operational Improvements

Safer Practices addresses the issues of consistency and completeness of safety management systems across government and industry. Establishing national governance and completing the implementation of the National Safety Management System (SMS) Standard within the participating organizations are major challenges. Likewise, implementation of enhanced safety monitoring and analysis capabilities that allow both forensic and prognostic safety assessments will be a challenging task.

Figure 5-2 presents the planned OIs that support the Safer Practices component of the Safety Management functional area. A major objective of Safer Practices is to provide consistent safety management approaches that are implemented throughout government and industry. OI-3004 supports improved operational processes, using the SMS, and with OI-3108, provides improved SMS standards and effectiveness. Another major objective is to provide enhanced monitoring and safety analysis of the air transportation system, as described by OI-3101. OI-3109 is expected to increase and improve safety information analysis and sharing, with greater scope and effectiveness. Lastly, a major objective is to provide enhanced methods for system safety, design certainty, operational procedures, and training, supported by OI-3102. This OI is expected to improved safety for NextGen evolution.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Safer Practices Operational Improvements																		
OI-3004: Improved Operational Processes Using the Safety Management System (SMS)							O	2014										
OI-3101: Enhanced Safety Information Analysis and Sharing							O	2014										
OI-3102: Improved Safety for NextGen Evolution									O	2016								
OI-3108: Improved SMS Standards and Effectiveness													O	2020				
OI-3109: Increased Safety Information Sharing and Analysis Scope and Effectiveness													O	2020				

Figure 5-2 Safer Practices OI Timetable

5.2.2 Safer Systems Operational Improvements

Safer Systems addresses the major issue of providing timely and relevant situational awareness for pilots, controllers, and aviation operations personnel. Current and future systems, and especially those with human interfaces, must be designed, with the user in mind, so that information is presented when needed in a clear and understandable fashion. Determining the proper function allocations between humans and automation is also a major challenge, assuring that the attributes of both humans and machines are used to assure the safety of the air transportation system. Finally, system designs, with fail-safe modes and graceful degradation after failure, are required to compensate for the potentially elevated risks of using automation to operate beyond the current boundaries of human capacity.

Consideration of human factors associated with NextGen improvements will be critical to ensuring NextGen safety. A thorough understanding of human performance limits, as well as the potential of unique human capabilities to ensure safety within NextGen, is required. The allocation of roles and responsibilities for air traffic management (ATM), between humans and automation, must be informed by this understanding. Human performance limits must be respected, while the unique capability of the human to recognize patterns, reason, and react to anomalous situations must also be determined and appropriately credited. Automated systems must be designed to engage humans to avoid complacency, while providing them the information required to accomplish their tasks in a way that ensures their situational awareness and allows them to appropriately engage the systems to ensure safety.

Figure 5-3 presents the planned OIs that support the Safer Practices component of the Safety Management functional area. A major objective of Safer Systems is to provide risk-reducing system interfaces. OI--3103 supports this objective by improving the safety associated with operational decision-making. Another major objective is to provide safety-enhancing technologies for airborne systems. OI-3104 supports this objective with enhanced safety due to the advanced reliability and airworthiness of aircraft, the use of vehicle systems health management, improved reliability and accuracy of aircraft operational information, improved aircraft conformance to more stringent operational requirements, and enhanced aircraft systems supporting crash survivability. Lastly, a major objective is to provide safety enhancements for ground-based systems, as described by OI-3105. This OI includes the use of advanced ground-based systems health management, as well as ground-based systems that contribute to enhanced crash survivability.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Safer Systems Operational Improvements																		
OI-3103: Improved Safety of Operational Decision Making																	2025	O
OI-3104: Enhanced Safety of Airborne Systems																	2025	O
OI-3105: Enhanced Safety of Ground-based Systems																	2025	O

Figure 5-3 Safer Systems OI Timetable

5.2.3 Safer Worldwide Operational Improvements

Safer Worldwide addresses the issue of consistency and compatibility of safety practices and systems across the global aviation community. Harmonizing the standards for handling dangerous goods transported by multiple transportation modes is an important challenge.

Figure 5-4 presents the planned OIs that support the Safer Worldwide component of the Safety Management functional area. A major objective of Safer Worldwide is to encourage development and implementation of safer practices and safer systems worldwide. OI3106 supports this objective by encouraging increased participation in international aviation safety and the creation of international aviation development partnerships. Another major objective is to establish equivalent levels of safety across air transportation system boundaries. OI-3107 supports this objective through the improved harmonization of regulations, standards, and procedures, especially for the transport of dangerous goods across multiple transportation modes.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Safer Worldwide Operational Improvements																		
OI-3106: Increased International Cooperation for Aviation Safety													O	2020				
OI-3107: Improved Safety Across Air Transportation System Boundaries													O	2020				

Figure 5-4 Safer Worldwide OI Timetable

5.3 SAFETY MANAGEMENT ENABLERS

The transformation to Safety Management requires the implementation of specific Enablers over the life of NextGen. These Enablers will provide the foundation for the realization of OIs and the overall NextGen vision. They must be researched, developed, and implemented in a certain sequence and timed to effectively meet the needs of the OIs they support. To describe these broad needs, the Safety Management Enablers have been aligned into functional groups, as summarized in Figure 5-5, supporting the three NASSP goal areas of Safer Practices, Safer Systems, and Safer Worldwide. The Safety Management Enabler timetable was developed recognizing that most OIs are continuous improvements. The Enabler functional groups are described in the following sections. Full descriptions of each Enabler, including their integration with other IWP elements, are provided in Appendix II, as well as on the interactive JPE, available at www.jpdo.gov.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Safer Practices Enablers																		
EN-3016: Aviation Safety Information Analysis and Sharing Environment (ASIAS) - Level 1	E 2008																	
EN-3017: Safety Information Analysis Tools - Level 1	E 2008																	
EN-3018: Safety Management Requirements	E 2008																	
EN-3024: Advanced Incident Contributing Factor Analysis			E 2010															
EN-3025: Automated Prognostic Risk Identification			E 2010															
EN-3027: Improved Fault Management			E 2010															
EN-3040: National SMS Standard Implementation - Level 1			E 2010															
EN-3023: Automated System Vulnerability Detection				E 2011														
EN-3036: Aviation Safety Information Analysis and Sharing Environment (ASIAS) - Level 2				E 2011														
EN-3119: Integrated Safety Assurance and Risk Management - Level 1				E 2011														
EN-3041: National SMS Standard Implementation- Level 2					E 2012													
EN-3050: Advanced Complex System Validation and Verification Methods					E 2012													
EN-3037: Aviation Safety Information Analysis and Sharing Environment (ASIAS) - Level 3						E 2013												
EN-3038: Safety Information Analysis Tools - Level 2						E 2013												
EN-3039: Safety Information Analysis Tools - Level 3							E 2014											
EN-3042: National SMS Standard Implementation- Level 3							E 2014											
EN-3105: Increase Data Access for Safety Risk Management							E 2014											
EN-3107: Advanced Capabilities for Integrated, Predictive Safety Assessment							E 2014											
EN-3108: Enhanced Focus on Safe Operational Procedures							E 2014											
EN-3109: Advanced Training Concepts for Safe System Operation							E 2014											
EN-3120: Integrated Safety Assurance and Risk Management - Level 2							E 2014											
EN-3121: Integrated Safety Assurance and Risk Management - Level 3								E 2015										
EN-3101: Safety Policy Effectiveness											E 2018							
EN-3102: Safety Risk Management Processes and Tools											E 2018							
EN-3103: Safety Assurance Processes and Tools											E 2018							
EN-3104: Safety Promotion Practices											E 2018							
EN-3106: Increase Confidence in Analytical Results											E 2018							

Figure 5-5 Safety Management Enabler Timetables

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Safer Systems Enablers																		
EN-3054: Improved Reliability and Airworthiness of Aircraft - Level 1								E	2015									
EN-3056: Improved Vehicle Systems Health Management - Level 1								E	2015									
EN-3058: Increased Reliability and Accuracy of Data and Information - Level 1								E	2015									
EN-3060: Improved Operational Decision Aids - Airborne Level 1								E	2015									
EN-3062: Ensure Aircraft Conformance to More Stringent Operations Requirements - Level 1								E	2015									
EN-3064: Increase Aircraft System Contributions to Survival in Crash Scenarios - Level 1								E	2015									
EN-3066: Improved Ground-Based Systems Health Management - Level 1								E	2015									
EN-3068: Improve Operational Decision Aids - Ground Level 1								E	2015									
EN-3070: Ensure Ground-based System Conformance to Operations Requirements - Level 1								E	2015									
EN-3072: Increase Ground-based System Contribution to Survival in Crash Scenarios - Level 1								E	2015									
EN-3110: Ensure the Availability and Accessibility of Required Information								E	2015									
EN-3111: Increase the Usefulness and Understandability of Information								E	2015									
EN-3112: Maintain Appropriate Human Engagement								E	2015									
EN-3122: Reduced Controlled Flight into Terrain - Level 1								E	2015									
EN-3127: Reduce Airborne Icing-Related Incidents - Level 1								E	2015									
EN-3130: Increased Crash Survivability - Aircraft Structures & Components								E	2015									
EN-3131: Increased Crash Survivability- Aircraft Fire Prevention & Suppression								E	2015									
EN-3132: Reduce Ground Icing-Related Incidents - Level 1								E	2015									
EN-3055: Improved Reliability and Airworthiness of Aircraft - Level 2																	2025	E
EN-3057: Improved Vehicle Systems Health Management - Level 2																	2025	E
EN-3059: Increased Reliability and Accuracy of Data and Information - Level 2																	2025	E
EN-3061: Improved Operational Decision Aids - Airborne Level 2																	2025	E
EN-3063: Ensure Aircraft Conformance to More Stringent Operations Requirements - Level 2																	2025	E
EN-3065: Increase Aircraft System Contributions to Survival in Crash Scenarios- Level 2																	2025	E
EN-3067: Improved Ground-Based Systems Health Management - Level 2																	2025	E
EN-3069: Improve Operational Decision Aids - Ground Level 2																	2025	E
EN-3071: Ensure Ground-based System Conformance to Operations Requirements - Level 2																	2025	E
EN-3073: Increase Ground-based System Contribution to Survival in Crash Scenarios - Level 2																	2025	E
EN-3113: Improve Reliability and Airworthiness of Aircraft																	2025	E
EN-3123: Airborne Weather Information Technologies- Level 1																	2025	E
EN-3124: Reduced Controlled Flight into Terrain - Level 2																	2025	E
EN-3125: Airborne Weather Information Technologies- Level 2																	2025	E
EN-3126: Improved Aircraft Upset Prevention and Recovery																	2025	E
EN-3128: Reduce Airborne Icing-Related Incidents - Level 2																	2025	E
EN-3133: Reduce Ground Icing-Related Incidents - Level 2																	2025	E

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Safer Worldwide Enablers																		
EN-3030: Standards Harmonization for Multi-mode Transport of Dangerous Goods					E	2012												
EN-3114: Participate Internationally in Aviation Forums									E	2016								
EN-3115: Establish International Aviation Development Partnerships									E	2016								
EN-3116: Support Execution of ICAO Global Aviation Safety Roadmap and Implementation Plan									E	2016								
EN-3118: Improve the Implementation of Harmonized Standards, Regulations, and Procedures									E	2016								
EN-3129: Harmonize Standards, Regulations and Procedures									E	2016								

Figure 5-5 Safety Management Enabler Timetables (continued)

5.3.1 Safer Practices Enablers

NextGen requires OIs that use new SMS standards, advanced safety information analysis and sharing, and comprehensive safety promotion and safety culture concepts. These OIs require Enablers that support the development and implementation of safer practices across government and industry.

Figure 5-6 presents the core group of Enablers that support the development and implementation of Safer Practices. A key Enabler is EN-3018 that provides the SMS standard needed to guide the development of consistent practices throughout the Federal agencies and industry. This cornerstone Enabler supports the development of approaches for safety policy, safety risk management, safety assurance, and safety promotion. The staged implementation of SMS is defined in three levels, described by EN-3040 for the Federal Aviation Administration (FAA), EN-3041 for Federal Partners, and EN-3042 for industry Partners.

Safer Practices Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-3016: Aviation Safety Information Analysis and Sharing Environment (ASIAS) - Level 1	E 2008																	
EN-3017: Safety Information Analysis Tools - Level 1	E 2008																	
EN-3018: Safety Management Requirements	E 2008																	
EN-3024: Advanced Incident Contributing Factor Analysis			E 2010															
EN-3025: Automated Prognostic Risk Identification			E 2010															
EN-3027: Improved Fault Management			E 2010															
EN-3040: National SMS Standard Implementation - Level 1			E 2010															
EN-3023: Automated System Vulnerability Detection				E 2011														
EN-3036: Aviation Safety Information Analysis and Sharing Environment (ASIAS) - Level 2				E 2011														
EN-3119: Integrated Safety Assurance and Risk Management - Level 1				E 2011														
EN-3041: National SMS Standard Implementation- Level 2					E 2012													
EN-3050: Advanced Complex System Validation and Verification Methods					E 2012													
EN-3037: Aviation Safety Information Analysis and Sharing Environment (ASIAS) - Level 3						E 2013												
EN-3038: Safety Information Analysis Tools - Level 2						E 2013												
EN-3039: Safety Information Analysis Tools - Level 3							E 2014											
EN-3042: National SMS Standard Implementation- Level 3							E 2014											
EN-3105: Increase Data Access for Safety Risk Management							E 2014											
EN-3107: Advanced Capabilities for Integrated, Predictive Safety Assessment							E 2014											
EN-3108: Enhanced Focus on Safe Operational Procedures							E 2014											
EN-3109: Advanced Training Concepts for Safe System Operation							E 2014											
EN-3120: Integrated Safety Assurance and Risk Management - Level 2							E 2014											
EN-3121: Integrated Safety Assurance and Risk Management - Level 3								E 2015										
EN-3101: Safety Policy Effectiveness											E 2018							
EN-3102: Safety Risk Management Processes and Tools											E 2018							
EN-3103: Safety Assurance Processes and Tools											E 2018							
EN-3104: Safety Promotion Practices											E 2018							
EN-3106: Increase Confidence in Analytical Results											E 2018							

Figure 5-6 Safer Practices Enabler Timetable

A key component of the Safer Practices functional group is the development and implementation of aviation safety information sharing and analysis (ASIAS) concepts. The ASIAS concepts are defined in three levels. Level 1, described by EN-3016, provides enhanced system capabilities that include the integration of disparate, publicly available safety information, with proprietary information voluntarily provided by the commercial aviation industry. The types of information to be integrated include; incident and accident data, operational exposure data, experiential reports, system state information, projections, and forecasts. ASIAS Level 2, described by EN-3016, builds upon Level 1 by expanding functionality and the use of net-centric technology. Level 2 allows NextGen Federal Partners to begin meeting the requirements found in the National SMS Standard. Level 2 includes the expansion and evolution of analytical tools and processes to identify and monitor system level issues. Finally, ASIAS Level 3, described by EN-3037, expands to additional NextGen stakeholders, including general aviation (GA), rotorcraft, airports, commercial aviation operators, and manufacturers. Level 3 will also evolve to include additional system safety metrics and modeling capabilities to support tactical, operational, and forecasting requirements.

ASIAS is envisioned to be governed by the ASIAS Executive Board (AEB) and supported by analytical tools. The AEB, comprised of stakeholder representatives, will govern the protection of and access to the information, prioritize studies, identify required resources, and disseminate findings among the stakeholders. Three levels of advanced analytical tools are envisioned to support the three levels of ASIAS. These three levels are defined by EN-3017, EN-3038, and EN-3039.

Another key component of Safer Practices is the development and implementation of integrated safety assurance and risk management. Integrated safety assurance and risk management is defined in three levels to use the staged functionality. Level 1, described by EN-3119, reduces the risk of accidents and incidents through enhanced analysis of safety data/information and the consistent application of safety assurance and prognostic methods of identifying and assessing risks. This enabler begins the transformation from reactive safety management to a more integrated proactive approach that requires advancing the methods used to identify and mitigate latent and emergent safety risk. Level 1 stakeholders include FAA, the National Aeronautics and Space Administration (NASA), and where appropriate, industry Partners. Level 1 leverages and integrates existing architectures, systems, data sources, tools, policies, and procedures. The success of this enabler is dependent on a trusted safety information-sharing environment, based on elements of a positive safety culture (e.g., informed culture, reporting culture). Government/industry safety information-sharing agreements are formalized. Similar to SMS and ASIAS, the Level 1 stakeholders and functionality are expanded to include Federal Partners in Level 2, described by EN-3120, and industry Partners in Level 3, described by EN-3121.

Safer Practices also includes Enablers that support the development of safety culture metrics and enhancements, improvements in safety communication and awareness processes. Advanced safety knowledge management methods and consideration of safety personnel competency requirements are also Enablers of the OIs in safer practices. Other Enablers include advanced tools and processes developed to improve the verification and validation of complex systems and software, and training programs designed to ensure all operators carry out operational procedures as intended, in a consistent and standardized manner.

Achieving the Enablers described in this timetable will require overcoming many challenges including:

- Gaining acceptance of the National SMS Standard across multiple agencies and industry Partners, as well as the commitment to implement.
- Gaining commitment from all stakeholders to participate fully in the information analysis and sharing effort.

5.3.2 Safer Systems Enablers

NextGen requires many OIs that are supported by advanced systems, technologies, and operational processes. These advancements need to address comprehensive user and safety requirements, and provide the required level of situational awareness for air and ground personnel. Safer Systems introduces specific safety-enhancing requirements and technologies that ensure the safety of advanced operational concepts. Figure 5-7 presents the core group of Enablers that support the development and implementation of Safer Systems.

Safer Systems Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-3054: Improved Reliability and Airworthiness of Aircraft - Level 1								E	2015									
EN-3056: Improved Vehicle Systems Health Management - Level 1								E	2015									
EN-3058: Increased Reliability and Accuracy of Data and Information - Level 1								E	2015									
EN-3060: Improved Operational Decision Aids - Airborne Level 1								E	2015									
EN-3062: Ensure Aircraft Conformance to More Stringent Operations Requirements - Level 1								E	2015									
EN-3064: Increase Aircraft System Contributions to Survival in Crash Scenarios - Level 1								E	2015									
EN-3066: Improved Ground-Based Systems Health Management - Level 1								E	2015									
EN-3068: Improve Operational Decision Aids - Ground Level 1								E	2015									
EN-3070: Ensure Ground-based System Conformance to Operations Requirements - Level 1								E	2015									
EN-3072: Increase Ground-based System Contribution to Survival in Crash Scenarios - Level 1								E	2015									
EN-3110: Ensure the Availability and Accessibility of Required Information								E	2015									
EN-3111: Increase the Usefulness and Understandability of Information								E	2015									
EN-3112: Maintain Appropriate Human Engagement								E	2015									
EN-3122: Reduced Controlled Flight into Terrain - Level 1								E	2015									
EN-3127: Reduce Airborne Icing-Related Incidents - Level 1								E	2015									
EN-3130: Increased Crash Survivability - Aircraft Structures & Components								E	2015									
EN-3131: Increased Crash Survivability- Aircraft Fire Prevention & Suppression								E	2015									
EN-3132: Reduce Ground Icing-Related Incidents - Level 1								E	2015									
EN-3055: Improved Reliability and Airworthiness of Aircraft - Level 2																	2025	E
EN-3057: Improved Vehicle Systems Health Management - Level 2																	2025	E
EN-3059: Increased Reliability and Accuracy of Data and Information - Level 2																	2025	E
EN-3061: Improved Operational Decision Aids - Airborne Level 2																	2025	E
EN-3063: Ensure Aircraft Conformance to More Stringent Operations Requirements - Level 2																	2025	E
EN-3065: Increase Aircraft System Contributions to Survival in Crash Scenarios- Level 2																	2025	E
EN-3067: Improved Ground-Based Systems Health Management - Level 2																	2025	E
EN-3069: Improve Operational Decision Aids - Ground Level 2																	2025	E
EN-3071: Ensure Ground-based System Conformance to Operations Requirements - Level 2																	2025	E
EN-3073: Increase Ground-based System Contribution to Survival in Crash Scenarios - Level 2																	2025	E
EN-3113: Improve Reliability and Airworthiness of Aircraft																	2025	E
EN-3123: Airborne Weather Information Technologies- Level 1																	2025	E
EN-3124: Reduced Controlled Flight into Terrain - Level 2																	2025	E
EN-3125: Airborne Weather Information Technologies- Level 2																	2025	E
EN-3126: Improved Aircraft Upset Prevention and Recovery																	2025	E
EN-3128: Reduce Airborne Icing-Related Incidents - Level 2																	2025	E
EN-3133: Reduce Ground Icing-Related Incidents - Level 2																	2025	E

Figure 5-7 Safer Systems Enabler Timetable

The Safer Systems Enabler functional group addresses advanced air and ground systems, as well as human-to-human, human-to-automation, and automation-to-automation interfaces. As shown in Figure 5-7, these Enablers are generally structured into two levels that define expected results of continuous improvement programs, in 2015 and 2025. The Safer Systems group is focused on the following topics:

- **Improved Conformance to Requirements:** As NextGen advances, new technologies will be needed to reduce deviations and improve the conformance to more stringent ground-based and airborne operational requirements. Two levels of ground-based Enablers are described by EN-3062 and EN-3063. Two levels of airborne Enablers are described by EN-3070 and EN-3071.

- **Improved Operational Decision Aids:** This area provides ground-based and airborne technologies that improve the response and reduce the decision time in response to system anomalies. Two levels of ground-based Enablers are described by EN-3068 and EN-3069. Two levels of airborne Enablers are described by EN-3060 and EN-3061.

- **Improved Reliability:** The reliability of aircraft systems and information greatly determines the overall safety of the air transportation system. The improved reliability and airworthiness of aircraft is described by EN-3113, EN-3054, and EN-3055. The increased reliability and accuracy of data and information is described by EN-3058, and EN-3059.

- **Improved Systems Health Management:** Monitoring the health of systems is an effective way to increase safety and prevent the potential of safety issues. Two levels of improved aircraft systems health management are described by EN-3056, and EN-3057. Two levels of improved ground-based systems health management are described by EN-3066, and EN-3067.

- **Improved Crash Survivability:** In the unlikely event of a crash, aircraft and ground-based technologies are needed to improve the ability to survive the crash. Improvements to aircraft systems and structures are described by EN-3064, EN-3065, EN-3130 and EN-3131. Improved ground-based technologies are described by EN-3072 and EN-3073.

- **Reduced Icing-Related Incidents:** Icing contributes to reduced operational safety in the air and on the ground. Two levels of improvements that reduce airborne icing-related incidents are described by EN-3127 and EN-3128. Two levels of improvements that reduce ground icing-related incidents are described by EN-3132 and EN-3133.

Other focus areas in this group include reduced controlled flight into terrain, improved airborne weather information technologies, maintaining appropriate human engagement, ensuring the availability and accessibility of required information, and improving aircraft upset prevention and recovery.

Achieving the enablers described in this timetable will require meeting and overcoming many challenges including:

- Completing the research and development (R&D) that produces risk-reducing system interfaces and safety-enhancing airborne and ground-based systems

- Completing reliability and certification testing, of the advanced systems and interfaces, in coordination with the FAA and industry

- Coordination, with the FAA and industry, to agree on the new operational concepts that will be included in NextGen.

5.3.3 Safer Worldwide Enablers

Many NextGen OIs require increased international cooperation for aviation safety. OIs that cross air transportation system boundaries, especially those dealing with dangerous goods, must be designed and implemented, using international standards and agreements. These OIs will require Enablers that increase international participation in aviation forums, establish international aviation partnerships, and support the creation and governance of international safety standards.

Figure 5-8 presents the core group of Enablers that support the development and implementation of Safer Worldwide. A core component of this group is the participation in international safety forums, described by EN-3114. This Enabler supports dissemination of NextGen concepts and understanding of the future air transportation system and safety concepts being development in the international community. To enhance this international exchange, EN-3115 supports the development of international partnerships for collaboration on R&D of aviation systems, technologies, and practices.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Safer Worldwide Enablers																		
EN-3030: Standards Harmonization for Multi-mode Transport of Dangerous Goods					E	2012												
EN-3114: Participate Internationally in Aviation Forums									E	2016								
EN-3115: Establish International Aviation Development Partnerships									E	2016								
EN-3116: Support Execution of ICAO Global Aviation Safety Roadmap and Implementation Plan									E	2016								
EN-3118: Improve the Implementation of Harmonized Standards, Regulations, and Procedures									E	2016								
EN-3129: Harmonize Standards, Regulations and Procedures									E	2016								

Figure 5-8 Safer Systems Enabler Timetable

Safer Worldwide also focuses on improvements on international safety standards. To improve the overall harmonization of safety standards, EN-3115 focuses on the development of standards, regulations, and procedures, while EN-3115 focuses on their consistent international implementation. EN-3116 supports the execution of the International Civil Aviation Organization (ICAO) Global Aviation Safety Timetable and implementation plan, improving international harmonization and implementation of safety regulations, procedures, and standards. To improve the safety of transporting hazardous materials across international boundaries, EN-3132 supports the harmonization of domestic and international standards for multiple modes.

Achieving the enablers, described in this timetable, will require overcoming many challenges including:

- Coordination with the international community in the development of research partnerships and the development of standards and policies
- Coordination with the international community in support of the Global Aviation System Timetable
- Coordination with the international community in the development of intermodal aviation safety standards.

5.4 RESEARCH AND DEVELOPMENT ACTIVITIES

Using the National Aviation Safety Strategic Plan as a guide, NextGen supports a transition to a Safety Management culture throughout the aviation community. The NextGen vision for Safety Management will be guided by the ongoing results from R&D Activities, supported by many NextGen Partners. The Safety Management R&D Activities are presented in Figure 5-9.

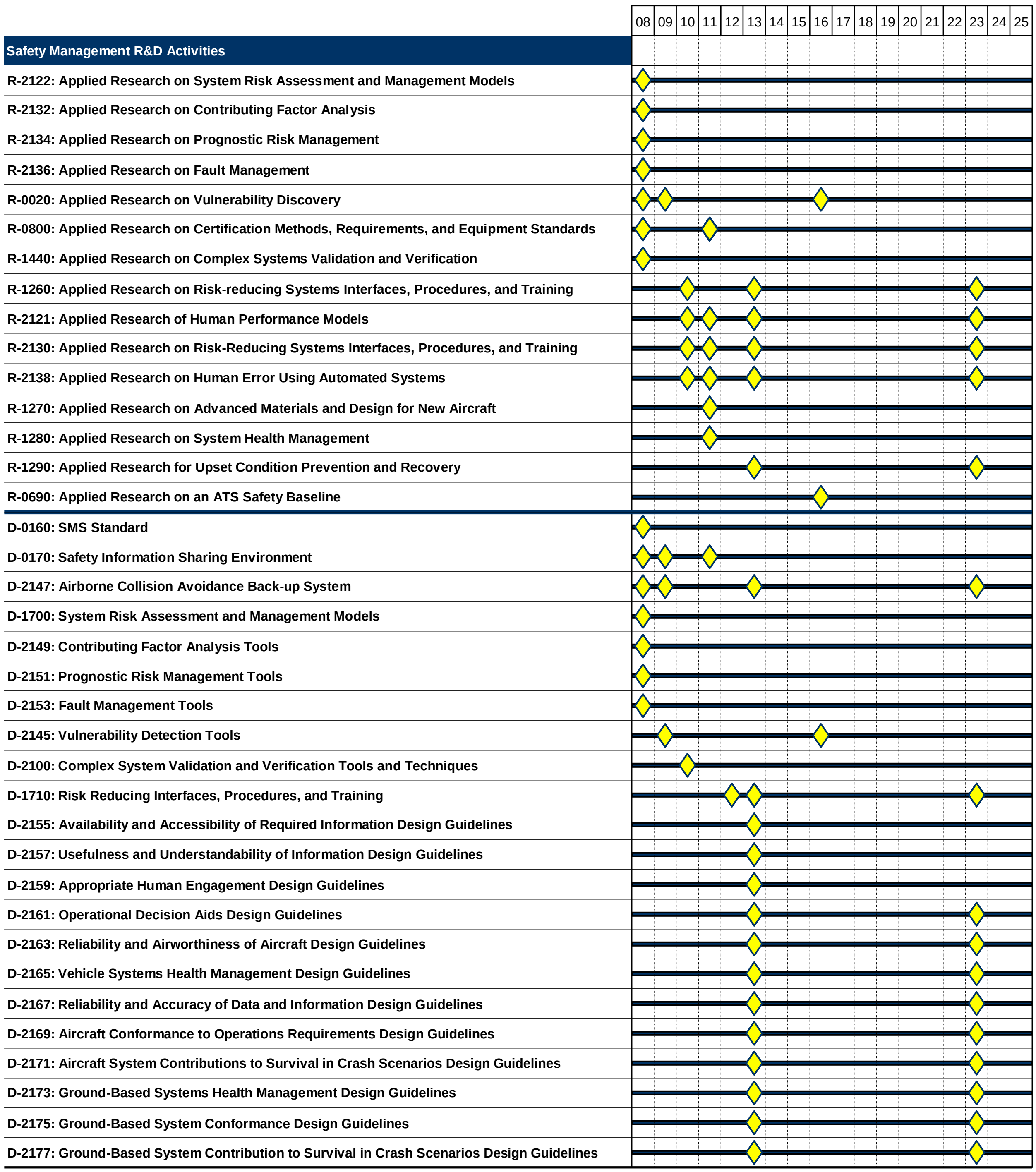

Figure 5-9 Safety Management R&D Activities Timetable

Safety Management R&D Activities are focused on providing Safer Practices and Safer Systems. For Safer Practices, research on vulnerability discovery and the development of tools to support the NextGen ASIAS capability will be major activities. Also important, for ASIAS, is research on integrated prognostic risk management and the development of contributing factor analysis tools for safety assurance and safety risk management. R&D of methods, for verification and validation of complex systems, to support NextGen risk assessment and certification decisions are also critical activities.

For Safer Systems, research to support human performance models that accurately capture human variability and human error, in highly automated NextGen systems, will lead to the development of risk-reducing interfaces, procedures, and training that reduce human error and complement the development of automation for NextGen. R&D of advanced materials properties for continued airworthiness of aircraft, and of adaptive control systems for upset condition prevention and recovery are also important activities. Completing R&D of system health management concepts for both air and ground systems to support alternative NextGen equipage decisions will be an important element in the overall R&D Activities.

Detailed information describing each R&D Activity, including their integration with other IWP elements, can be found in Appendix III, as well as on the interactive JPE, available at www.jpdo.gov.

5.5 POLICY ISSUES

Vision 100 charges the JPDO with creating a national vision for an air transportation system capable of meeting the traffic demands of 2025, developing a multi-agency roadmap to NextGen, and coordinating related research activities within the Federal Government with United States aviation and aeronautical firms. In keeping with this directive, JPDO agencies are asked to approve and implement a jointly developed National Safety Strategic Plan that articulates NextGen interagency safety goals, coordinated research priorities, and roles and responsibilities.

Today's NAS operates at an extraordinarily high level of safety performance, which the public expects to continue in NextGen. Significant growth in air traffic volume and complexity is predicted for NextGen. Continuing the extraordinarily high level of safety performance commensurate with what is being achieved today will require safety improvements to be achieved through national implementation of the SMS. In addition to today's post-accident, investigative "fix and fly" measures, SMS will enable a proactive, predictive approach to preventing accidents and incidents. SMS makes each aviation organization responsible for continually improving its own safety performance through risk identification/mitigation/management, community-wide safety information sharing and analysis, and fostering of positive safety culture. To maximize safety in NextGen it will be necessary for JPDO agencies to join with private sector aviation organizations in implementing the NextGen SMS initiatives. Interagency policy is needed to foster Federal government-wide adherence to a national aviation safety standard, agreements to share safety information, and adoption of methods to monitor progress and address issues related to agency SMS implementation. Policy also will be sought fostering collaboration and sharing of best practices, and applying SMS in other modes of transportation to reduce the risks associated with transfer of hazardous cargo between aviation and other types of transport.

National implementation of SMS will be the basis for new and improved standards, methodologies, and processes for safety assessment/approval and certification of NextGen technologies, equipment and procedures. Policy and technical initiatives will focus on assuring that certification/approval of aircraft and interfacing ATS improvements are synchronized so that one element of the system is not waiting for the other before the full capability can be implemented; and that NextGen operational improvements are assessed as integrated capabilities, with the safety enhancing properties of combined systems recognized and additional hazards addressed. It also may be necessary to develop new or improved safety assessment standards, methodologies, and verification and validation tools, and employ adequate numbers of appropriately skilled safety experts to meet NextGen safety assessment/certification requirements.

In tandem with U.S. safety improvements, international alignment and compatibility with U.S. NextGen safety initiatives, technologies and standards, including SMS, must be pursued through bi- and multilateral partnerships.

The Safety Management Policy Issues are presented in Figure 5-10. These Policy Issues are intended to encourage targeted stakeholder engagement in solving policy challenges that may impede progress toward Safety Management OIs and Enablers. Depending on the maturity of a given issue, descriptions range from specific policy suggestions to recommendations for further analysis and open discussion. Further information concerning specific Policy Issues, including their integration with other IWP elements, can be found in Appendix IV, as well as on the interactive JPE available at www.jpdo.gov.

Safety Management Policy Issues	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
PI-0030: Safety Management Requirements	P 2008																	
PI-0031: Safety National Leadership Organization	P 2008																	
PI-0033: National Aviation Safety Strategic Plan (NASSP)	P 2008																	
PI-0115: NextGen Safety Assessment/Certification - Synchronization of Aircraft and ANS			P 2010															
PI-0116: NextGen Safety Assessment/Certification - Standards and Tools			P 2010															
PI-0117: NextGen Safety Assessment/Certification - Resources			P 2010															
PI-0032: Government-Wide Safety Information Sharing				P 2011														
PI-0092: Network-Enabled Aviation Safety Information Sharing Environment - Stakeholders				P 2011														
PI-0107: Intermodal Safety Management Integration					P 2012													
PI-0094: Aviation Safety - Global Harmonization									P 2016									

Figure 5-10 Safety Management Policy Issues Timetable

5.6 SUMMARY - SAFETY MANAGEMENT

Safety Management seeks to ensure that the development and implementation of NextGen concepts achieves all of the NextGen goals, while maintaining or improving safety. Achieving NextGen's goals requires a fundamental change in the way the air transportation community manages safety.
Within the transition to NextGen, safety-enhancing practices and systems must be deployed as the product of an integral design-to-implementation safety management process. NextGen concepts must address current safety issues and the future safety risks of new operational concepts. Safety Management is a continuous improvement process that applies to all aspects of the aviation system, throughout all phases of its lifecycle. The NextGen Safety Management approach is fully described by the products and policies produced by the JPDO Safety Working Group including the *National Aviation Safety Strategic Plan*, the *National Safety Management System Standard*, the *Aviation Safety Information Analysis and Sharing Concept of Operations*, and the *Safety Culture Improvement Resource Guide.*

Challenges: Improved safety is an enabling component of air transportation system transformation. However, significant safety-related challenges must be addressed to enable NextGen. They include the adoption of the recently approved SMS Standard, the expansion of aviation safety sharing, and the enhancement of system safety analysis methods, training, and procedure development. The development of safety enhancing interfaces, technologies, and requirements, for airborne and ground based systems, also represents major challenge areas. Overcoming these challenges, while ensuring that the solutions are compatible with evolving aviation and intermodal systems worldwide, will present a challenge as well.

Operational Improvements: The *National Aviation Safety Strategic Plan* provides specific goals, objectives, and strategies that support the transformation to NextGen and the achievement of its capacity-enhancement goals, while improving safety. The Safety Management OIs were created in concert with the strategic plan's objectives and are organized into the plan's goal areas of Safer Practices, Safer Systems, and Safer Worldwide.

- **Safer Practices** addresses the issues of consistency and completeness of safety management across government and industry, the development and enhancement of data sharing and information analysis capabilities, and the creation of safety as an inherent characteristic of NextGen. NextGen will require OIs that introduce new SMS standards, advanced information analysis and sharing approaches, and comprehensive safety culture concepts, along with enhanced methods that ensure safety is an inherent characteristic of NextGen.
- **Safer Systems** addresses the issues of situational awareness for pilots, controllers, and other operators, and the integration of safety enhancing requirements and technologies into future systems. NextGen will require OIs that are supported by technology advancements for both airborne and ground-based systems.
- **Safer Worldwide** addresses the issues of consistency and compatibility of safety practices and systems across air transportation system boundaries. NextGen will require OIs that are brought about by increased international cooperation for aviation safety. It is also important to improve safety across air transportation system boundaries, especially those dealing with dangerous goods.

Enablers: Safer Practices Enablers emphasize an integrated, systematic approach to safety risk management through implementation of formalized SMS. These SMSs incorporate safety data analysis processes and the enhancement of safety certainty, operational procedures, and training, supporting NextGen evolution. Safer Systems Enablers emphasize implementation of safety-enhancing technologies, which will improve safety for human-centered interfaces and enhance the safety of airborne and ground-based systems. Safer Worldwide Enablers encourage coordinating the adoption of the safer practices and safer systems technologies, policies, and procedures worldwide.

Research and Development Activities: The NextGen goals are to be achieved through a combination of new policies, procedures, operations, and advances in technology deployed to safely manage all air traffic operations. Safety-related R&D is implicit in the applied R&D associated with all the capabilities described in this plan. For safer practices, research on vulnerability discovery and the development of tools, to support the NextGen ASIAS capability, will be required. R&D of methods for verification and validation of complex systems, to support NextGen risk assessment and certification decisions, are also critically important. Research to support human performance models that accurately capture human variability and human error, in highly automated NextGen systems, will lead to the development of risk-reducing interfaces, procedures, and training.

Policy Issues: Many of the Safety Management Enablers will require a strategic decision or resolution of Policy Issues. These policies are needed to help shape, guide, and support the realization of the NextGen vision. The policy section provides the initial set of Policy Issues supporting the Safety Management Enablers. Safety risks must be addressed within the context of NextGen planning, incorporating safety requirements into the NextGen OIs and their performance estimates. Addressing safety, after developing NextGen concepts, will impose capacity constraints on the future air transportation system, ensuring NextGen's goals are not achieved.

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6 Layered Adaptive Security

Layered Adaptive Security is defined as a risk-managed security system that depends on multiple technologies, policies, and procedures, adaptively scaled and arranged to defeat a given threat or threat category. This adaptability further permits the use of increased variability in security system operations, creating more uncertainty for the terrorist. Adversaries cannot defeat one particular security measure of the system and thereby, achieve a "break-through" which permits them to operate freely with no further barriers to their activities. Furthermore, the security system has the adaptability to scale its systems and procedures to the risk level of a threat in a given situation rather than being bound to an inflexible "one size fits all" approach.

Layered Adaptive Security supports the Next Generation Air Transportation System (NextGen) Capabilities to *Provide Effective Information Sharing Environment*, *Provide Integrated Regulatory and Risk Management, Provide Efficient Trajectory Management, Provide Collaborative Capacity Management,* and *Provide Flexible Airport Facility and Surface Operations*. A combined goal of these capabilities, concerning Layered Adaptive Security, is to provide a secure air transportation system using a layered, adaptive, and collaborative approach that integrates flight and facility risk parameters into the development and management of flight trajectories within an acceptable level of service. In addition, Layered Adaptive Security must support the capability to store, transport, and retrieve NextGen information among providers and consumers on a reliable, scalable, and secure net-centric infrastructure (NCI). The issues and challenges in supporting these capabilities are the development of a risk-based approach to guide the development and implementation of the supporting technology, procedures, and policies to provide the level of security required and mitigate the perceived risk. Additionally, the establishment of national level policies and directives to determine the financing, certification, standards, and installation of security systems throughout the air transportation system is critical.

6.1 Introduction

This chapter presents the results, timing, and dependencies of work efforts necessary to achieve the NextGen vision for Layered Adaptive Security. The goal of Layered Adaptive Security is to incorporate an effective security system without unduly limiting mobility or making unwarranted intrusions upon the civil liberties of users and employees, while not adversely impacting airline operations or aviation economics. NextGen will incorporate Layered Adaptive Security measures throughout the air transportation system, from reservation to destination.

6.2 Layered Adaptive Security Operational Improvements

The NextGen vision for Layered Adaptive Security requires the implementation of a broad range of security improvements in the air and on the ground. It requires the implementation of new technologies, processes, policies, and approaches to security. To describe these broad needs, the Layered Adaptive Security Operational Improvements (OIs) have been aligned into six functional groups, as summarized in Figure 6-1. The OI functional groups are described in the following sections. Full descriptions of each OI, including their integration with other IWP elements, are provided in Appendix I, as well as on the interactive Joint Planning Environment (JPE), available at www.jpdo.gov.

Secure People Operational Improvements	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
OI-4101: Integrated Passenger Screening, Credentialing and Identification - Level 1					O 2012													
OI-4106: Integrated Passenger Screening, Credentialing and Identification - Level 2						O 2013												
OI-4103: Integrated Aviation Worker Screening and Credentialing							O 2014											
OI-4105: Improved Passenger Checkpoint Screening - Level 1										O 2017								
OI-5011: Integrated International Passenger Arrival Processing										O 2017								
OI-4107: Improved Passenger Checkpoint Screening - Level 2														O 2021				

Secure Airports Operational Improvements	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
OI-4201: Reduced Threat from Unauthorized Persons Entering Airport - Level 1 Components									O 2016									
OI-4203: Reduce CBRNE Threats from Entering Airport									O 2016									
OI-4204: Common and Synchronized Airport Emergency and Disaster Response									O 2016									
OI-4202: Reduced Threat from Unauthorized Persons Entering Airport - Level 2 LEO Integration															O 2022			

Secure Checked Baggage, Cargo and Mail Operational Improvements	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
OI-4400: Improved Processing of Cargo and Mail Transported via SSCE and CSCE							O 2014											
OI-4401: Improved Cargo and Mail Screening - Level 1 Components								O 2015										
OI-4300: Improved Baggage Screening - Level 1 Components									O 2016									
OI-4301: Improved Baggage Screening - Level 2 Integrated											O 2018							
OI-4403: Improved Cargo and Mail Screening - Level 2 Integrated											O 2018							

Secure Airspace Operational Improvements	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
OI-4501: Improved Security Restricted Airspace Planning/Management - Level 1 Pre-Defined					O 2012													
OI-4500: Integrated Flight Risk Management and Risk Mitigation - Level 1 Static							O 2014											
OI-4511: Improved Security Restricted Airspace Planning/Management - Level 2 Integration								O 2015										
OI-4502: Integrated Flight Risk Management and Risk Mitigation - Level 2 Dynamic																		2025 O
OI-4512: Improved Security Restricted Airspace Planning/Management - Level 3 Flight Risk																		2025 O

Secure Aircraft and UAS Operational Improvements	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
OI-4600: Reduced Threat of Aircraft and UAS Destruction or Used as a Weapon									O 2016									
OI-4601: External Aircraft/UAS Threat Protection											O 2018							

Integrated Risk Management Operational Improvements	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
OI-4520: Integrated Risk-Based Planning and Management of Security Resources							O 2014											
OI-4521: Integrated Command/Control for Security Incident Response and Recovery														O 2021				

Figure 6-1 Layered Adaptive Security OI Timetables

6.2.1 Secure People Operational Improvements

NextGen requires Secure People OIs with an integrated security approach that combines passenger and aviation worker credentialing and identification processing with screening. Reducing the potential of high-risk passengers becoming threats to aviation security will be achieved by deploying the most effective technologies at all major airports. The prescreening /credentialing and screening processes will provide several layers of security designed to prevent the usage of chemical, biological, nuclear, radiological, and explosive agents, while insuring that consideration be given to the privacy issues associated with background checks on passengers. In addition to threat reduction goals, the new technologies will provide the ability to process increased volumes of passengers through checkpoints, while reducing the required infrastructure and airport footprint required for screening.

Figure 6-2 presents the planned evolution of OIs that support the Secure People component of the Layered Adaptive Security functional area. As shown in Figure 6-2, the near-term need to reduce the potential threat risks of passengers is addressed by OI-4101 that provides the first level of integrated passenger screening, credentialing, and identification by 2011. Through continually improved biometric technologies and enhanced vetting capabilities, OI-4106 provides the next level of integrated passenger screening, credentialing, and identification by 2013. This OI uses enhanced technologies that are integrated with a modernized watch list to focus alarms on passengers of concern. Beyond passenger screening improvements, OI-4103 provides integrated aviation worker screening and credentialing by 2014. By 2017, OI-4105 provides passenger checkpoint screening that integrates improved international passenger arrival credentialing. While improved passenger checkpoint screening is an ongoing process, it is anticipated that a new generation of security prevention will begin in 2017 and continue to improve and satisfy the complete requirements with OI-4107.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Secure People Operational Improvements																		
OI-4101: Integrated Passenger Screening, Credentialing and Identification - Level 1					O 2012													
OI-4106: Integrated Passenger Screening, Credentialing and Identification - Level 2						O 2013												
OI-4103: Integrated Aviation Worker Screening and Credentialing							O 2014											
OI-4105: Improved Passenger Checkpoint Screening - Level 1										O 2017								
OI-5011: Integrated International Passenger Arrival Processing										O 2017								
OI-4107: Improved Passenger Checkpoint Screening - Level 2														O 2021				

Figure 6-2 Secure People OI Timetable

A key component of Secure People is the integration of the checkpoints, digitally linked to the airport security command center using embedded sensors located throughout the terminal buildings, departure curbs, and approach roadways. This feature enables and expands the Layered Adaptive Security beyond the typical security checkpoint. Sensor integration with the command center data system will provide instantaneous alerts and recognition of any threat making its way to a checkpoint/gate. Another key component is the integration of international counterparts, through OI-5011 that provides integrated international passenger arrival processing. The initial implementation is scheduled for 2017, including checkpoint policies and procedures that are coordinated with the international community.

Achieving the OIs in this timetable requires a high degree of engagement with internal, external, and international stakeholders, as well as overcoming many challenges including:

- A key decision to establish the international policies and performance standards for passenger, carry-on baggage, cargo, checked baggage, and mail security requirements, will be needed before an integrated international passenger arrival process can be established.
- To reduce international processing times, an information sharing protocol must be identified, while maintaining immigration, customs, and security requirements.
- Communications plans to involve internal, external, and international stakeholders are critical to the gathering and development of screening and credentialing requirements. The goals of the plans, as well as respective performance metrics, must be inserted into individual performance plans to provide a level of accountability.

6.2.2 Secure Airports Operational Improvements

NextGen requires Secure Airports OIs that rely on an integrated approach to combine technological and procedural measures to protect against dynamically evolving threats. The use of NCI will provide security in air/land and vendor supply areas, by preventing the launching of chemical, biological, radiological, nuclear, and high-yield explosive threats. Alignment with local law enforcement organizations, as well as extending airport perimeters to prevent a perimeter breach, and providing screening opportunities at a distance from the airport centers, are prime objectives of this component of the Layered Adaptive Security strategy.

Figure 6-3 presents the planned evolution of OIs that support the Secure Airports component of the Layered Adaptive Security functional area. As shown in Figure 6-3, the most urgent need will be fulfilling the requirements of OI-4201 and OI-4203 that reduce the threat from unauthorized persons and threatening materials entering the airport and deploying one of the security threats. These OI are slated for initial operations by 2016. In the same year, OI-4204 will provide the means to coordinate a common and synchronized airport emergency response, as well as appropriate disaster responses, with its integration into the risk-managed security system. By 2022, OI-4202 will be available to provide advanced levels of threat reductions from unauthorized persons entering the airport. This advanced capability integrates the local law enforcement organizations with data sharing of all threat awareness opportunities.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Secure Airports Operational Improvements																		
OI-4201: Reduced Threat from Unauthorized Persons Entering Airport - Level 1 Components									O	2016								
OI-4203: Reduce CBRNE Threats from Entering Airport									O	2016								
OI-4204: Common and Synchronized Airport Emergency and Disaster Response									O	2016								
OI-4202: Reduced Threat from Unauthorized Persons Entering Airport - Level 2 LEO Integration															O	2022		

Figure 6-3 Secure Airports OI Timetable

A key feature of Secure Airports is the use of NCI to provide security in airside, landside, and vendor supply areas. Advanced surveillance technologies will also provide access control for both individuals and vehicles to prevent chemical, radiological, nuclear, biological, and explosive threats. All relevant stakeholders, including local law enforcement, must be included in the system architecture design for the airport command, control, and communications facilities. The requirements from all relevant stakeholders are critical for a complete and accurate classified information exchange, and for timely and integrated responses to possible catastrophic emergencies or disasters.

Achieving the OIs in this timetable requires a high degree of engagement with internal, external, and international stakeholders, as well as overcoming many challenges including:

- Key decision points to finalize airport emergency response protocols, policies, and procedures are required inputs to the system requirements gathering and architecture design efforts.
- To provide complete detection of threat movements of unauthorized individuals or vehicles, the ability to transmit the information to the airport operations centers, as well as supporting law enforcement organizations, is critical. Situational awareness must be maintained, until law enforcement can engage and resolve the potential threat. To implement a complete solution, stakeholders from industry, local airports, and local law enforcement groups must engage and collaborate to define requirements for the network-enabled information sharing.

- Security information sharing will migrate from verbal to digital exchange. Policies must be developed to determine the types of security systems that will be installed at airports.
- Policies must be developed to decide who determines what security information to share with whom, and when. Policies must also be developed to determine who will be responsible for reconfiguring airports with new security systems, and who will be financially responsible. The results of these policies may affect the implementation timeframe of these security technologies.

6.2.3 Secure Checked Baggage, Cargo and Mail Operational Improvements

NextGen requires Secure Checked Baggage, Cargo, and Mail OIs based on prevention, detection, and mitigation measures. Research will identify technologies that reduce the risk of the cargo and mail being used as a threat to aircraft, aviation facilities, and people. The flow of commerce and throughput of baggage and cargo will be enhanced by new technologies and processes. To improve cargo operations, either the shipper must be credentialed and adhere to 'sterile area' precautions for packaging as a Secure Supple Chain Entity (SSCE), or cargo must be screened by a Certified Supply Chain Entity (CSCE). The benefit of SSCE processing is that with adherence to cargo integrity procedures, no further screening is required.

Figure 6-4 presents the planned evolution of OIs that support the Secure Checked Baggage, Cargo, and Mail component of the Layered Adaptive Security functional area. As shown in Figure 6-4, OI-4400 provides improved processing of cargo and mail transported via SSCE and CSCE by 2014. OI-4401 provides improved cargo and mail screening by 2015, while OI-4300 provides improved baggage screening by 2016. These Level 1 capabilities are enhanced to the next level, as defined by OI-4301 and OI-4403. These Level 2 capabilities will provide detection systems that are integrated with sensor fusion and utilize the NCI by 2018. These technologies will be flexible enough to be scalable to the size of a specific airport.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Secure Checked Baggage, Cargo and Mail Operational Improvements																		
OI-4400: Improved Processing of Cargo and Mail Transported via SSCE and CSCE							O 2014											
OI-4401: Improved Cargo and Mail Screening - Level 1 Components								O 2015										
OI-4300: Improved Baggage Screening - Level 1 Components									O 2016									
OI-4301: Improved Baggage Screening - Level 2 Integrated											O 2018							
OI-4403: Improved Cargo and Mail Screening - Level 2 Integrated											O 2018							

Figure 6-4 Secure Checked Baggage, Cargo and Mail OI Timetable

A key component of this group of OIs is the criticality of deploying reliable and accurate chemical, biological, radiological, nuclear, and explosive (CBRNE) screening systems. The scalability and flexibility of the Level 2 components will provide integration with the NCI, but the most important goal is the increased sensitivity, accuracy, and throughput of the screening systems, as well as the smaller, lighter screening devices. The overall throughput will be further enhanced by utilizing the Remote Terminal Security Screening (RTSS) concept that incorporates screening locations away from airports.

Achieving the OIs in this timetable requires overcoming many challenges including:

- Deploying screening devices that detect CBRNE threats, by 2015, will be a challenge. The current planning and research and development (R&D) efforts have concentrated on the explosive threat type. Strategic planning of the detection devices for all threat types has not been integrated into one strategic plan. This introduces a risk that detection of one or more of the threat types may not meet the schedule goals of the current screening and detection OIs.

- Determining a process to maintain an information-sharing infrastructure, to include the international stakeholders by 2010, is critical for the success of the NextGen initiative. An analysis must be completed to determine the completeness and accuracy of the information exchange, relative to requirements and testing standards. Not including all international stakeholders injects a high degree of risk, and it is critical to ensure a robust, accurate flow of data to the worldwide airport security community.

- The mandated goal of screening 100% of air cargo on passenger aircraft will require constant collaboration with all Transportation Security Administration (TSA) R&D efforts.

6.2.4 Secure Airspace Operational Improvements

NextGen requires Secure Airspace OIs that are based on Security Restricted Airspace (SRA) and integrated flight risk management and risk mitigation procedures. The air navigation service provider (ANSP) defines and manages the SRA according to the security airspace types and establishes pre-defined time-dependent and risk-based security restriction parameters. The evolution to Level 2, of these improvements, focuses on data sharing of public airspace security information, through the Notice to Airmen (NOTAM). Risk management and risk mitigation of high-risk flights, identified by the Security Service Provider (SSP), are based on information in databases maintained by SSP and its mission partners. This process provides for the sharing of situational awareness and surveillance data from flight behavior assessments. As risk management evolves through Levels 2 and 3, automation and decision support capabilities will be implemented to better identify anomalous behaviors. The risk capabilities become more adaptive, as additional risk profiles change, resulting in improved access to airspaces.

Figure 6-5 presents the planned evolution of OIs that support the Secure Airspace component of the Layered Adaptive Security functional area. As shown in Figure 6-5, OI-4501 provides the first level of improved SRA planning and management by 2012. It also provides a security airspace waiver database that will be deployed by the ANSP or its designee. By 2015, OI-4511 provides the second level of improved SRA planning and management, with enhancements, including sophisticated automated sharing and tracking of security airspace waivers amongst all security stakeholders.

Secure Airspace Operational Improvements	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
OI-4501: Improved Security Restricted Airspace Planning/Management - Level 1 Pre-Defined					O	2012												
OI-4500: Integrated Flight Risk Management and Risk Mitigation - Level 1 Static							O	2014										
OI-4511: Improved Security Restricted Airspace Planning/Management - Level 2 Integration								O	2015									
OI-4502: Integrated Flight Risk Management and Risk Mitigation - Level 2 Dynamic																	2025	O
OI-4512: Improved Security Restricted Airspace Planning/Management - Level 3 Flight Risk																	2025	O

Figure 6-5 Secure Airspace OI Timetable

Airspace waiver information is also integrated with the flight risk management capabilities. Since a risk management approach is a core component of NextGen, timely data sharing and collaboration are vital procedures to ensure situational awareness among all stakeholders. OI-4500 provides the initial level of integrated flight risk management by 2014, with more dynamic risk assessment and decision support for integrated response coordination provided by OI-4502 in 2025. The third and most advanced integrated airspace planning, configuration, and distribution capabilities are provided in OI-4512, by 2025. These capabilities establish time-dependent and risk-based security restriction parameters. This improvement makes SRA more adaptive to flight risk determination. Such adaptive parameters minimize the impact, on the overall airspace, due to security and improve overall airspace access. In addition, the information is automatically sent to the cockpit.

A key component of this group of OIs is risk management responses for risk mitigation. A secure communications and information infrastructure is needed to allow ANSP and SSP to coordinate the responses and determine the magnitude of the responses by considering the effect of the responses on the overall airspace. As communications and information sharing are critical to the mission success, collaboration is required to ensure the information needs of all stakeholders are implemented.

Achieving the OIs in this timetable requires overcoming many challenges including:

- Implementation of this set of OIs is dependent upon the issuance of formal policies to predefine security levels, criteria, and approval processes to form the basis for sharing surveillance data between public and private stakeholders. This includes attributes regarding accuracy and timeliness. The requirements gathering process must involve both public and private groups, and it is scheduled for completion in 2009. The success of this effort will largely depend on the successful organization of a more collaborative sharing and communicative environment to ensure all data needs have been presented by all relevant groups.
- Developing the policies that define which organizations will be responsible for maintaining the central data repository and archived repository for aviation information is a key milestone for mission success. These policies are aggressively scheduled for completion by 2009 to 2010. The protection of Top Secret, Secret, Controlled but Unclassified, and industry proprietary information must be considered as the policy decisions are being made. The management of the interconnected domains must also be defined and planned to adhere to legal concerns regarding access to appropriate Community of Interest (COI) related data.

6.2.5 Secure Aircraft and UAS Operational Improvements

NextGen requires Secure Aircraft and Unmanned Aircraft Systems (UAS) OIs that implement policies and technologies aimed at reducing the probability of aircraft and UAS from being hijacked, used as a Weapon of Mass Destruction (WMD), an explosive device, and/or a transport vehicle for CBRNE. UAS will be safeguarded by installing on-board systems that leverage safety modifications and are supplemented by ground-based and procedural systems to protect against lasers, Man-Portable Air Defense Systems (MANPADS), directed energy, or Electromagnetic Pulse (EMP) threats.

To accomplish these improvements, the establishment of streamlined US and international regulatory/policy coordination through International Civil Aviation Organization (ICAO) Separation and Airspace Safety Panel and/or other bilateral/multilateral partnerships must be completed. The policies will guide the development of standards and compatibility requirements for ground/air and non-cooperative surveillance equipment. This is meant to address foreign aircraft flying inside the National Airspace System (NAS), as well as domestic aircraft exiting the NAS. Policies will be established to gather requirements for UAS operations in the NAS, as well as separation standards and equipment requirements for UAS.

Figure 6-6 presents the planned evolution of OIs that support the Secure Aircraft and UAS component of the Layered Adaptive Security functional area. As shown in Figure 6-6, OI-4600 provides reduced threat of aircraft and UAS destruction or used as a weapon. To achieve this OI by 2016, integrated aircraft/UAS security policies, plans, and procedures are initially needed by 2010. Also needed are airport perimeter security policies to identify the organizations responsible for determining what types of security systems will be installed at airports, as well as who decides which airport-related information should be shared. These policies will also determine who will be authorized to receive the airport related security information. The ability to incorporate on-board systems to protect UAS is provided through OI-4601 by

2018. The key component of aircraft security is the development of technologies to reduce the possibility of hijacking or unauthorized diversion of aircraft or UAS through means of force. Since this action enabled the 911 tragedy, eliminating the likelihood of this occurring is the key component of mission success. As with other security areas, being aware of evolving threats and adapting to thwart them will be the cornerstone of the NextGen effort.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Secure Aircraft and UAS Operational Improvements																		
OI-4600: Reduced Threat of Aircraft and UAS Destruction or Used as a Weapon									O	2016								
OI-4601: External Aircraft/UAS Threat Protection											O	2018						

Figure 6-6 Secure Aircraft and UAS OI Timetable

Achieving the OIs in this timetable requires the successful development of key technologies, establishing effective hijacking and unauthorized diversion prevention procedures, and overcoming many challenges including:

- As perimeter security is a key part of ensuring parked aircraft are protected from tampering and unauthorized use, determining who has ownership of important decisions must be established early in the NextGen effort. Decisions about the types of security systems to install, as well as who will be authorized to view security-related information, must be made so other plans can be implemented.
- One of the biggest challenges is determining who has financial responsibility for installing the perimeter security technology improvements. Since the lines of decision-making authority are currently ambiguous, establishing who pays for the improvements is critical to mission success. Without these decisions, the ability to meet the related strategic goals will be jeopardized.
- Currently, perimeter security related information is shared verbally. As new threats arise and the passenger numbers significantly increase, a more elaborate information sharing structure is required. Establishing who gets what data will be critical to the successful implementation of security data systems. It is also critical to ensure that all users of data are properly represented in any database design sessions.

6.2.6 Integrated Risk Management Operational Improvements

NextGen Integrated Risk Management (IRM) OIs require policies and procedures that support collaboration between many security communities. Aviation security resources will be managed using an integrated adaptive approach that promotes the generation of decisions that are risk-informed. To accomplish this goal, NextGen operators will rely on a larger network of data sources than they currently utilize. A more flexible, adaptive risk analysis process requires contributions and communication from non-government sources. The policies that will be developed must provide guidance on how to validate the trustworthiness of the source, as well as data accuracy and integrity. As a result, security mission partners will be able to adapt and quickly respond to evolving risks.

To maximize aviation security that is responsive and adaptive, security and defense service providers will collaborate to manage security resources. Service providers will coordinate and respond to security incidents by using an integrated security command and control capability that includes unified security operations protocols, communications, procedures, and tactics.

Figure 6-7 presents the planned evolution of OIs that support the IRM component of the Layered Adaptive Security functional area. As shown in Figure 6-7, the first implementation is OI-4520 that provides integrated risk-based planning and management of security resources by 2014. OI-4520 requires policies that direct how surveillance data and requirements for data security are to be established, as well as policies that help provide accurate and timely surveillance data, allowing each user of the system to meet operational obligations. By 2021, OI-4521 provides integrated command and control for security incident responses and recovery, enabling security and defense service providers (DSP) to jointly manage security resources and coordinate the response to security incidents.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Integrated Risk Management Operational Improvements																		
OI-4520: Integrated Risk-Based Planning and Management of Security Resources							O	2014										
OI-4521: Integrated Command/Control for Security Incident Response and Recovery														O	2021			

Figure 6-7 Integrated Risk Management OI Timetable

To accomplish an integrated risk-based adaptive approach to aviation security, data contributors and non-governmental stakeholders will all play a role in aviation security. As the types of security communities expand beyond the current government agencies, the need for timely and effective collaboration becomes critical. At a minimum, Department of Defense (DOD), Department of Homeland Security (DHS), Department of Transportation/Federal Aviation Administration (DOT/FAA), and operators must collaborate on policies regarding the collection and distribution of surveillance data, and requirements for data security, network security and access. The expectations are that these policies will be in place by 2009.

Achieving the OIs in this timetable requires a high degree of engagement with internal, external, and local stakeholders. Successful collaboration is the key element that must occur to ensure the entire aviation security community is operationally successful. Achieving the OIs also requires overcoming many challenges including:

- The Integrated Work Plan (IWP) initial operational capability (IOC) dates are critically dependent upon timely policy and procedural agreements among different stakeholders. Without these agreements, the implementation of a risk-informed decision process will be at risk.
- The aviation security stakeholder community is sufficiently large to warrant a plan to ensure all security partners are included in the policy development efforts. The group is expanding beyond the government community to private entities. The manner in which these communities communicate and share information is not likely to be similar. Therefore, an effort must be made to identify the cultural differences and include the differences in an official collaboration and information-sharing plan. The key to aviation security success depends on how successful the collaboration environments are designed and nurtured.

6.3 LAYERED ADAPTIVE SECURITY ENABLERS

The transformation to Layered Adaptive Security requires the implementation of many Enablers. These Enablers will provide the foundation for the realization of OIs and the overall NextGen vision. Enablers must be researched, developed, and implemented in a certain sequence and timing to effectively meet the needs of the OIs they support. Enablers also can support the implementation of other Enablers. To describe these broad needs, the Layered Adaptive Security Enablers have been aligned into six functional groups, as shown in summary in Figure 6-8. The Enabler functional groups are described in the following sections. Full descriptions of each Enabler, including their integration with other IWP elements, are provided in Appendix II as well as on the interactive JPE available at www.jpdo.gov.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Screening Enablers																		
EN-4113: Passenger Checkpoint Screening - Requirements			E 2010															
EN-4114: Passenger Checkpoint Screening - National Standards			E 2010															
EN-4107: Checkpoint Screening Technology - Enhance Passenger Screening Throughput				E 2011														
EN-4205: BPR Technology and Procedures				E 2011														
EN-4109: Checkpoint Screening Technology - Reduction and Improved False Alarm Resolution					E 2012													
EN-4120: Integrated Passenger Screening, Credentialing and Risk Management System - Level 1					E 2012													
EN-4121: Integrated Passenger Screening, Credentialing and Risk Management System - Level 2					E 2012													
EN-4110: Checkpoint Screening Technology - Optimize Screening Infrastructure Requirements								E 2015										
EN-5028: Integrated International Customs Border Protection/Security Service Provider Services								E 2015										
EN-4106: Checkpoint Screening Technology - CBRNE and Weapons									E 2016									
EN-4116: Off Airport Passenger and Baggage Security Screening (RTSS)									E 2016									
EN-4118: Checkpoint Screening Technology - Threat Containment									E 2016									
EN-4108: Checkpoint Screening Technology - Integrated Screening System										E 2017								

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Airport Security Enablers																		
EN-4119: Biometrics and Credential Standards with Airport Access Focus		E 2009																
EN-4210: Airport Command, Control, and Communications Center Architecture			E 2010															
EN-4203: Multi-Agency Security Information Sharing/Delegation Protocols				E 2011														
EN-4202: Integrated and Secure Airport Voice/Data Network					E 2012													
EN-4206: National Airport Emergency Response Protocol/Policies/Procedures					E 2012													
EN-4204: Transportation Worker Identification Credentialing /Access Control/Tracking System						E 2013												
EN-4201: Airport Surveillance, Tracking and Detection System - Level 1							E 2014											
EN-4208: Airport CBRNE Detection Systems								E 2015										
EN-4250: Airport Surveillance, Tracking and Detection System - Level 2													E 2020					

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Baggage/Cargo/Mail Security Enablers																		
EN-4311: Cargo & Mail Screening - National Standards			E 2010															
EN-4310: Cargo & Mail Screening - Requirements				E 2011														
EN-4312: Baggage/Cargo Screening Technology - Threat Containment						E 2013												
EN-4401: Certified Supply Chain Entity						E 2013												
EN-4403: Secure Supply Chain Entity						E 2013												
EN-4301: Baggage/Cargo Screening Technology - CBRNE and Weapons							E 2014											
EN-4302: Baggage/Cargo Screening Technology - Increased Effectiveness								E 2015										
EN-4307: Baggage/Cargo Screening Technology - Integrated Screening System									E 2016									

Figure 6-8 Layered Adaptive Security Enabler Timetables

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Airspace Security Enablers																		
EN-4500: Flight Risk Management System - Level 1 Static					E	2012												
EN-4510: Security Airspace Planning and Management - Level 1					E	2012												
EN-4511: Security Airspace Planning and Management - Level 2							E	2014										
EN-4521: Flight Risk Management System - Level 2 Dynamic									E	2016								
EN-4512: Security Airspace Planning and Management - Level 3																	2025	E

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Aircraft Security Enablers																		
EN-4601: Aircraft Hijack/Unauthorized Diversion Technologies and Procedures					E	2012												
EN-4602: Aircraft Threat Containment and Survivability Hardening					E	2012												
EN-4600: Aircraft Security Systems and Policies									E	2016								
EN-4610: Aircraft External Threat Defense/Mitigation Systems										E	2017							

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Integrated Risk Management Enablers																		
EN-1274: NextGen Security Information Services - DHS Group 1					E	2012												
EN-4520: Integrated Risk Management (IRM) System					E	2012												
EN-4522: Unified National Aviation Command, Control and Communication Architecture													E	2020				

Figure 6-8 Layered Adaptive Security Enabler Timetables (continued)

6.3.1 Screening Enablers

As described in the Section 6.2.1, the Secure People OIs need to ensure that individuals using and operating the aviation system are secure using a comprehensive and integrated screening program. To achieve the screening improvements requires Enablers that upgrade the overall security infrastructure. The screening timetable outlines a comprehensive approach to apply a risk-based Layered Adaptive Security methodology.

Figure 6-9 presents the planned evolution of the Enablers that support efforts to secure passengers and employees at airports. The initial Enablers establish standards and requirements, enhance screening technology to include throughput and improve false alarms, and integrate the screening systems. The next Enablers are to deploy the new technology and optimize the screening infrastructure. Subsequent Enablers build on the newly established checkpoint. The highlights from Figure 6-9 are:

- EN-4113 provides the requirements for passenger checkpoint screening. These requirements define and establish national security performance requirements for the screening of passengers and carry-on baggage. EN-4114 will use these requirements to establish the national standards for passenger checkpoint screening.
- EN-4120 and EN-4121 describe two levels for an integrated passenger screening, credentialing, and risk management system. This vetting system utilizes smart name matching algorithms to check against watch lists to identify high-risk passengers on commercial flights. High-risk passengers are categorized at different risk levels, including no-fly and selectees. The former cannot board, while the latter will receive more screening attention at the checkpoint.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Screening Enablers																		
EN-4113: Passenger Checkpoint Screening - Requirements			E 2010															
EN-4114: Passenger Checkpoint Screening - National Standards			E 2010															
EN-4107: Checkpoint Screening Technology - Enhance Passenger Screening Throughput				E 2011														
EN-4205: BPR Technology and Procedures				E 2011														
EN-4109: Checkpoint Screening Technology - Reduction and Improved False Alarm Resolution					E 2012													
EN-4120: Integrated Passenger Screening, Credentialing and Risk Management System - Level 1					E 2012													
EN-4121: Integrated Passenger Screening, Credentialing and Risk Management System - Level 2					E 2012													
EN-4110: Checkpoint Screening Technology - Optimize Screening Infrastructure Requirements								E 2015										
EN-5028: Integrated International Customs Border Protection/Security Service Provider Services								E 2015										
EN-4106: Checkpoint Screening Technology - CBRNE and Weapons									E 2016									
EN-4116: Off Airport Passenger and Baggage Security Screening (RTSS)									E 2016									
EN-4118: Checkpoint Screening Technology - Threat Containment									E 2016									
EN-4108: Checkpoint Screening Technology - Integrated Screening System										E 2017								

Figure 6-9 Screening Enabler Timetable

- EN-4107 defines the need to develop and deploy checkpoint-screening systems capable of processing passenger volumes at twice the current rate with fewer screeners.
- EN-4205 establishes the Behavioral Pattern Recognition (BPR) automated system and procedures that enhances human-observation methods to detect anomalies in behavior and alerts to potential threats.
- EN-4109 reduces the occurrence of and increases the ability to resolve false alarm by combining and integrating explosives and weapons screening systems.
- EN-4110 set the requirements for screening infrastructure that optimizes the airport terminal space required for checkpoint screening and reduces the overall footprint of the screening equipment. These two objectives provide increased passenger screening capability and capacity.
- EN-5028 integrates the functions of Customs Border Protection (CBP) using NextGen shared situational awareness capabilities, integrated procedures, and technology. This enables more efficient processing in terms of both time and space/passenger. Additionally, CBP functions are coordinated with the SSP to minimize the duplication of screening processes.
- EN-4106 expands the ability of current weapons and explosive screening systems to address the full range of CBRNE threats.
- EN-4116 mitigates the increased number of passengers and carry-on baggage screened at airport terminal buildings by screening passengers at locations remote from the airport terminal building and transporting them securely to the boarding area.
- EN-4118 defines the requirement to test and evaluate threat containment devices for use at checkpoints.
- EN-4108 defines an advanced checkpoint screening system that contains multiple technologies and can enhance the type of detection screening required for particular threats.

Achieving the Enablers described in this timetable requires overcoming several important challenges including:

- Establishing comprehensive, secure, and cost-effective integrated screening infrastructure at all commercial passenger airports
- Maintaining and upgrading the screening infrastructure, which will require an open architecture that will accommodate change, to meet the evolving threat
- Reducing processing times and maintaining an environment that provides security and continues to be supported by the American public.

6.3.2 Airport Security Enablers

The Secure Airport OIs described in Section 6.2.2 requires a range of integrated airport security Enablers. People and workers will be screened and credentialed, as required, with emerging technologies, policies, and procedures. Credentialing standards for people security will be published to establish guidelines for introducing biometrics into the security scheme. Detection systems will be deployed at airports for CBRNE threats and trigger system isolation procedures, as needed. To maintain situational awareness among the security partners, multi-agency security information sharing protocols will be established to allow disparate users access to the network.

Worker identification and credentialing will be performed through Transportation Worker Identification Credentialing - the planned vetting and credentialing program. This program will ensure that workers have access to only those areas they are authorized to access. A tiered role-based system, to provide secure and data encrypted data streaming to authorized users at different classified levels (intra-government and non-government), will be the data network component of the Layered Adaptive Security concept. Surveillance for perimeter security will provide situational awareness to airport security partners by transmitting information to an airport operations center where the threat object can be monitored until intercepted by a Law Enforcement Organization (LEO).

Figure 6-10 presents the planned evolution of Enablers that provide Airport Security. EN-4119 is the earliest Enabler and provides biometrics and credential standards with a focus on airport access by 2009. EN-4210 provides an airport command, control, and communications center architecture, by 2010, that complies with government security and data protocols for the exchange of classified information. Through EN-4203, multi-agency security information-sharing and delegation protocols will be established to support national, regional, state, and inter-airport connectivity on protected systems by 2011. These protocols and standards can then be used on EN-4202 that provides an integrated and secure airport voice/data network with secure/encrypted data streaming to various users at different Sensitive Security Information (SSI)/classified levels.

EN-4206 defines the national airport emergency response protocols, policies, and procedures that will support more seamless responses to disasters or emergencies by regional and national security partners. EN-4204 provides a transportation worker identification, credentialing, access control and tracking system. With this system, airports will have a level of access control where workers can only gain access if their identity has been verified. Passive and active tracking mechanisms, which track employees to ensure the worker only accesses those areas they are authorized to access, will also be available by 2013. By 2015, EN-4208 provides a tactical system that is deployable in airport Heating, Ventilation and Air-conditioning (HVAC) systems to detect comprehensive CBRNE threats and trigger system isolation.

Airport Security Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-4119: Biometrics and Credential Standards with Airport Access Focus		E 2009																
EN-4210: Airport Command, Control, and Communications Center Architecture			E 2010															
EN-4203: Multi-Agency Security Information Sharing/Delegation Protocols				E 2011														
EN-4202: Integrated and Secure Airport Voice/Data Network					E 2012													
EN-4206: National Airport Emergency Response Protocol/Policies/Procedures					E 2012													
EN-4204: Transportation Worker Identification Credentialing /Access Control/Tracking System						E 2013												
EN-4201: Airport Surveillance, Tracking and Detection System - Level 1							E 2014											
EN-4208: Airport CBRNE Detection Systems								E 2015										
EN-4250: Airport Surveillance, Tracking and Detection System - Level 2													E 2020					

Figure 6-10 Airport Security Enabler Timetable

Airport surveillance, tracking, and detection systems are planned in two levels identified by EN-4201and EN-4250. EN-4201 provides the first level, by 2014, including surveillance to detect threat presence in the form of unauthorized personnel, vehicles, or objects, and transmitting this information to an operations center. By 2020, EN-4250 provides the second level that integrates LEOs into the overall information-sharing environment.

6.3.3 Baggage/Cargo/Mail Security Enablers

The Secure Checked Baggage, Cargo, and Mail OIs, described Section 6.2.3, are based on prevention, detection, and mitigation measures. They require Enablers that are implemented in a comprehensive time-phased approach to support the OI requirements. Figure 6-11 presents the planned evolution of the key Enablers that support Baggage, Cargo, and Mail Security at airports.

Baggage/Cargo/Mail Security Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-4311: Cargo & Mail Screening - National Standards			E 2010															
EN-4310: Cargo & Mail Screening - Requirements				E 2011														
EN-4312: Baggage/Cargo Screening Technology - Threat Containment						E 2013												
EN-4401: Certified Supply Chain Entity						E 2013												
EN-4403: Secure Supply Chain Entity						E 2013												
EN-4301: Baggage/Cargo Screening Technology - CBRNE and Weapons							E 2014											
EN-4302: Baggage/Cargo Screening Technology - Increased Effectiveness								E 2015										
EN-4307: Baggage/Cargo Screening Technology - Integrated Screening System									E 2016									

Figure 6-11 Baggage/Cargo/Mail Enabler Timetable

The highlights include:

- EN-4311 and EN-4310 establish the national security performance standards and requirements for the screening of cargo and mail.
- EN-4312 provides testing and evaluating threat containment vessels within and adjacent to baggage screening and alarm resolution equipment capabilities are identified in Baggage/Cargo Screening Technology – Threat Containment.

- EN-4401 provides CSCE Program requirements for cargo/mail to prevent the introduction of threat material into the air transportation system. Cargo/Mail is shipped through a CSCE that includes vetted cargo packers, sterile cargo packing areas, a verified chain of custody, and tamper resistant/alerting technology, reducing the requirements to further screen cargo/mail.

- EN-4403 attempts to have the SSCE ensure that all Cargo/Mail is identified and is capable of being tracked through the air transportation system. Cargo Identification and Tracking reduces the risk of the introduction of threat material and provides tampering alerting. Positive identification and tracking information provides the ability to identify critical information on cargo/mail including shipper, screening methods, and points of origin, destination, and location.

- To address the levels of false alarms, EN-4302 provides decreased levels of false alarm, higher baggage throughput, higher levels of threat detection, and smaller, lighter, and lower cost detection equipment. It also provides multi-technology screening systems to clear alarms faster as well as for alternative screening concepts for airports processing a lower volume of passengers.

- EN-4307 defines the requirement to ensure that baggage and cargo received, from other than a CSCE via the SSCE, requires screening prior to entry and tracked throughout the air transportation secure system for CBRNE threat material. The improvement provides for detection and decreased levels of false alarm, higher cargo throughput, higher levels of threat detection, and smaller, lighter, and lower costs detection equipment. It provides screening using multi-technology screening systems to clear alarms faster, as well as for alternative screening concepts for airports processing a lower volume of baggage and cargo.

Achieving the Enablers described in this timetable requires overcoming important challenges including:

- Cargo is divided into various commodities classes that range in size and type from car engines, electronic equipment, machine parts, apparel, and medical supplies to fresh food and other perishable goods. Additionally, items are shipped in a variety of shipping configuration types. To establish a cargo-screening infrastructure, new technologies must be qualified to detect security threats and support the varied types of cargo and shipping approaches, while not impeding the flow of commerce.

- Establishing a portfolio of qualified air cargo explosives, chemical, biological detection technologies; air cargo alternative screening technologies to ensure no presence of explosives detonation components; stowaway detection technologies; blast mitigation technologies; and supply chain integrity technologies with the proposed timelines is a significant issue.

6.3.4 Airspace Security Enablers

The Secure Airspace OIs, described in Section 6.2.4, require advanced flight risk management and airspace management systems and risk mitigation procedures. Due to the complex nature of securing the airspace, these Enablers will be implemented in multiple stages, as shown in Figure 6-12. Highlights of the Enabler timetable include:

- EN-4500 provides the first level of a flight risk management system that synthesizes static security-relevant data to assess the risk profile of flights. By 2011, this system identifies risks of specific flights and notifies security stakeholders of these risk flights using integrated information system capabilities. The system has collaboration capabilities that allow ANSPs, SSPs and DSPs to coordinate and share information. Security activities and events are automatically logged and shared with stakeholders providing shared situational awareness with common surveillance data.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Airspace Security Enablers																		
EN-4500: Flight Risk Management System - Level 1 Static					E	2012												
EN-4510: Security Airspace Planning and Management - Level 1					E	2012												
EN-4511: Security Airspace Planning and Management - Level 2							E	2014										
EN-4521: Flight Risk Management System - Level 2 Dynamic									E	2016								
EN-4512: Security Airspace Planning and Management - Level 3																	2025	E

Figure 6-12 Airspace Security Enabler Timetable

- EN-4510 identifies the requirement to develop a capability that facilitates the design and the creation of the airspace volume and associated security constraints (volumetric expression, access criteria, and time intervals) to minimize overall airspace system impact. In addition, security airspace advisories are distributed with an improved NOTAM system. Airspace Waivers process and capabilities are in place.

- EN-4511 establishes a capability that facilitates the design and the creation of the airspace volume and their associated security constraints (volumetric expression, access criteria, and time intervals), in order to minimize overall NAS impact. In addition, security airspace advisories are distributed with an enhanced digital NOTAM system that gives users better interface. The Level 2 Airspace Waiver process and capabilities are integrated with the flight risk management system.

- EN-4521 establishes the requirement to develop a capability that synthesizes static security-relevant data and dynamic flight object behavior data (both ATM 4 Dimensional Trajectory (4DT) and security-relevant elements), to assess the risk profile of flights. Once identified, risk flights are notified to the security stakeholders on their display systems. The system has decision support capabilities to assist in risk prediction, event correlation, and security measure impact analysis. In addition, the system has collaboration capabilities that the ANSP/SSP/DSP can coordinate and share information. Furthermore, all stakeholders have shared situational awareness with geo-spatial visualization.

- EN-4512 provides requirements for a capability that facilitates the design and the creation of the airspace volume and their associated security constraints (volumetric expressions, access criteria, and time intervals), in order to minimize overall NAS impact. The airspace access criteria are based on specific flight risk. Security airspace advisories are distributed directly to the cockpit. Security Airspace Planning and Management (SAPM) are integrated with the Flight Risk Management System (FRMS).

Achieving the Enablers described in this timetable requires overcoming several important challenges including:

- Implementation of this set of security Enablers is dependent upon the implementation of NextGen airspace capabilities and having shared situational awareness with common surveillance data.

- Early development of policies for air space use and equipage are necessary for understanding dynamic flight object behavior data security-relevant elements to assess the risk profile of flights.

- Defining organizational responsibilities and practices for maintaining the data repository for aviation information is key for the Enablers to be implemented.

6.3.5 Aircraft Security Enablers

As described in Section 6.2.5, NextGen requires Aircraft Security OIs to prevent and mitigate risks from potential CBRNE and other external threats. Aircraft security will be accomplished through a combination of technologies, policies, personnel, and procedural methods. On-board systems capable of monitoring the cabin, cockpit, and cargo compartment with video and CBRNE detection capability and relaying the information to both on board and external monitoring systems will be implemented for all aircraft. These systems, technologies, and procedures reduce the possibility of hijacking or unauthorized diversion of the aircraft, or UAS, through the means of force or coercion. Aircraft threat containment and survivability hardening systems protect equipment and provide redundant flight control capability, as well as provide cabin and cargo surveillance for the detection of weapons. Aircraft external threat defense and mitigation systems reduce and mitigate the threat from lasers, MANPADS, directed energy, or EMP against aircraft or UAS.

Figure 6-13 presents the planned evolution of strategic Enablers that support the Aircraft Security component of NextGen. The initial requirement is to approve a set of integrated aircraft and UAS policies and procedures by 2010. These policies will lay the groundwork for the on-board system requirements for surveillance, equipment hardening, and aircraft structure tolerance features. EN-4601 defines the requirement to implement aircraft systems that reduce the possibility of hijacking or unauthorized diversion of the aircraft, or UAS, through the means of force or coercion, by 2012.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Aircraft Security Enablers																		
EN-4601: Aircraft Hijack/Unauthorized Diversion Technologies and Procedures					E 2012													
EN-4602: Aircraft Threat Containment and Survivability Hardening					E 2012													
EN-4600: Aircraft Security Systems and Policies									E 2016									
EN-4610: Aircraft External Threat Defense/Mitigation Systems										E 2017								

Figure 6-13 Aircraft Security Enabler Timetable

By the same date, aircraft systems that provide for survivability through critical component hardening and redundant flight control capability will be in effect as outlined in EN-4602. These capabilities will enable the aviation industry to mitigate the effects of explosive devices and provide improvements in the tolerance of aircraft structures and systems to explosives. EN-4600 states the requirement to implement on-board systems capable of monitoring the cabin, cockpit, and cargo compartment with video, and CBRNE detection capabilities, as well as relaying the information to both on-board and external monitoring systems, by 2016. The final capability is outlined in EN-4610 that describes the need to implement on-board and ground based systems to reduce and/or mitigate the threat from lasers, MANPADS, directed energy or EMP against aircraft or UAS. This capability is scheduled for availability by 2017 and is the final component of the implementation of capabilities to eliminate threats from external sources.

The development of streamlined US and international regulatory/policies will require precise coordination through ICAO and/or other bilateral/multilateral partnerships. An important decision will be needed to define the applicable standards for aircraft defense systems and whether those standards should be uniform to all aircraft or tailored for each type of aircraft. Certain types of aircraft have different propensity for security breaches than others (i.e., more or less vulnerable to different threat types). To accurately mitigate these threats, it must be decided whether different aircraft types should have different or uniform applicable standards for defense systems. Since these mitigation elements have high costs, the challenge is to engage all national and international security partners in this decision process.

6.3.6 Integrated Risk Management Enablers

As described in Section 6.2.6, the IRM OIs will require policies, procedures, and technologies that support the decision-making process, when aviation partners are faced with a security breach. The process and tools must provide a structure to help define investment strategies, asset/resource allocation and prioritization, and policy/procedure changes. The IRM strategy provides a federated set of operations centers of ANSP/SSP/DSP, airports, other stakeholders that have command, control, communication structure, and infrastructure and resources to provide integrated security incident management. The establishment of several policies regarding a global approach to information distribution, predefined security levels for access to surveillance information, and a national integrated surveillance plan are critical to the successful implementation of the integrated adaptive risk management approach to aviation security. As the sources and requests for information transcend beyond government organizations to the private sector, collaboration in defining the data security requirements from all relevant stakeholders will also be critical.

Figure 6-14 presents the planned evolution of Enablers that support the IRM operational component of NextGen. The most immediate need is to develop EN-4520 that provides an IRM system. This system includes quantitative tools and measures that supports: automated, risk-based, decision-making investment strategies; asset/resource allocation and prioritization; and policy/procedure changes.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Integrated Risk Management Enablers																		
EN-1274: NextGen Security Information Services - DHS Group 1					E	2012												
EN-4520: Integrated Risk Management (IRM) System					E	2012												
EN-4522: Unified National Aviation Command, Control and Communication Architecture													E	2020				

Figure 6-14 Integrated Risk Management Enabler Timetable

EN-4522 provides a federated set of operations centers. The operations centers will consist of SSP/DSP, airport, and other stakeholders that have command, control, communication structure, infrastructure, and resources and assets that provide integrated security incident management, and they will be fully functional by 2020. The policies that define the "owners" of the central information repository, housed by the operations centers, are scheduled for completion by 2009 to 2010. By the end of this year, policies regarding access controls and trusted relationships will also be established to provide appropriate information access by authenticated COI users.

The key to the IRM timetable is its focus on the tools and processes that support the most effective decisions regarding investment strategies, asset allocation and prioritization, and policy changes. This calls for the generation of surveillance information sharing strategies and security requirements that are compatible with a diverse, international group of security partners. This component is key to establishing the ability to distribute surveillance data to the appropriate security communities.

Implementing improvements described in this timetable will require a high degree of engagement with internal, external, and local stakeholders. The following challenges will need to be overcome:

- Risk Management requires input from many security partners. Ensuring partners' requirements and concerns are incorporated will determine the success of the IRM process. The international community must be engaged to guide the development of standards and compatibility requirements for ground and air surveillance equipment.

- Determining the levels of security will be challenging. Unlike current processes, public and private information will be collected and distributed to the IRM system. This culture change will require much discussion and collaboration among all NextGen Partners.

6.4 RESEARCH AND DEVELOPMENT ACTIVITIES

Using the National Strategy for Aviation Security as a guide, NextGen must transition toward Integrated Security Risk Management. Research is focused toward this area through the development of an integrated contingency management capability in 2012. The risk management approach will guide the selection of adaptable new capabilities emerging from research into securing passengers, cargo, airports, aircraft, and airspace. The Layered Adaptive Security R&D Activities are presented in Figure 6-15. Detailed information describing each R&D Activity, including their integration with other IWP elements, can be found in Appendix III, as well as on the interactive JPE available at www.jpdo.gov.

The R&D Activities are designed to support the Layered Adaptive Security Enabler functional groups. The near term R&D highlights for each functional group area are as follows:

- **Secure People:** Near term R&D effort focuses on checkpoint design to increase screening throughput and minimize airport configuration changes with the integration of chemical, biological, radiological, explosive, and nuclear detection capabilities.

- **Secure Airports**: Near term R&D effort focuses on developing the technology to provide secure connectivity and shared situational awareness for airport command and control facilities. This information will be selectively shared on an as required basis with law enforcement personnel from multiple agencies through an optimized enterprise data management system. A capability to identify and track personnel and vehicles with hostile intent, throughout airport facilities, in real time will also be developed.

- **Secure Checked Baggage, Cargo, and Mail**: Near term R&D activities focus on the development of cargo tracking and tamper alerting technology supporting Secure and Certified Supply Chain Entity cargo screening and handling concept of operations. The focus for cargo R&D was based around a comprehensive portfolio of cargo functions to include explosives, chemical, biological detection technologies; stowaway detection technologies; blast mitigation technologies; and supply chain integrity technologies. Baggage screening R&D focuses on the checkpoint design to increase screening throughput and minimize airport configuration changes while integrating the detection capability for chemical, biological, radiological, and nuclear threat material in addition to explosives.

- **Secure Airspace:** Focuses on flight risk assessment algorithms development, which is based on trajectory behavior. The technology supports the implementation of a system providing flight risk identification, alert notification, decision-making collaboration, and response coordination.

- **Secure Aircraft and Unmanned Aircraft System (UAS):** Focuses on the development of ramp support systems that reduce the number of personnel, equipment, and vehicles present on the airside to prepare the aircraft for flight. A key focus is aircraft hardening and cabin and cargo surveillance for the detection and mitigation of threats to the aircraft.

- **IRM:** Focuses on the development of an initial Integrated Risk Management approach that includes the ability to collect information about potential threats to the air transportation system, assess and prioritize the threats to determine the overall risk, and manage potential mitigation response. The approach will support an Integrated Risk Management implementation decision and evaluate potential threats, determine potential impacts, and manage overall response.

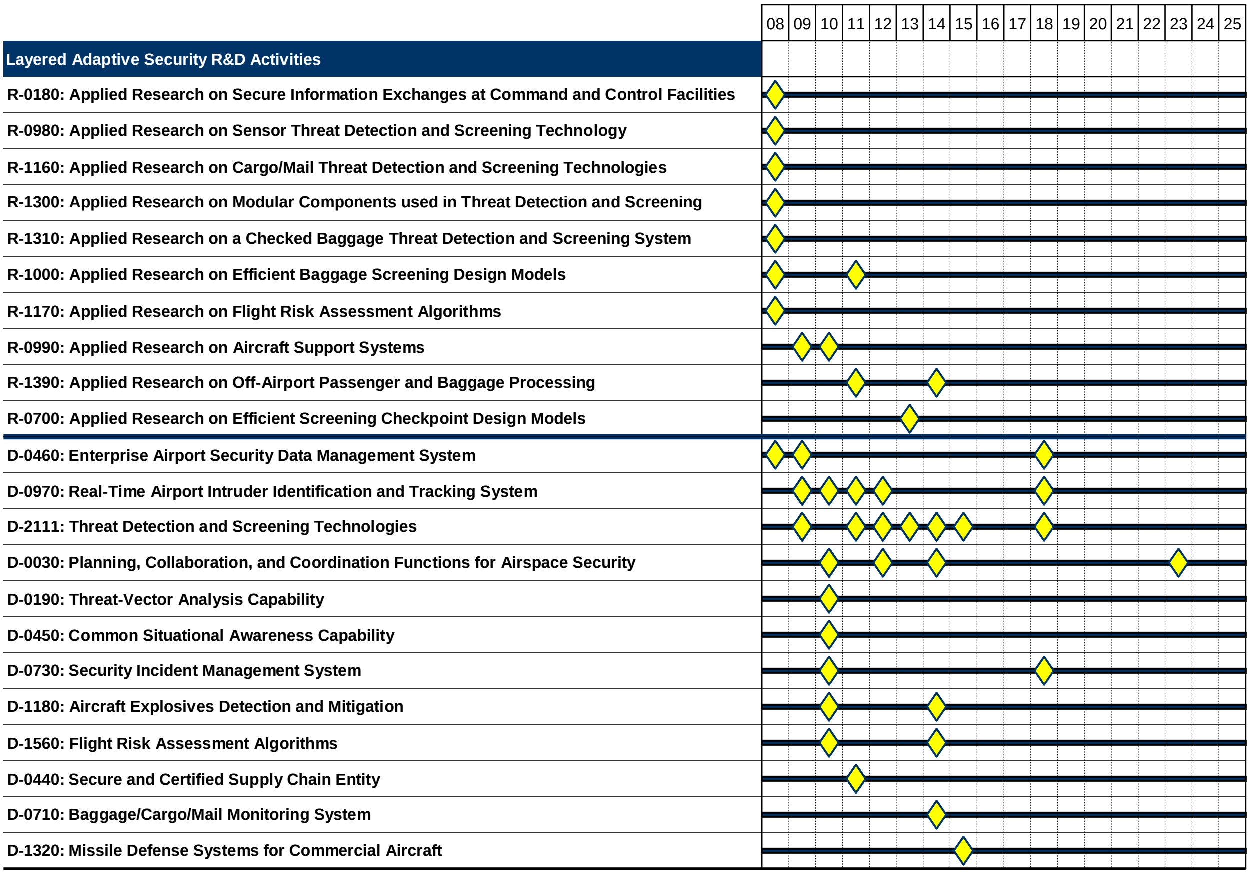

Figure 6-15 Layered Adaptive Security R&D Activities Timetable

6.5 POLICY ISSUES

Global security threats continue to target or manipulate aspects of the U.S. air transportation system. Projected growth in business traffic, air cargo, and leisure travel will further strain security mechanisms intended to prevent and contain breaches to the NAS. In order to continue to improve our ability to detect and respond to security incidents, several strategic policy decisions require resolution. The Layered Adaptive Security Policy Issues are presented in chronological order within Figure 6-16.

The Layered Adaptive Security Policy Issues were developed to provide the ability to simultaneously establish the policies and procedures across all six security related areas. This provides the capability to enhance security measures across all areas of the air transportation system. Policy Issues in Chapter 6 are intended to encourage targeted stakeholder engagement in solving policy challenges that may impede progress toward Layered Adaptive Security OIs. Depending on the maturity of a given issue, descriptions range from specific policy suggestions to recommendations for further analysis and open discussion. Detailed information on each Policy Issue, including their integration with other IWP elements, can be found in Appendix IV, as well as on the interactive JPE available at www.jpdo.gov.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Layered Adaptive Security Policy Issues																		
PI-0079: Global Security			P	2010														
PI-0080: Screening Requirement For Meeters And Greeters			P	2010														
PI-0095: National Security Policies for Passenger and Cargo Screening			P	2010														
PI-0096: Security Financing Responsibility for Passenger and Cargo Screening			P	2010														
PI-0098: Non-Cooperative Target Support			P	2010														
PI-0099: Air Cargo and Mail Security Requirements			P	2010														
PI-0111: Airport Security Governance				P	2011													
PI-0071: Defense System Standards - Global Harmonization					P	2012												
PI-0072: Use of Unmanned Aircraft for Security Missions					P	2012												
PI-0081: Perimeter Security					P	2012												
PI-0074: General Aviation Airport Security Requirements						P	2013											
PI-0091: Airport Worker Vetting						P	2013											
PI-0100: Certified Supply Chain Entity (CSCE)						P	2013											

Figure 6-16 Layered Adaptive Security Policy Issues Timetable

The Security Policy Issues were developed with the following considerations:

- **Secure People:** Calls for the establishment of national policies, performance standards, financial responsibility, and equipment certification requirements for the physical screening of passengers, both domestic and international, as well as the people that meet and greet passengers.
- **Secure Airports:** Calls for the establishment of decision-making authority and funding responsibilities for the requirement, development, installation, operations, and maintenance of airport security related systems and infrastructure. Policies are required to establish a national biometric standard and requirements for airport worker access to sterile and operations areas.
- **Secure Checked Baggage, Cargo, and Mail:** Calls for the establishment of national policies, performance standards, financial responsibility, and equipment certification requirements for the physical screening of baggage, cargo, and mail, both domestic and international. Additional issues include the requirements for the establishment of the CSCE and SSCE programs.
- **Secure Airspace:** Calls for the development of a coordinated national surveillance decision among partner agencies to comprehensively address the functional requirements and financial responsibilities of provision/use of surveillance equipment, services, and information. Policy is necessary to incorporate various airspace user/stakeholders operational and financial needs.
- **Secure Aircraft and Unmanned Aircraft System (UAS):** Policy calls for developing streamlined US and international regulatory/policy coordination, through ICAO and/or other bilateral/multilateral partnerships, for applicable standards for aircraft defense systems and whether those standards should be uniform to all aircraft or tailored for each type of aircraft. In addition, this road map calls for the establishment of the requirements for UAS operations in the NAS, the timeline for the integration of UAS into the NAS, and the establishment of separation standards and equipment requirements for UAS.
- **Integrated Risk Management:** Calls for the establishment of international standards for the security measures for passenger and cargo screening, identification and reporting of passengers, and identification and reporting of aircraft flight trajectories. Policy development calls for harmonizing international security requirements with US requirements.

6.6 SUMMARY - LAYERED ADAPTIVE SECURITY

Layered Adaptive Security seeks to predict, prevent, detect, identify, secure, and mitigate the impact from threats to the entire air transportation system, without unduly limiting mobility or making unwarranted intrusions on the civil liberties of users, providers, and employees. From reservation to destination, security will be improved with adaptive technologies, policies, and procedures that are scaled and layered to the potential threats in each area.

Challenges: Layered Adaptive Security must support the development of a risk-based approach to guide the advancement and implementation of technology, procedures, and policies to provide the security required and mitigate the perceived risk. Additionally, the establishment of national level policies and directives to determine the financing, certification, standards, and installation of security systems throughout the air transportation system is of critical importance. The envisioned security environment must not impede the flow of commerce while reducing processing times, increasing security, and continuing the support of the American public.

Operational Improvements: NextGen seeks to improve the operational efficiency and effectiveness of securing people, airports, checked baggage, cargo, mail, airspace, and aircraft throughout the air transportation system based on a risk-managed framework. NextGen security OIs are highly dependent on the coordinated development and execution of national and international policies, standards, requirements, processes, and procedures by organizations throughout the public and private sectors. Coordinated and collaborative information sharing environments must be designed, implemented, and nurtured for successful aviation security.

Enablers: NextGen security OIs and SSP require: advanced screening, detection, and containment technologies; integrated information processing and screening systems; advanced prediction, prevention, identification, containment, and response processes; and enterprise integrated risk management systems and approaches. A near-term and fundamental need is to establish National Security Performance Requirements and Standards for the screening of passengers, carry-on baggage, cargo, and mail. A transformational Supply Chain Entity Program will reduce security risks and improve overall efficiency. An integrated flight risk management system will improve airspace security by actively assessing risks and monitoring flights.

Research and Development Activities: NextGen security requires: the development of improved people and cargo screening technologies; improved technologies for the detection of hazardous materials; flight risk assessment algorithms; integrated risk management approaches for threat determination, impacts, and overall response; and increased protection and survivability of aircraft.

Policy Issues: Improved safety certification policies, tools, and processes are needed to allow the rapid, yet safe, adoption of new technologies in the most effective manner, balancing public and private sector resources. National policies and performance standards are needed for the physical screening of all passengers, the people that meet and greet passengers, baggage, cargo, and mail. Standardized requirements are needed to establish the CSCE and SSCE programs.

7 Environmental Management Framework

The NextGen vision includes the management of critical environmental resources and impacts through an Environmental Management Framework (EMF) that is fully integrated into all NextGen operations. The EMF is an overall strategy designed to balance aviation operational growth with environmental protection goals to achieve a sustainable air transportation system. The EMF supports the NextGen Capabilities to provide *Integrated Regulatory and Risk Management, Efficient Trajectory Management, and Flexible Airport Facility and Surface Operations*.

The EMF is structured to address the management of environmental resources using five functional groups focused on policy, operations, technology, tools, and science and metrics. The EMF must account for interdependencies among many environmental issues so that in addressing some, others are not exacerbated. While at the same time, the EMF must maintain a balance between environmental goals and the need to advance aviation safety, national security, and economic well-being.

Critical to the success of this framework is a commitment from Federal agencies to a strategy that addresses the environmental constraints on system capacity and international coordination. This strategy requires support for research, aircraft technology, alternative fuels development, operational enhancements, and other policy initiatives to achieve near-term and future gains. Success will result in the absolute reduction of significant noise and air quality impacts, the rate of fuel burn, and the impact of aviation greenhouse gas emissions on global climate. Success will also result in proactively addressing other important environmental issues such as water quality, fuel production and availability, and protection of noise-sensitive areas. Objectives of the NextGen EMF [1] include:

- Reduce significant community noise and air quality emissions impacts in absolute terms
- Limit or reduce the impact of aviation greenhouse gas emissions on global climate including the rate of fuel burn
- Improve energy efficiency of air traffic operations
- Support alternative fuels development
- Proactively address other environmental issues.

To help achieve these goals, the NextGen EMF promotes the development of a national Environmental Management System (EMS) approach. EMS includes a management process to help users systematically identify, manage, monitor, and adapt to the environmental demands associated with the high volume and dynamic nature of the air transportation system. The national EMS approach is intended to facilitate an effective and common process that is adopted by all applicable U.S. aviation organizations, and therefore provides a mechanism for integrating environmental protection objectives into the core business and operational decision making of NextGen. While EMF provides the overarching strategy needed to achieve environmentally sustainable aviation growth, EMS delivers a management process for achieving environmental protection in user actions.

1 The objectives were defined within the 2004 *NGATS Integrated Plan*: Environmental Protection that Allows Sustained Aviation Growth and the key principle of the *2005 Vision*: Integrated Environmental Performance.

7.1 INTRODUCTION

This chapter presents the results, timing and dependencies of work efforts necessary to achieve the NextGen vision for the Environmental Management Framework. Anticipated increases in air transportation demand will place significant environmental pressures on the national airspace system (NAS). Current operational trends show that environmental impacts resulting from aircraft noise and aviation emissions will be the principal constraint on the capacity and flexibility of the NextGen unless managed and mitigated. Aviation impacts affect noise footprints, air quality, water quality, and the global climate.[2] Environmental issues have already resulted in the delay and/or down-scaling of certain airport capacity and airspace redesign projects over the past decade. These challenges are a concern to commercial and general aviation as well military users. For example, military readiness is being constrained by restrictions on training and operations due to environmental issues.

The NextGen challenge is to reduce aviation's environmental footprint while supporting projected aviation growth. This includes reducing the impacts of aviation noise, air quality and greenhouse gas emissions in a cost-beneficial manner. NextGen must achieve a balance between aviation's environmental impacts and other societal objectives, both domestically and internationally. NextGen can meet these challenges by eliminating system-induced congestion and delay, accelerating the aircraft technology development and penetration cycle, and by advancing alternative fuels to manage aviation's environmental impacts.

An immediate challenge for the transformational and dynamic nature of NextGen is compliance with the National Environmental Policy Act (NEPA), which requires environmental review and documentation for Federal actions. Many of the initiatives, permits, approvals, and licenses issued by the Federal Aviation Administration (FAA) for NAS improvements (e.g., airport layout plan approval for construction or extension of an airport runway and re-designs of airspace) to accommodate NextGen capacity goals will require NEPA review. The NEPA review process requires time for collection and analysis of information to assess the significance of impacts on the environment and in some cases (e.g., preparation of an environmental impact statement), there are prescribed timeframes for public review and comment on NEPA documents describing the impacts of the proposed actions. If NextGen is to be a truly transformed and dynamic system, the need for NEPA review of actions with potential impacts on the environment will have to be given careful consideration and integrated into NextGen planning.

7.2 EMF OPERATIONAL IMPROVEMENTS

Achieving the NextGen vision of environmental protection that allows sustained aviation growth requires the implementation of a broad range of OIs. These OIs represent fundamental changes in the NAS to serve the needs of the air transportation community. Figure 7-1 presents the timetable of OIs needed to achieve the objectives of the EMF. Full descriptions of each OI, including their integration with other IWP elements, are provided in Appendix I, as well as on the interactive JPE available at www.jpdo.gov.

As shown in Figure 7-1, most of the EMF OIs are defined with two levels that identify the progression from initial OI inception to a refined point throughout the life of the NextGen program. In other words, Level 1 OIs address near term improvements while Level 2 OIs address the continuation of improvements needed to achieve the EMF strategy.

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2 Fuel consumption, per se, is not an environmental impact, but is discussed as a surrogate for emissions impacts, [especially those related to greenhouse gases (GHGs)] such as carbon dioxide (CO2). It should also be noted that there are many potential impact areas, but the primary environmental constraints on the capacity and flexibility of NextGen are noise, air quality, global climate impacts, water quality, and energy production and consumption.

EMF Operational Improvements	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
OI-6014: Implement EMS Framework - Level 1				O 2011														
OI-6005: Environmentally and Energy Favorable En Route Operations - Level 1								O 2015										
OI-6008: Environmentally and Energy Favorable Terminal Operations - Level 1								O 2015										
OI-6012: Implement NextGen Environmental Engine and Aircraft Technologies - Level 1								O 2015										
OI-6017: Increased Use of Alternative Aviation Fuels								O 2015										
OI-6020: Implement EMS Framework - Level 2											O 2018							
OI-6021: Environmentally and Energy Favorable Terminal Operations - Level 2													O 2020					
OI-6022: Environmentally and Energy Favorable En Route Operations - Level 2													O 2020					
OI-6023: Implement NextGen Environmental Engine and Aircraft Technologies - Level 2														O 2021				

Figure 7-1 Environmental Management Framework OI Timetable

The first group of OIs provides the staged implementation of the EMS framework as described in OI-6014 and OI-6020. By 2011, OI-6014 provides the first implementation of the EMS framework, including environmental goals and decision support tools to address, plan, and mitigate environmental issues. The EMS framework is expanded through OI-6020, which includes refined environmental goals and decision support tools, and availability of enhanced environmental information to address, plan and mitigate environmental issues.

The second group of OIs provides environmental and energy improvements to en route operations as described in OI-6005 and OI-6022 and terminal operations as described by OI-6008 and OI-6021. En route operations are enhanced to reduce emissions, fuel burn, and noise using technologies such as advanced flight management systems and aircraft avionics to provide energy management guidance. Terminal operations are enhanced to reduce emissions, fuel burn, and noise using environmentally friendly procedures such as Optimized Profile Descent (OPD) and standard instrument departure (SID) procedures that minimize level segments on climb out. It also includes surface operation mechanisms and procedures to maximize airport throughput while further reducing aircraft fuel burn and emissions

The third group of OIs implements NextGen environmental engine and aircraft technologies as described in OI-6012 and OI-6023. These OIs provide reductions in aircraft noise, emissions, and fuel burn through improvements in aircraft engine and airframe technologies and alternative fuels. Technologies will be at sufficient readiness level to achieve the goals of the FAA's continuous low emissions, energy, and noise (CLEEN) program and future generations of advanced aircraft with enhanced capabilities as described by NASA as next generation (N+1) and generation after next (N+2) configurations.

Finally, OI-6017 seeks to increase the use of alternative aviation fuels by first determining the feasibility and market viability of alternative aviation fuels for civil use. OI-6017 also seeks to obtain certification of synthetic paraffinic kerosene (SPK) fuels from fossil and renewable resources that are compatible with existing infrastructure and fleet, thus meeting the requirement to be a "drop in" alternative fuel.

Numerous challenges must be resolved to bring the EMF vision to reality. First, the means are needed to measure, model and predict how specific aviation operations or mitigation techniques will impact the environment. These means will allow analysis that can help to determine target impact levels, guide the development of reduction techniques, and assess their costs, benefits, and trade-offs. This analysis will then help to establish the targets, goals, and policies needed to guide the OIs that will achieve NextGen environmental objectives. These OIs will not only include changes to operations and other capacity enhancing measures, they will also include advanced technologies, alternative fuels, and the development and deployment of a EMS framework approach for adoption by all applicable U.S. aviation organizations.

7.3 ENVIRONMENTAL MANAGEMENT FRAMEWORK ENABLERS

The realization of the NextGen EMF requires the implementation of many Enablers. These Enablers will provide the foundation for the achievement of OIs and the overall NextGen vision. Enablers must be researched, developed and implemented in a certain sequence to effectively meet the needs of the OIs and other Enablers they support. To describe these broad needs, the EMF Enablers have been aligned into the five functional groups of Policy, Operation, Technology, Tool, and Science and Metric as shown in summary in Figure 7-2. The Enabler groups are described in the following sections. Full descriptions of each Enabler, including their integration with other IWP elements, are provided in Appendix II, as well as on the interactive JPE available at www.jpdo.gov.

Similar to the EMF OIs, many Enablers have time-phased levels synchronized with the NextGen capabilities they support. Level 1 is considered "initial", Level 2 and subsequent levels provide refinements or further progress towards a "fully operational" condition. Level 1 EMF Enablers describe actions and products based upon current or legacy conditions to achieve improved environmental performance for NextGen. Level 2 and beyond Enablers describe actions informed by further research and improved baseline understanding of conditions, and serve as a more integrated approach to addressing environmental issues facing NextGen.

EMF Policy Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-6000: Environmental Management Strategy	E 2008																	
EN-6001: EMS Framework - Level 1 Development	E 2008																	
EN-6013: NextGen Environmental Protection Goals - Level 1 Initial	E 2008																	
EN-6002: EMS Framework - Level 2 Pilot		E 2009																
EN-6016: EMS Outreach Program		E 2009																
EN-6027: EMS Framework - Level 3 Ongoing Improvements				E 2011														
EN-6041: NextGen Environmental Protection Goals - Level 2 Refined				E 2011														
EN-6018: Enhanced Environmental Information								E 2015										

EMF Operation Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-6020: Environmentally Improved Surface Operations - Level 1 - Initial			E 2010															
EN-6004: Environmentally Improved Terminal Area Navigation - Level 1 Tools								E 2015										
EN-6005: Environmentally Improved En Route Air Navigation -Level 1 Route Planning/Selection								E 2015										
EN-6008: Avionics to Reduce Environmental Impacts - Level 1								E 2015										
EN-6046: Environmentally Improved Surface Operations - Level 2 - Enhanced								E 2015										
EN-6030: Environmentally Improved En Route Air Navigation -Level 2 Dynamic Routing											E 2018							
EN-6042: Environmentally Improved Terminal Area Navigation - Level 2 Automation/Mechanisms											E 2018							
EN-6044: Avionics to Reduce Environmental Impacts - Level 2											E 2018							
EN-6043: Environmentally Improved Terminal Area Navigation - Level 3 Dynamic Information													E 2020					
EN-6045: Avionics to Reduce Environmental Impacts - Level 3													E 2020					

Figure 7-2 EMF Enabler Timetables

EMF Technology Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-6010: Available Alternative Fuels - Level 1	E 2008																	
EN-6049: Available Alternative Fuels - Level 2		E 2009																
EN-6007: Environmentally Improved Airframe and Engine Technology - Level 1 (N+1)						E 2013												
EN-6050: Available Alternative Fuels - Level 3						E 2013												
EN-6035: Environmentally Improved Aircraft Airframe and Engines - Level 1								E 2015										
EN-6051: Available Alternative Fuels - Level 4								E 2015										
EN-6036: Environmentally Improved Airframe and Engine Technology - Level 2 (N+2)											E 2018							
EN-6037: Environmentally Improved Aircraft Airframe and Engines - Level 2														E 2021				

EMF Tools Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-6012: Baseline Environmental Condition - Level 1	E 2008																	
EN-6011: Environmental Impact Modeling and Assessment - Level 1				E 2011														
EN-6047: Baseline Environmental Condition - Level 2								E 2015										
EN-6048: Environmental Impact Modeling and Assessment - Level 2											E 2018							

EMF Science and Metrics Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-6022: Science and Metrics of Noise - Level 1 Baseline	E 2008																	
EN-6023: Science and Metrics of Local Emissions - Level 1 Baseline	E 2008																	
EN-6024: Environmental Tradeoffs and Metrics of Fuel Burn – Level 1 Baseline	E 2008																	
EN-6038: Science of Global Climate - Level 1 Baseline	E 2008																	
EN-6006: Baseline of Required Water Pollution Mitigation Needs				E 2011														
EN-6032: Science and Metrics of Noise - Level 2 Advanced				E 2011														
EN-6033: Science and Metrics of Local Emissions - Level 2 Advanced				E 2011														
EN-6034: Environmental Tradeoffs and Metrics of Fuel Burn - Level 2 Enhanced				E 2011														
EN-6039: Enhanced Global Climate Metrics				E 2011														
EN-6053: Science of Global Climate - Level 2 Advanced				E 2011														
EN-6054: Enhanced Water Pollution Mitigation									E 2016									

Figure 7-2 EMF Enabler Timetables (continued)

7.3.1 EMF Policy Enablers

As described in Section 7.2, NextGen requires environmental improvements that are fully integrated into all operations. These OIs require Enablers that support the planning, design, and implementation of a EMS framework, and supports national and international harmonization of aviation environmental management policies.

Figure 7-3 presents the core group of Enablers that support the development and implementation of EMS policies, approach, strategy and framework, including clarification of environmental policy and research and development for NextGen. As shown in Figure 7-3, the first three near-term Enablers identify the operational concepts, environmental strategy, goals, targets, and management mechanisms needed to achieve the long-term environmental viability and sustainability of the NAS. These initial Enablers include EN-6000 that provides the environmental management strategy, EN-6001 that provides the first level of the EMS framework, and EN-6013 that provides the first level of the NextGen environmental protection goals.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EMF Policy Enablers																		
EN-6000: Environmental Management Strategy	E 2008																	
EN-6001: EMS Framework - Level 1 Development	E 2008																	
EN-6013: NextGen Environmental Protection Goals - Level 1 Initial	E 2008																	
EN-6002: EMS Framework - Level 2 Pilot		E 2009																
EN-6016: EMS Outreach Program		E 2009																
EN-6027: EMS Framework - Level 3 Ongoing Improvements				E 2011														
EN-6041: NextGen Environmental Protection Goals - Level 2 Refined				E 2011														
EN-6018: Enhanced Environmental Information								E 2015										

Figure 7-3 EMF Policy Enabler Timetable

A core component of this Enabler group is the multi-stage development of EMS that was started at the first level with EN-6001 in 2008 and continues with the second and third levels in EN-6002 and EN-6027 by 2009 and 2011 respectively. Supporting these key EMS Enablers are EN-6016 that provides the EMS outreach program, and EN-6018 that provides enhanced environmental information.

This integrated strategic EMS approach provides the foundation for integrating environmental protection policies and objectives into the core business and operational strategies of NextGen. The EMS approach and framework helps to manage the environmental performance aspects of NextGen. It is expected that NextGen Partners will individually and collectively support the implementation of this EMS approach and framework within their own organizations. This collective effort will integrate environmental objectives and goals into the planning, decision-making, and operation of NextGen, helping to manage the environmentally sustainable growth of air transportation.

The EMF policy Enabler timetable was developed with the following considerations:

- Further maturation of science and metrics to guide NextGen environmental protection goals is critical to execution of policy decisions, particularly with regard to understanding the effect of global climate and hazardous air pollutants (HAPs) from aviation emissions.
- Development and adoption of commonly used metrics, models, and decision support tools will facilitate the EMS cycle.
- Development of a coordinated EMS approach across all portions of the aviation industry (e.g. airports, air carriers, and federal agencies) that drive towards common NextGen goals and targets.
- For enhanced environmental information, advances in automated collection of applicable data, real-time calculations, and mitigation of aviation's environmental impacts and energy use, are needed using standardized processes to calculate environmental benefits automatically across programs and for different operational scenarios. A network of environmental communication, providing instant access to key environmental data and targets, is needed to enable users of the air transportation system to access the best possible information to assist in selecting and implementing cost-beneficial management options.
- Successful development of new technologies, including engine/airframe technologies and alternative fuels, and their integration into the commercial fleet are critical to achievement of environmental protection goals for 2015 and beyond.

7.3.2 EMF Operations Enablers

NextGen requires environmental improvements to support a wide range of aircraft operations. These OIs require Enablers that provide environmentally-improved air traffic procedures and surface operations as well as avionics to support reduced aircraft noise and fuel burn and emissions.

Figure 7-4 presents the core group of Enablers that support efforts to develop aviation environmentally-improved NAS operations. As shown in Figure 7-4, these Enablers are grouped into support for surface, terminal, and en route operations, as well as avionics. Multiple levels of Enablers are envisioned for each of the operational support areas. EN-6020 and EN-6046 support two levels of improved surface operations in 2010 and 2015, respectively. Similarly, EN-6004, EN-6042, and EN-6043 support three levels of improved terminal operations in 2015, 2018 and 2020, respectively. Finally, EN-6005 and EN-6030 support two levels of improved en route operations in 2015 and 2018, respectively. This group of operations Enablers supports the near-term implementation of OPDs, pilot and controller tool development, gap analysis, requirements development, human-in-the-loop evaluations, and development of an en route planning tool to optimize emission/fuel burn reductions.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EMF Operation Enablers																		
EN-6020: Environmentally Improved Surface Operations - Level 1 - Initial			E	2010														
EN-6004: Environmentally Improved Terminal Area Navigation - Level 1 Tools								E	2015									
EN-6005: Environmentally Improved En Route Air Navigation -Level 1 Route Planning/Selection								E	2015									
EN-6008: Avionics to Reduce Environmental Impacts - Level 1								E	2015									
EN-6046: Environmentally Improved Surface Operations - Level 2 - Enhanced								E	2015									
EN-6030: Environmentally Improved En Route Air Navigation -Level 2 Dynamic Routing											E	2018						
EN-6042: Environmentally Improved Terminal Area Navigation - Level 2 Automation/Mechanisms											E	2018						
EN-6044: Avionics to Reduce Environmental Impacts - Level 2											E	2018						
EN-6043: Environmentally Improved Terminal Area Navigation - Level 3 Dynamic Information													E	2020				
EN-6045: Avionics to Reduce Environmental Impacts - Level 3													E	2020				

Figure 7-4 EMF Operations Enabler Timetable

In parallel with these operational support Enablers, three levels of avionics are envisioned that support environmental improvements. These start with EN-6008 in 2015 and continue with EN-6044 and EN-6044 in 2018 and 2020, respectively.

The EMF operations Enabler timetable was developed with the following considerations:

- Conduct human-in-the-loop or field evaluation of surface planning tools to minimize environmental impact and integrate findings into trajectory operations capabilities.
- Complete the draft of an operational concept for operating a terminal area to minimize environmental impact while maintaining capacity and throughput. The goal will be to work out how OPDs (commonly referred to as Continuous Descent Arrivals) would be integrated into the 4D trajectory.
- Develop an en route planning tool to optimize routes for environmental emissions reductions and integration within a common automation platform.

- Transition risks exist from transitioning OPD concept development and demonstration to NAS deployment. The goal will be to manage concept validation employing modeling and simulation, prototyping and field demonstrations in an operational environment to assist in accelerating the transition from concepts, research, and development to implementation of operational systems.

7.3.3 EMF Technology Enablers

To achieve its environmental goals, NextGen requires technology Enablers that provide environmentally-improved aircraft airframes and engines, and support the development of alternative aviation fuels.

Figure 7-5 presents the core group of enablers that support efforts to develop aviation environmentally-improved technology for NextGen. As shown in Figure 7-5, these Enablers are grouped in multiple levels for alternative fuels, the technology for airframe and engine, as well as the actual engines and airframes.

The improvements for alternative fuels are described by EN-6010, EN-6049, EN-6050, and EN-6051 that develop from 2008 through 2015. The underlying technologies that support the development of environmentally-improved airframes and engines are described by EN-6049 and EN-6036 that are achieved in 2013 and 2018, respectively. Using these underlying technologies, new engines and airframes will subsequently be available through EN-6035 and EN-6037 in 2015 and 2021. The technology Enabler group includes a balance of research into environmental technologies between mature and long-term initiatives for airframes, more efficient engines, advanced propulsion concepts, and new materials to reduce source noise and emissions. This includes development of an improved science-based understanding of alternative fuels and their potential aviation applications, while quantifying any impacts and interrelationships resulting from aviation use.

EMF Technology Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-6010: Available Alternative Fuels - Level 1	E	2008																
EN-6049: Available Alternative Fuels - Level 2		E	2009															
EN-6007: Environmentally Improved Airframe and Engine Technology - Level 1 (N+1)						E	2013											
EN-6050: Available Alternative Fuels - Level 3						E	2013											
EN-6035: Environmentally Improved Aircraft Airframe and Engines - Level 1								E	2015									
EN-6051: Available Alternative Fuels - Level 4								E	2015									
EN-6036: Environmentally Improved Airframe and Engine Technology - Level 2 (N+2)											E	2018						
EN-6037: Environmentally Improved Aircraft Airframe and Engines - Level 2														E	2021			

Figure 7-5 EMF Technology Enabler Timetable

The EMF technology Enabler timetable was developed with the following considerations:

- Research that determines the feasibility of alternative aviation fuels, including defining the market viability and the ability to produce significant quantities

- Obtain certification from American Society for Testing and Materials (ASTM) for "drop in" alternative fuels from conventional or synthetic sources

- Build a balanced portfolio between long-term and maturing aviation environmental technologies in airframes and propulsion systems and determine mechanisms to accelerate introduction of technologies into fleets.

7.3.4 EMF Tools Enablers

NextGen requires Enablers that support improved metrics, measurement techniques, and modeling to understand and quantify the impacts and relationships of aviation environmental factors. These capabilities will be utilized to understand, monitor, and predict the environmental performance of the NAS as NextGen progresses towards achieving environmental goals.

Figure 7-6 presents the core group of Enablers that support efforts to develop aviation environmentally-improved tools for NextGen. As shown in Figure 7-6, these Enablers are grouped in multiple levels to baseline environmental conditions, as well as modeling and assessment of environmental impacts.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EMF Tools Enablers																		
EN-6012: Baseline Environmental Condition - Level 1	E	2008																
EN-6011: Environmental Impact Modeling and Assessment - Level 1				E	2011													
EN-6047: Baseline Environmental Condition - Level 2								E	2015									
EN-6048: Environmental Impact Modeling and Assessment - Level 2											E	2018						

Figure 7-6 EMF Tools Enabler Timetable

These Enablers start with EN-6012 that provides the first level of baseline of environmental conditions in 2008. This baseline includes current levels of aviation noise and emissions to provide a benchmark for the analysis of NextGen benefits or impacts. This baseline supports EN-6011 that provides the first level of environmental impact modeling and assessment in 2011. This first generation of models and baselines will help to inform the decisions needed to guide NextGen environmental development. These first levels are followed by EN-6047 that provides the second level of baseline environmental conditions in 2015, and EN-6048 that provides the second level of environmental impact modeling and assessment in 2018.

The development of baselines, models and assessments allows the "portfolio management" of policy, technological, operational, and market-based measures to cost-effectively manage aviation's environmental impacts. This is supported by continued transition from legacy tools to aviation environmental design tools (AEDT), release of improved analysis methodologies and inventory databases, and work towards a framework for aviation environmental portfolio management tools (APMT).

The EMF tools Enabler timetable was developed with the following considerations:

- Verification, validation and assessment of integrated environmental tools are completed and stakeholder acceptance of these tools exists.
- Configuration management and use of latest tools for all NextGen analyses and advancing tool integration to eliminate the need for human-in-the-loop analysis is completed.

7.3.5 EMF Science and Metrics Enablers

NextGen requires Enablers that support the science and metrics needed to develop improved metrics, science-based understanding of impacts of aviation on noise, air quality, fuel burn, airport water quality, and global climate to support decisions and policies for environmental performance of the NAS.

Figure 7-7 presents the core group of Enablers that support efforts to develop aviation environmental science and metrics for NextGen. As shown in Figure 7-7, these Enablers are grouped in multiple levels to support science and metrics for noise, local emissions, fuel burn, global climate and water pollution.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EMF Science and Metrics Enablers																		
EN-6022: Science and Metrics of Noise - Level 1 Baseline	E	2008																
EN-6023: Science and Metrics of Local Emissions - Level 1 Baseline	E	2008																
EN-6024: Environmental Tradeoffs and Metrics of Fuel Burn – Level 1 Baseline	E	2008																
EN-6038: Science of Global Climate - Level 1 Baseline	E	2008																
EN-6006: Baseline of Required Water Pollution Mitigation Needs				E	2011													
EN-6032: Science and Metrics of Noise - Level 2 Advanced				E	2011													
EN-6033: Science and Metrics of Local Emissions - Level 2 Advanced				E	2011													
EN-6034: Environmental Tradeoffs and Metrics of Fuel Burn - Level 2 Enhanced				E	2011													
EN-6039: Enhanced Global Climate Metrics				E	2011													
EN-6053: Science of Global Climate - Level 2 Advanced				E	2011													
EN-6054: Enhanced Water Pollution Mitigation									E	2016								

Figure 7-7 EMF Science and Metrics Enabler Timetable

The first set of these EMF science and metrics enablers are EN-6022, 6023, 6024, 6038, and 6006 which respectively support the science and metrics of noise, local emissions, environmental tradeoffs and metrics of fuel burn, advances the science of global climate, and a provides a baseline of required water pollution mitigation needs. These first level Enablers are achieved between 2008 and 2011 and support the development of a baseline understanding for the characterization and definition of NextGen noise, air quality, fuel burn, airport water quality, and global climate impacts. They also support the development or refinement of metrics to support establishment of refined NextGen environmental policies, such as targets and goals. The science and metrics Enablers help to develop revised environmental targets in noise and emissions, improved metrics, measurement techniques, and modeling to understand and quantify impacts and inter-relationships of aviation environmental factors.

The EMF science and metrics Enabler timetable was developed with the following considerations:

- The further maturation of science and metrics to guide NextGen Environmental protection goals is critical to execution of policy decisions. Develop and adopt commonly used metrics, particularly with regard to understanding the health and welfare effects of global climate and particulate matter from aviation emissions.
- Evaluating the impact of alternative fuels on affecting air quality and global climate change.
- Defining effects of noise on public health and welfare and establishing noise impact metrics for National Parks and wildlife. Developing low- frequency noise impact metrics and assess mitigation techniques based on completed low-frequency noise metrics assessment. Developing preliminary sonic boom acceptance metrics.
- Developing models and decision support tools will facilitate the EMS cycle.

7.4 RESEARCH AND DEVELOPMENT ACTIVITIES

The transformation to NextGen requires R&D Activities that will guide advancements in technology, processes and operations that will reduce aviation's impact on the environment. The initial set of R&D Activities identified to support the NextGen EMF is shown in Figure 7-8. These R&D Activities align with the National Plan for Aeronautics R&D and Related Infrastructure, and have been primarily drawn from the NextGen FY2009- FY2013 R&D Plan. Additional R&D details were gathered from the FAA 2008 National Aviation Research Plan. As appropriate, the R&D Activities are aligned to Enablers and describe when specific information from the R&D is necessary to achieve the Enablers' goals, as well as the overall IWP. Detailed information describing each R&D Activity, including their integration with other IWP elements, can be found in Appendix III, as well as on the interactive JPE available at www.jpdo.gov.

EMF R&D Activities	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
R-2124: Applied Research on Ultra-Low Sulfur Conventional Jet Fuels	◆																	
R-0740: Applied Research on "Drop-in" Alternative Aviation Fuels		◆																
R-0810: Applied Research on Noise, Emissions, and Performance Trade-offs for N+1 Aircraft		◆		◆														
R-1760: Applied Research on the Methodologies and Metrics to Assess Climate Change Impacts		◆																
R-0050: Applied Research on Sustainable Environmental Ramp Operations				◆		◆												
R-1030: Applied Research on Environmental Metrics for New and Alternative Vehicle Classes				◆		◆												
R-1340: Applied Research on Aviation Procedures to Reduce Environmental Impacts				◆														
R-1750: Applied Research on the Policy and Procedures to Reduce Aviation Environmental Impact				◆														
R-0200: Applied Research on Noise and Emissions Relationship Science and Models							◆		◆									
R-0760: Applied Research on Water Pollution Impacts and Mitigation Options							◆											
R-1330: Applied Research on Noise and Emissions Analysis Tools							◆		◆									
R-1780: Applied Research on Tools and Metrics to Model the Impacts of Emissions							◆		◆									
R-1450: Applied Research into Generation After Next (N+2) Vehicle Technologies								◆	◆									
R-1380: Applied Research on Rotorcraft Configurations									◆									
R-1410: Applied Research on Noise, Emissions, and Performance Trade-offs for N+2 Aircraft									◆									
R-1570: Applied Research on Overland Supersonic Cruise Aircraft									◆									
D-2139: ULS Conventional Jet Fuels	◆																	
D-2141: Methodologies and Metrics to Assess Aviation's Impact on Climate Change		◆																
D-0750: "Drop-In" Alternative Aviation Fuels				◆		◆												
D-1010: NextGen Vehicle Technologies				◆														
D-1730: Aircraft Procedures and Control Technologies to Reduce Environmental Impacts						◆			◆		◆							
D-1740: Environmental Impact Management Capability						◆												
D-2110: Environmental Metrics of New and Alternative Vehicle Classes						◆						◆						
D-1020: NextGen (N+1) EMS Analysis Tools									◆									

Figure 7-8 EMF R&D Activities Timetable

Noise, air quality, water quality, global climate impact, and fuel burn rates are the primary environmental constraints on NextGen's flexibility. NextGen must interweave these environmental concerns while ensuring aviation safety, national security and economic well-being. These goals can be achieved through advancing technology and aircraft operation, establishing more environmentally-sustainable ATM procedures, and sound environmental practices at airports. These elements are crucial in countering the environmental pressures that will be placed on the NAS due to an increase in air transportation demand.

Concerns about aviation's environmental impacts and energy efficiency may impede its ability to grow; however, aviation must have a reliable, diverse, and cost-effective energy supply. The following near-term R&D activities are provided to address the key environment challenges for aviation:

- Alternative aviation fuel and energy development is critical to enabling energy sources that are more diverse and environmentally friendly than those currently derived from petroleum.
- A comprehensive understanding of the complex interdependencies that exist between aircraft noise, emissions, and fuel burn with particular attention to cost-benefits analysis. Optimize aircraft noise, fuel efficiency, and emissions impacts using advanced technologies, operational procedures, and computer models.
- Reduce scientific uncertainties on life-cycle impacts of alternative aviation fuels, aviation emissions (such as NOx and particulate matter), and hazardous air pollutants on air quality. Overcome process uncertainties regarding approaches for quantifying aviation emissions and their global distribution, which is critical for assessing impacts to health.
- Improve pollutant concentration modeling around airports and throughout the atmosphere to enable a consensus among the scientific community in quantifying the scale of, and the metrics associated with, aviation's impact on climate, including the relationships between long-term impacts like CO_2 and shorter-lived impacts like NOx.
- Characterize response of humans and structures to noise exposure from current and future aircraft in diverse ambient settings. Understand how, what level of aircraft noise exposure, and what acoustic and non-acoustic factors contribute to adverse effects of noise, which is critical to understanding impact public health and welfare.

Addressing these challenges will require significant advancement in state-of-the-art technology and aviation capabilities. A key component of this advancement is the pursuit of long-term, stable foundational research, including atmospheric and combustion chemistry, fluid mechanics of internal flows, acoustics, and computational science.

7.5 POLICY ISSUES

New environmental policies are required to support planning, design, and implementation of a NextGen environmental management system framework and to support national and international harmonization of aviation environmental standards. Figure 7-9 presents the Policy Issues that support EMF. These Policy Issues are intended to encourage targeted stakeholder engagement in solving policy challenges that may impede progress toward EMF OIs and Enablers. Depending on the maturity of a given issue, descriptions range from specific policy suggestions to recommendations for further analysis and open discussion. Further information concerning specific Policy Issues, including their integration with other IWP elements, can be found in Appendix IV as well as on the interactive JPE available at www.jpdo.gov. These Policy Issues fall into four groups:

- **Aviation Environmental Policy and Long-Term Environmental Goals and Targets:** Provide high-level direction for addressing aviation environmental impacts of primary concern for NextGen. This inclusive and comprehensive policy will address all major aviation impacts, including their interrelationships with each other and with aviation energy use. The policy will also establish NextGen environmental protection goals for community noise, air quality, airport water quality, and global climate change impacts.

- **Environmental Management Systems (EMS):** Establish a national framework for developing and applying an EMS approach to achieving NextGen environmental protection goals.
- **Global Harmonization of Environmental Standards:** Foster development of international policies for standards, recommended practices, and guidance that complement NextGen efforts.
- **Environmental Technologies Development**: Enable sufficient technology development and facilitating its timely introduction into the fleet.

EMF Policy Issues	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
PI-0101: Initial Aviation Environmental Policy	P 2008																	
PI-0102: Initial NextGen Long-Term Environmental Goals and Targets	P 2008																	
PI-0104: Initial EMS Approach	P 2008																	
PI-0114: Environmental Standards - Global Harmonization			P 2010															
PI-0105: Refined NextGen Long-Term Environmental Targets				P 2011														
PI-0106: Evolved EMS Approach				P 2011														
PI-0113: Environmental Impact Modeling and Assessment				P 2011														
PI-0103: Refined Aviation Environmental Policy					P 2012													
PI-0109: Environmental Technologies Development					P 2012													
PI-0112: Dynamic Environmental Management Systems Approach								P 2015										

Figure 7-9 EMF Policy Issues Timetable

7.6 SUMMARY

The fuel use and environmental impacts on noise, air, water, and global climate from aviation operations will be significant constraints on the capacity and flexibility of NextGen unless they can be effectively managed and mitigated. The EMF functional area seeks to balance the competing goals of minimizing environmental impacts, while maximizing the ability to meet increasing air transportation service demands. The NextGen vision is for an EMF strategy that is integrated into all NextGen operations. The EMF includes an EMS management approach that provides a systematic process to identify, manage, monitor, and mitigate the environmental demands of NextGen, while meeting the increased volumes and dynamic nature of the air transportation system.

Challenges: An immediate challenge will be to understand and incorporate mission-critical environmental impacts that are fully integrated into all NextGen operations, to account for interdependencies among many environmental issues and to ensure that by addressing some, others are not exacerbated. An additional implementation challenge for NextGen will be compliance with existing environmental regulations, such as NEPA. This process requires time for collection and analysis of information to assess the significance of impacts resultant from Federal actions. Therefore, careful consideration and an integrated process into NextGen planning are needed to ensure timely completion of NextGen activities.

Operational Improvements: NextGen technology, operations and policy OIs that benefit the environment are achieved through the development of informed policy objectives, implementation of environmental and energy-favorable operations, use of environmentally-improved engine and aircraft technologies, and the use of alternative aviation fuels. These improvements address the NextGen vision of preventing or reducing aviation’s noise, air quality, fuel burn, airport water quality, and global climate impacts.

Enablers: NextGen is supported by Enablers that measure, monitor, manage, and mitigate environmental impacts including advanced EMS, environmentally-favorable Optimized Profile Descents (OPD), alternative aviation fuels, and advanced science models, and prediction tools and techniques.

Research and Development Activities: Aggressive R&D programs are critical to developing new technology such as aircraft, engines, and alternative fuels, as well as new operational advances to reduce aviation's environmental impact. R&D is critical to advancing scientific understanding of complex aircraft noise and emissions atmospheric impacts, and to advancing modeling capabilities to predict human health and welfare responses and interrelated environmental consequences. Together, these capabilities will enable implementing cost-beneficial environmental and energy improvements to keep pace with aviation growth.

Policy Issues: New environmental policies are required to support planning, design, and implementation of a NextGen EMS and to support national and international harmonization of aviation environmental management. This includes providing a high-level direction for addressing aviation environmental impacts of primary concern for NextGen, as well as establishing a national framework for developing and applying an EMS approach to achieving NextGen environmental goals.

8 Net-Centric Infrastructure

A foundational and transformational component of the NextGen vision is the creation and use of an enterprise-wide Net-Centric Infrastructure (NCI). Net-centricity is defined as a robust, broadly-interconnected network environment that shares authenticated information in a timely, open, consistent, and secure way among users, applications, and platforms. By securely interconnecting distributed users and systems, net-centricity provides a resilient, efficient, and effective information-sharing environment enabling substantially improved situational awareness and shortened decision cycles.

NCI supports the NextGen Capability *Provide Effective Information Sharing Environment*. The goal of this capability is to improve the ability to store, transport, and retrieve NextGen information between providers and consumers on a reliable, scalable, and secure net-centric infrastructure. Some examples of relevant NextGen information provided by the NCI include: flow/trajectory information, advisories/alerts, surveillance, real-time National Airspace System (NAS) configuration, and weather reports/forecasts.

There are numerous challenges and issues that must be addressed and resolved to successfully establish Next Generation Air Transportation System (NextGen) NCI including:

- Creating NCI requires extensive cooperation among the agencies and third parties that participate in NextGen. Whereas many NextGen capabilities rely on a single implementing agency or group, or perhaps two or three cooperating parties, NCI requires broad cooperation and collaboration among all agencies and groups. As each agency is an "enterprise" on its own, with associated agency enterprise network initiatives, NCI requires an "enterprise of enterprises", or perhaps more precisely a "federation of enterprises". As a federation, it requires mutual agreement at the management and technical level for many operational and governance issues, as well as technical standards.

- The scale and technical complexity of NextGen enterprise networking presents a formidable challenge. The NextGen NCI is expected to simultaneously serve many thousands of users, provide access to hundreds of different information services, offer virtually 100% availability, and sustain data flows totaling billions of bits per second. Enterprise networks involve dozens of standards and protocols that overlap and interrelate at multiple network levels, from physical signals to service-oriented architectures (SOA). The NCI must incorporate various types of data connections, from ground to airborne. Successful design and operation of the NextGen NCI requires technical experts that can properly navigate all these issues and more.

- Information security is a key concern for the NCI. The NCI must provide authenticated information, as well as provide the information in a secure yet open manner. This is also a complex undertaking that requires constant vigilance and the cooperation and agreement across NextGen Partners.

NCI is vital to the success of NextGen. It presents significant issues and challenges that can be met through the open, active and sustained collaboration among NextGen Partners.

8.1 INTRODUCTION

This chapter presents the results, timing and dependencies of work efforts necessary to achieve the NextGen vision for NCI. Some steps require evolutionary improvements and expansions of existing systems. In other cases, entirely new infrastructure and services must be introduced. NextGen envisions an open and integrated network that shares information in standardized formats using standardized services connecting the information systems used by all users including Air Navigation Service Providers (ANSPs), agencies, carriers, aircraft, airport operators, service providers, and general users. Accordingly, this integrated network will incorporate a ground segment, an air-ground segment, and an air-air segment.

The ground network is the backbone of the NextGen NCI. It will leverage the best of commercial technologies to implement an integrated, secure, scalable framework for NextGen services and information flows. The ground segment will carry virtually all of the inter-facility data in the NextGen network. In addition, many of the gateways between agencies and other organizations will be implemented in the ground segment. The ground network will also be an essential support for the air-ground segment, by transporting data to and from the appropriate ground radio equipment.

The air-ground network will carry data from ground systems to the cockpit and vice versa. This critical segment of the NextGen network enables the delivery of real-time surveillance, weather data, and relevant security information to the cockpit, and enables the negotiation of complex trajectories and separation responsibility contracts. The air-ground segment also supports surface movement operations. This segment utilizes and expands existing air-ground radio infrastructure and may require the allocation of new radio frequency (RF) spectrum and technologies in the future.

The air-air segment will build on existing technologies allowing aircraft to share critical real-time information, such as surveillance and weather data. In addition to providing valuable situational awareness, this capability builds a measure of safety and intelligence into the aviation transportation system that is wholly independent of ground systems.

At a level higher than the physical infrastructure, the NCI implements two principal types of services – Information Services and Infrastructure Services. Information Services provides data and information to subscribers when and where needed. Infrastructure Services provides a framework of communications connectivity to ensure that information flows reliably and securely. Both types of services are supported by lower-level protocols and the physical network of infrastructure equipment. As shown in Figure 8-1, the Information Services, Infrastructure Services, and Network Infrastructure components of NCI work together in a layered design to meet high-level NextGen requirements.

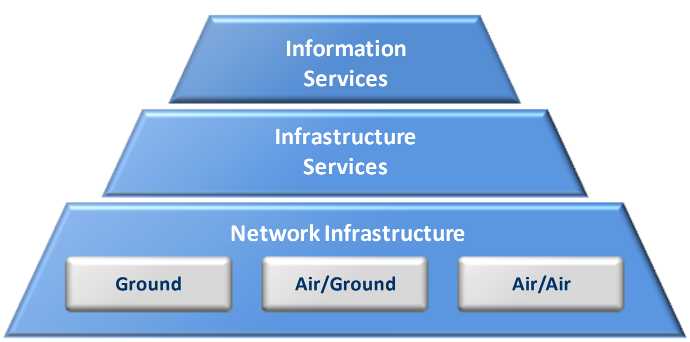

Figure 8-1 Net-Centric Infrastructure Overview

Infrastructure Services operating within NCI are focused on providing and managing connectivity. These services handle duties such as access control, the basic transport of data, bandwidth provisioning, network monitoring, and diagnostics. Security services are a special subset of Infrastructure Services. As a whole, Infrastructure Services form a foundation and a supportive environment for the Information Services.

Information Services are built on top of the Infrastructure Services and are focused on providing content in the appropriate ways to the appropriate users. Information Services are tailored to implement the various specific needs within the aviation transportation system. Many types of services are expected in the NextGen environment including; delivery of weather data from a ground database to the cockpit, sharing security data between agencies, carrying voice data between facilities, and sharing trajectories between aircraft.

Services are a foundational NCI concept. In common use, a “service” has a typical meaning such as, “a particular task performed by one party for another.” This definition holds true in the context of NCI in a general sense, but more precise definitions are needed in order to fully understand NCI. In the context of air-ground data exchanges, for example, “radio services” are provided by the ANSP. In this case, the “services” have a relatively straightforward definition: communications (ground stations, transmitters, receivers) and systems operating at the appropriate frequencies that implement specific protocols to carry out the exchange of data with flight crews.

The matter gets more complex with “Infrastructure Services”, in which there are certain “services” that refer to technical capabilities offered by the infrastructure itself. For example, “security services” and “message mediation services” are implemented by the NCI itself, in accordance with particular standards and protocols. The delivery (and benefit) of these services is intertwined with the delivery of many varied, context-specific services.

Finally, the majority of the net-centric references to “services” – in particular “Information Services”– are associated with an even more specific definition, one that is drawn from the domain of enterprise networking and service-oriented architecture. In this domain, a “service” is functionality offered by one system/software application (the provider) to other system/software applications (the requestors). In some cases, requesting software may represent an end user that needs information. In other cases, the requesting software may represent a system that needs to notify another system of some event. One system may request a “subscription” to another system’s periodic data.

There are many possible types of services in a service-oriented architecture. Nonetheless, there are key characteristics in common. The service transaction is carried out via the electronic exchange of data over an enterprise network, and it follows precise rules and protocols according to a “service definition” (a machine-readable, technical description of the service offered). Such services are implemented on the foundation of the NCI.

A clear understanding of the term “service” in different contexts is critical, as enterprise services and enterprise network infrastructure comprise the over-arching conceptual framework for virtually all of the information exchanges envisioned in NextGen.

This chapter contains aspects of the NCI that are common to all areas of NextGen, such as communications links, networks, infrastructure services, and standards. However, as a consequence of the specialized nature of Information Services, they are, in general, not described in this chapter. Information Services are defined and described in the chapter that is most relevant to their application.

8.2 NET-CENTRIC INFRASTRUCTURE ENABLERS

The transformation to NCI requires the implementation of many Enablers. These Enablers will provide the foundation for the realization of Operational Improvements (OIs) and the overall NextGen vision. Enablers must be researched, developed, and implemented in a certain sequence and timing to effectively meet the needs of the OIs they support. Enablers can also support the implementation of other Enablers. To describe these broad needs, the NCI Enablers have been grouped into five areas, as shown in summary in Figure 8-2. The Enabler groups are described in the following sections with full descriptions of each Enabler, including their integration with other IWP elements, provided in Appendix II, as well as on the interactive Joint Planning Environment (JPE) available at www.jpdo.gov.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Radio-Based Communications Enablers																		
EN-1032: Radio-Based Voice Network - Legacy VHF/UHF	E 2008																	
EN-1060: Radio Data Link - Legacy 1090/1030	E 2008																	
EN-1190: Radio Data Link - Legacy General Aviation UAT	E 2008																	
EN-1750: Radio Data Link: Legacy Satcom	E 2008																	
EN-1201: Mobile Radio - Data Communications Level 1		E 2009																
EN-1033: Fixed Radio - Data Communications Level 1			E 2010															
EN-1010: Future Radio Spectrum					E 2012													
EN-1061: Fixed Radio - Data Communications Level 2															E 2022			
EN-1202: Mobile Radio - Data Communications Level 2															E 2022			
Aviation Voice and Data Network Enablers																		
EN-1035: Ground Voice Network- (Legacy Voice Communications)	E 2008																	
EN-1180: Ground Integrated Voice/Data Network - Level 1	E 2008																	
EN-1036: Ground Voice Network - NAS Voice Switch Level 1					E 2012													
EN-1037: Ground Voice Network - NAS Voice Switch Level 2								E 2015										
EN-1181: Ground Integrated Voice/Data Network - Level 2										E 2017								
EN-1048: Ground Voice Network - NAS Voice Switch Level 3											E 2018							
EN-1170: Integrated Ground and Air Network for Voice/Data																		2025 E
Enterprise Networks and Standards Enablers																		
EN-1229: Enterprise Networking Governance Model		E 2009																
EN-1230: Enterprise Networking Governance Structure			E 2010															
EN-1015: Enterprise Network Management Standards				E 2011														
EN-1016: Enterprise Networks Infrastructure Services Standards				E 2011														
EN-1043: Enterprise Networks Security Services Standards				E 2011														
EN-1231: NextGen Enterprise Network - FAA				E 2011														
EN-1234: NextGen Enterprise Network - DOC				E 2011														
EN-1237: NextGen Enterprise Network - DOD				E 2011														
EN-1240: NextGen Enterprise Network - DHS				E 2011														

Figure 8-2 NCI Enabler Timetables

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Information Sharing Standards Enablers																		
EN-1250: Information Sharing Standards: Flow Information			E 2010															
EN-1251: Information Sharing Standards: Flight and Surveillance Information			E 2010															
EN-1252: Information Sharing Standards: Airspace Information			E 2010															
EN-1253: Information Sharing Standards: Aviation Safety Information			E 2010															
EN-2050: Information Sharing Standards: Weather Information			E 2010															
EN-5036: NetCentric Airport Information Standards				E 2011														
EN-1254: Information Sharing Standards: Security Information					E 2012													

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Air-Ground Data Exchange Enablers																		
EN-1062: Mobile Data Communications Management Applications - Level 1					E 2012													
EN-1203: Air - Ground Data Exchange - Data Communications Management Services - Tower					E 2012													
EN-1206: Air - Ground Data Exchange – Clearance and Instruction Services – Tower Group 1					E 2012													
EN-1215: Air - Ground Data Exchange – FIS – Tower					E 2012													
EN-1204: Air - Ground Data Exchange – Data Communications Management Services – En Route							E 2014											
EN-1209: Air - Ground Data Exchange – Clearance and Instructions Services – En Route Group 1							E 2014											
EN-1216: Air - Ground Data Exchange – FIS – En Route							E 2014											
EN-1220: Air - Ground Data Exchange – Advisory Services – En Route Group 1							E 2014											
EN-1063: Mobile Data Communications Management Applications - Level 2										E 2017								
EN-1205: Air - Ground Data Exchange – Data Communications Management Services – TRACON										E 2017								
EN-1207: Air - Ground Data Exchange – Clearance and Instruction Services – Tower Group 2										E 2017								
EN-1212: Air - Ground Data Exchange – Clearance and Instructions Services – TRACON Group 1										E 2017								
EN-1213: Air - Ground Data Exchange – Clearance and Instructions Services – TRACON Group 2										E 2017								
EN-1217: Air - Ground Data Exchange – FIS – TRACON										E 2017								
EN-1219: Air - Ground Data Exchange – Advisory Services – Tower										E 2017								
EN-1223: Air - Ground Data Exchange – Advisory Services – TRACON										E 2017								
EN-1210: Air - Ground Data Exchange - Clearance and Instructions Services - En Route Group 2											E 2018							
EN-1221: Air - Ground Data Exchange – Advisory Services – En Route Group 2											E 2018							
EN-1224: Air - Ground Data Exchange – Flight Position Intent Services – Multi Domain											E 2018							
EN-1064: Mobile Data Communications Management Applications - Level 3															E 2022			
EN-1208: Air - Ground Data Exchange – Clearance and Instruction Services – Tower Group 3															E 2022			
EN-1211: Air - Ground Data Exchange - Clearance and Instructions Services - En Route Group 3															E 2022			
EN-1214: Air - Ground Data Exchange – Clearance and Instructions Services – TRACON Group 3															E 2022			
EN-1225: Air - Ground Data Exchange – Delegated Separation Services – Multi Domain															E 2022			

Figure 8-2 NCI Enabler Timetables (continued)

8.2.1 Radio-Based Communication Enablers

Whether for air-ground or air-air communications, radios are the critical link for data to or from the aircraft. While radio technologies are not usually considered particularly "net-centric", they are included in this chapter because they are the physical link by which net-centric capabilities may be delivered to the aircraft. As NextGen moves from legacy radio systems to future radio systems, there should be evident transformation from special-purpose radio communications to integrated and flexible radio data communications.

Figure 8-3 presents the planned evolution of radio-based communication Enablers that will support the NextGen vision for shared information in the cockpit and mobile platforms. Legacy radio Enablers that are currently in use, or available for use, are vital to the current and future NextGen communication needs. These legacy Enablers include: EN-1032, the current VHF/UHF radios; EN-1060, the current 1090/1030 Mode S radios; EN-1190, the general aviation universal access transceiver (UAT) radios; and EN-1750, the current satellite communication links. These legacy radio networks must be maintained until new infrastructure and services are introduced.

Radio-Based Communications Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-1032: Radio-Based Voice Network - Legacy VHF/UHF	E 2008																	
EN-1060: Radio Data Link - Legacy 1090/1030	E 2008																	
EN-1190: Radio Data Link - Legacy General Aviation UAT	E 2008																	
EN-1750: Radio Data Link: Legacy Satcom	E 2008																	
EN-1201: Mobile Radio - Data Communications Level 1		E 2009																
EN-1033: Fixed Radio - Data Communications Level 1			E 2010															
EN-1010: Future Radio Spectrum					E 2012													
EN-1061: Fixed Radio - Data Communications Level 2															E 2022			
EN-1202: Mobile Radio - Data Communications Level 2															E 2022			

Figure 8-3 Radio-Based Communication Enabler Timetable

Very High Frequency Data Link (VDL) Mode 2 technology is envisioned as the foundational element supporting safety-critical NextGen air traffic control (ATC) data communications for the foreseeable future. This technology is defined by EN-1033 that provides the fixed ground radios, and EN-1201 that provides the mobile or aircraft radios. These radios are expected to be the primary transport mechanisms for the NextGen air-ground data exchanges defined in Section 8.2.5. The most significant change in the next decade will be the widespread use of data communications in lieu of voice communications for domestic airspace ATC operations. Rather than receiving all instructions by voice, flight operators will exchange data messages with the ANSP. Voice communications will play more of a backup and confirmatory role supporting data communications. This transition from voice to data is key to increasing ANSP/operator efficiency and to transferring complex trajectory data and detailed information to and from the cockpit in a practical way.

As needs continue to grow and more capacity is required, it may be necessary to add additional spectrum to the NextGen radio environment, as well as new radios that have more flexibility and capacity. Given the long-term life-cycle of adding next spectrum and industry-wide radio technology, EN-1010, supported by R-0470, is targeted to define the needs for additional spectrum and new technology by 2012. Depending on the results of this analysis, the NextGen plan includes the addition of new fixed and mobile radios defined by EN-1061 and EN-1202, respectively. These new radios are targeted for initial availability in 2022. Ongoing research and development, international standardization, and other factors will be needed to more accurately define these future NCI radio-based communications Enablers.

Challenges related to radio-based communications include:

- A vision is needed beyond VDL Mode 2. This mode of communications cannot feasibly handle high-bandwidth information such as detailed real-time weather maps.
- Coordination and collaboration among current and planned national and international radio communications programs across NextGen stakeholders, including non-ATC and non-Federal Aviation Administration (FAA).

8.2.2 Aviation Voice and Data Network Enablers

Figure 8-4 presents the planned evolution of aviation voice and ground network Enablers that will support the NextGen vision for timely, open, and shared information across all ANSP platforms. One of the key programs is the National Airspace System (NAS) Voice Switch, an FAA program to modernize routing and distribution of ATC voice communications. The NAS Voice Switch begins with EN-1036 that provides the new voice capabilities in the terminal environment in 2012, followed by the en–route environment with EN-1037 in 2015. Full implementation of the NAS Voice Switch is presented in EN-1048 that provides full NAS implementation in terminal, en route, and ground environments.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Aviation Voice and Data Network Enablers																		
EN-1035: Ground Voice Network- (Legacy Voice Communications)	E	2008																
EN-1180: Ground Integrated Voice/Data Network - Level 1	E	2008																
EN-1036: Ground Voice Network - NAS Voice Switch Level 1					E	2012												
EN-1037: Ground Voice Network - NAS Voice Switch Level 2								E	2015									
EN-1181: Ground Integrated Voice/Data Network - Level 2										E	2017							
EN-1048: Ground Voice Network - NAS Voice Switch Level 3											E	2018						
EN-1170: Integrated Ground and Air Network for Voice/Data																	2025	E

Figure 8-4 Aviation Voice and Data Network Enabler Timetable

NextGen requires an integrated voice/data network that is currently being provided by EN-1180, also known as the FAA Telecommunications Infrastructure. This infrastructure will be expanded to include more ground-to-air addressable systems through EN-1181 and provide for the maximum use of common network infrastructure to distribute voice data and other types of data. Finally, to provide seamless connectivity between ground and air segments of the network, EN-1170 is envisioned to provide an integrated ground and air network for voice and data by 2025.

The main challenges related to ground voice/data networks are:

- The development and deployment of the NAS Voice Switch needs to proceed according to plan.
- The planning, design, and integration of optimal ground voice and data networks needs to be an integrated and coordinated effort. Multiple complementary FAA communications efforts are currently underway, including the NAS Voice Switch and Federal Telecommunications Infrastructure (FTI). Similar efforts are underway within the Departments of Defense (DOD) and Homeland Security (DHS) and other Federal agencies. System engineering efforts are needed to develop an integrated plan and design to understand how these various infrastructure efforts and technologies can support each other and take advantage of broader enterprise networking frameworks.
- As defined in Section 8.2.3, the NextGen vision includes establishing a NextGen communications governance structure and standardization authority. It will be important to continue current efforts, yet be aware and compliant with planned standards, so that initial technologies and network infrastructure do not become obsolete, can be easily upgraded, and do not require costly retrofits once broader standards are adopted.

8.2.3 Enterprise Networks and Standards Enablers

A key concept in NextGen is information sharing. Information must flow from source agencies or organizations to other agencies or organizations efficiently and seamlessly. At a network level, this requires the interconnection of agency and organization networks, collectively supporting federation of enterprises. Standards for certification and interoperability are critical in order for data to successfully flow between networks.

Figure 8-5 presents the planned evolution of governance, standards, and networks that will support the NextGen vision for timely, open, and shared information across all NextGen Partners. The first requirement is for an appropriate enterprise networking governance model, defined by EN-1229, which is then realized by a governance structure, defined by EN-1230. These are near-term needs that must be accomplished by 2010 to allow NextGen NCI to effectively proceed with a minimum duplication of efforts and the maximum effectiveness and use of resources. The governance structure will be the authority on all NextGen standards related to enterprise networking. The governance structure, working through public and private stakeholders, will develop NextGen enterprise network management standards, defined by EN-1015; NextGen enterprise networks infrastructure services standards, defined by EN-1016; and NextGen enterprise networks security services standards, defined by EN-1043. These standards will specify how agencies and other organizations can implement enterprise networks that are compatible with NextGen. Finally, each NextGen Partner will be responsible for implementing an enterprise network that is in compliance with the standards. Only agency networks are currently identified in the Integrated Work Plan (IWP). Industry and other networks may be added in future IWP revisions.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Enterprise Networks and Standards Enablers																		
EN-1229: Enterprise Networking Governance Model		E 2009																
EN-1230: Enterprise Networking Governance Structure			E 2010															
EN-1015: Enterprise Network Management Standards				E 2011														
EN-1016: Enterprise Networks Infrastructure Services Standards				E 2011														
EN-1043: Enterprise Networks Security Services Standards				E 2011														
EN-1231: NextGen Enterprise Network - FAA				E 2011														
EN-1234: NextGen Enterprise Network - DOC				E 2011														
EN-1237: NextGen Enterprise Network - DOD				E 2011														
EN-1240: NextGen Enterprise Network - DHS				E 2011														

Figure 8-5 Enterprise Networks and Standards Enabler Timetable

The relationship of these Enablers is shown in Figure 8-6. The NextGen Enterprise Networking Governance Structure is the key to implementing the NextGen NCI. The effective establishment of this critical organization is the single most important, near-term activity of net-centricity to move NextGen forward.

Generating consensus on all the technical details necessary for efficient interoperability will require a great deal of energy, effort, and active participation on the part of the governance body and the participating agencies and organizations. Establishing a governance structure quickly, with the appropriate level of resources and technical expertise, will be a significant challenge. In addition, successfully implementing and managing interoperable networks requires expertise and investment, disseminated throughout the NextGen web of agencies and organizations.

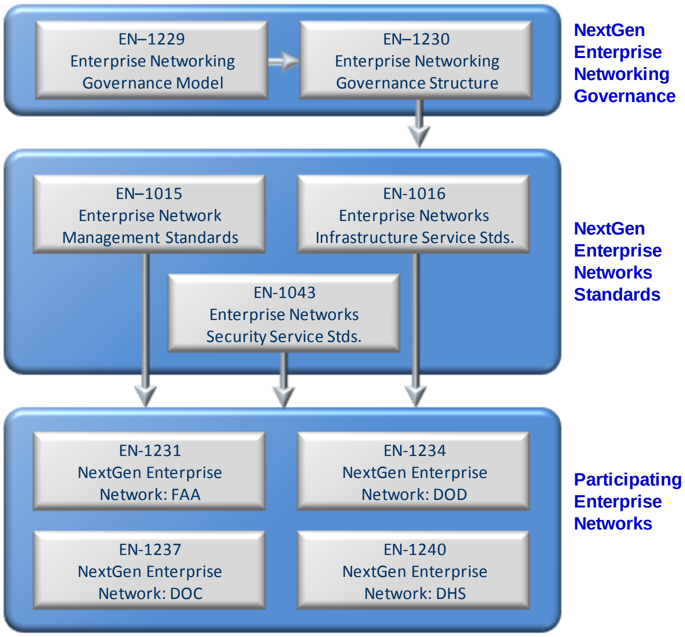

Figure 8-6 Enterprise Networks and Standards Enabler Relationships

In the detailed descriptions provided in Appendix II, for the participating enterprise networks described by EN-1231, EN-1234, EN-1237, EN-1240, the reader will note that they are linked extensively as prerequisites to Enablers in other chapters. Each information service must be hosted on an agency or organization enterprise network. For example, EN-1237 is a prerequisite for all weather information services offered by the National Oceanic and Atmospheric Administration (NOAA) within the Department of Commerce (DOC). In this manner, the enterprise network Enablers support many specific information services, described in different areas of the IWP.

8.2.4 Information Sharing Standards Enablers

In order to share information among NextGen Partners in a consistent and efficient manner, open standards, formats, and protocols are needed that are specific to the information being shared. Figure 8-7 presents the initial evolution of information sharing standards that will support the NextGen vision for timely, open, and shared information across all NextGen Partners. The information sharing standards are developed by various communities of interest (COI) and endorsed by the net-centric governance structure referenced in Section 8.2.3. Each standard in Figure 8-7 represents a category of NextGen data or information. The development and endorsement of each standard will have direct impact on the service or services that are providing the information. For example, EN-1251 defines the information sharing standards for flight and surveillance information. Upon endorsement of this standard, providers and consumers of this type of information, such as the FAA, DOD and DHS, could share surveillance data in a standardized manner without the need to develop custom interfaces that are unique to each system that is providing or consuming the information. Additionally, DHS, DOD, and the FAA share other air domain security data, such as flights of interest and airspace waivers. The standards will provide the framework to any and all authorized consumers of these services.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Information Sharing Standards Enablers																		
EN-1250: Information Sharing Standards: Flow Information			E 2010															
EN-1251: Information Sharing Standards: Flight and Surveillance Information			E 2010															
EN-1252: Information Sharing Standards: Airspace Information			E 2010															
EN-1253: Information Sharing Standards: Aviation Safety Information			E 2010															
EN-2050: Information Sharing Standards: Weather Information			E 2010															
EN-5036: NetCentric Airport Information Standards				E 2011														
EN-1254: Information Sharing Standards: Security Information					E 2012													

Figure 8-7 Information Sharing Standards Enabler Timetable

Figure 8-8 depicts the relationship between the highlighted information sharing standards described in this section with the related Enablers from Section 8.2.3, as well as information services described in other sections. Table 8-1 presents examples of related information services described in other sections.

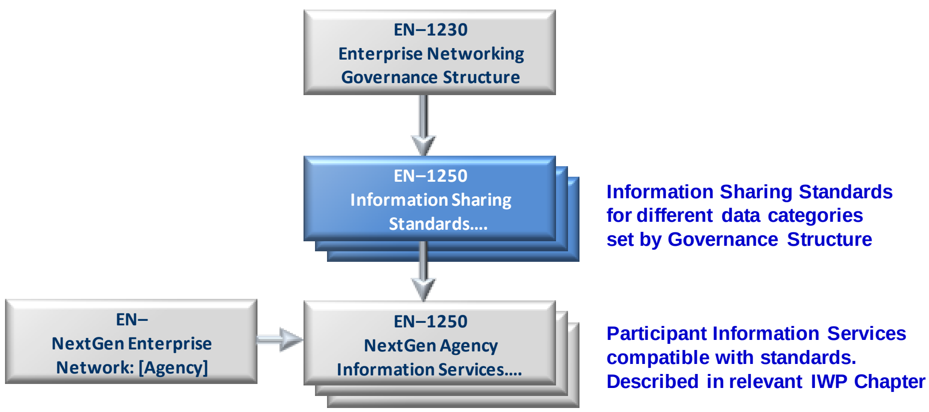

Figure 8-8 Information Sharing Standards Enabler Relationships

Table 8-1 Information Sharing Standards and Related Services

Information Sharing Standard	Supported Information Services
EN-1251: Information Sharing Standards: Flight and Surveillance Information	Cooperative Surveillance (Ch. 10)
	Non-Cooperative Surveillance (Ch. 10)
	Flight and Surveillance Information (Ch. 2)
EN-5036: Net-Centric Airport Information Standards	Deicing Holdover Time (Ch. 3)
EN-2050: Information Sharing Standards: Weather Information	Weather Observations (Ch. 4)
	Legacy Weather (Ch. 4)
	Weather Cube (Ch. 4)

The primary challenge to Information Sharing Standards is the extensive collaboration with experts in domains of discrete information categories. Information sharing standards cannot be specified by net-centric experts alone. For example, security information sharing standards require collaboration between net-centric experts and security professionals. Moreover, since information sharing standards will be applied across all NextGen agencies and organizations, it may be necessary to bring together domain experts from multiple sources. It will be essential for the net-centric governance structure to establish productive working relationships with the appropriate parties associated with each category of data or information.

8.2.5 Air-Ground Data Exchange Enablers

In the NextGen environment, it will no longer be possible to rely exclusively on voice communications for the exchange of information. Transition from voice for flight crew-controller communication to predominance of data communication has been identified as a key goal for ATC and ATM. This transition to a system where critical information is exchanged digitally requires many Enablers including reliable on-board radios and avionics, as well as the necessary radio services provided by an ANSP to support the data exchange.

Figure 8-9 presents the evolution of Enablers that will provide the necessary data communication services and on-board applications required for air-ground data exchange within NextGen. The Air-Ground Data Exchange Enablers are aligned into the following groups:

- **Data Communications Management Services:** Data Communications Management Services provides the foundation of the air-ground data exchange within NextGen. Services include establishing and terminating data links, frequency selections, and handoffs. The first deployment is described by EN-1203 that is planned for the tower environment in 2012. This is followed by EN-1204 in the en route environment in 2014, and EN-1205 in the terminal radar approach control (TRACON) environment in 2017.

- **Clearance and Instruction Services:** Three multi-staged groups of Clearance and Instruction Services Enablers are planned with increasing capabilities and services. This service provides the capability for aircraft and ANSPs to safely and effectively exchange information digitally for clearances, arrival/departure and taxi instructions, flight crew requests, and 4D trajectory agreements. The clearance and instructions service is envisioned as part of the integrated suite of services providing data communication to support improvements in airspace use and capacity.

  The first group supports the tower environment and includes: EN-1206 that provides data exchange capability for ATC clearances, departure clearances, data link taxi departure, and text messaging in 2012; EN-1207 that expands to include data link taxi arrival and common trajectory coordination by 2017; and EN-1208 that supports 4D trajectory exchange agreements, trajectory constraints, trajectory requests, trajectory clearances, and trajectory non-conformance reports by 2022.

  The second group supports the en route environment and includes: EN-1209 that provides en-route data exchange capability to obtain ATC clearances and text messaging to the cockpit in 2014; EN-1210 that expands to provide common trajectory coordination of initial 4DTs in mixed capability airspace, 4DT agreements, and down-stream clearances by 2018; and EN-1211 that provides the exchanging of trajectory agreements, trajectory constraints, trajectory requests, trajectory clearances, and trajectory non-conformance reports within the en-route environment by 2022.

The third group supports the Terminal Radar Approach Control (TRACON) environment and includes: EN-1212 that provides data exchange capability for ATC clearances, instructions, flight crew requests, reports, notifications, and compliance indications, and text messaging in 2017; EN-1213 that supports data link taxi arrival clearances, instructions, flight crew requests, reports, notifications, and compliance indications in 2017; and EN-1214 that supports 4DT operations by exchanging trajectory agreements, trajectory constraints, trajectory requests, trajectory clearances, and trajectory non-conformance reports by 2022.

- **Flight Information Services:** Flight Information Services uplink certain types of operational information to the flight deck via data communications. The primary content is Automatic Terminal Information Service (ATIS) reports, which includes current meteorological and procedural information, in addition to other items that impact airborne and surface operations. EN-1215 delivers this capability to the Tower environment in 2012, followed by EN-1216 for the en route environment in 2014, and EN-1217 for the TRACON environment in 2017.

- **Advisory Services:** Advisory Services uplink real-time, flight-specific information to the flight deck via data communications. Advisory Services are deployed to the en route environment in two "groups". In the Tower and TRACON environments, Advisory Services are deployed all at once.

  The first En Route group (EN-1220) is delivered in 2014. It implements an Advisory Service specific to the en route environment: the uplink of controlled arrival times at points along the aircraft's route.

  The remaining Enablers all deliver the same capability to the different phases of flight (Tower: EN-1219 in 2017, TRACON: EN-1223 in 2017, and En Route Group 2: EN-1221 in 2018). These enablers represent the capability to uplink information including sequencing, flow management, airspace configuration, and Notices to Airmen (NOTAMs).

- **Flight Position Intent Services:** Flight Position Intent Services are deployed simultaneously to all domains (Tower, TRACON, and En Route) in 2018, as described in EN-1224. These services facilitate the automatic exchange of information about the aircraft's filed flight plans, on-board Flight Management System (FMS) trajectories representing intent and current/predicted positions. These services enable the detection of inconsistencies between flight crew expected routes, controller expected routes, and actual routes.

- **Delegated Separation Services:** Delegated Separation Services are deployed simultaneously to all domains (Tower, TRACON, and En Route) in 2022, as described in EN-1225. These services support delegated separation operations by exchanging contracts, acknowledgements, surveillance, and related information.

- **Mobile Data Communications Applications:** Three levels of data communications management applications are planned for aircraft or other mobile platforms that interact with data services. These are generally the industry-developed avionics applications that understand the data services protocols and interface appropriately with flight deck personnel and systems. The three levels are aligned with the data exchange services (implemented by the ANSP) so that the available services are supported as they are deployed over time. Each level also represents increasing degrees of integration with flight deck systems. EN-1062 is the first level and is implemented in 2012, followed by Level 2 (EN-1063) in 2017, and Level 3 (EN-1064) in 2022.

Data communication will provide a more efficient air/ground information exchange mechanism, and an additional means of communication between flight crews and controllers. Data communication will reduce congestion on the voice channels, reduce operational errors and flight crew deviations resulting from misunderstood instructions and read back errors, enable trajectory-based operations, and reduce controller and flight crew workload.

Air-Ground Data Exchange Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-1062: Mobile Data Communications Management Applications - Level 1					E 2012													
EN-1203: Air - Ground Data Exchange - Data Communications Management Services - Tower					E 2012													
EN-1206: Air - Ground Data Exchange – Clearance and Instruction Services – Tower Group 1					E 2012													
EN-1215: Air - Ground Data Exchange – FIS – Tower					E 2012													
EN-1204: Air - Ground Data Exchange – Data Communications Management Services – En Route							E 2014											
EN-1209: Air - Ground Data Exchange – Clearance and Instructions Services – En Route Group 1							E 2014											
EN-1216: Air - Ground Data Exchange – FIS – En Route							E 2014											
EN-1220: Air - Ground Data Exchange – Advisory Services – En Route Group 1							E 2014											
EN-1063: Mobile Data Communications Management Applications - Level 2										E 2017								
EN-1205: Air - Ground Data Exchange – Data Communications Management Services – TRACON										E 2017								
EN-1207: Air - Ground Data Exchange – Clearance and Instruction Services – Tower Group 2										E 2017								
EN-1212: Air - Ground Data Exchange – Clearance and Instructions Services – TRACON Group 1										E 2017								
EN-1213: Air - Ground Data Exchange – Clearance and Instructions Services – TRACON Group 2										E 2017								
EN-1217: Air - Ground Data Exchange – FIS – TRACON										E 2017								
EN-1219: Air - Ground Data Exchange – Advisory Services – Tower										E 2017								
EN-1223: Air - Ground Data Exchange – Advisory Services – TRACON										E 2017								
EN-1210: Air - Ground Data Exchange - Clearance and Instructions Services - En Route Group 2											E 2018							
EN-1221: Air - Ground Data Exchange – Advisory Services – En Route Group 2											E 2018							
EN-1224: Air - Ground Data Exchange – Flight Position Intent Services – Multi Domain											E 2018							
EN-1064: Mobile Data Communications Management Applications - Level 3															E 2022			
EN-1208: Air - Ground Data Exchange – Clearance and Instruction Services – Tower Group 3															E 2022			
EN-1211: Air - Ground Data Exchange - Clearance and Instructions Services - En Route Group 3															E 2022			
EN-1214: Air - Ground Data Exchange – Clearance and Instructions Services – TRACON Group 3															E 2022			
EN-1225: Air - Ground Data Exchange – Delegated Separation Services – Multi Domain															E 2022			

Figure 8-9 Air-Ground Data Exchange Enabler Timetable

Achieving the Enablers described in this timetable requires overcoming many challenges including:

- Defining the operational concept and detail interactions among the many technology components needed for the exchange of flight information via data communication and the integration with decision support tools.
- Automation enhancements to functions within En Route Automation Modernization (ERAM) and Traffic Flow Management (TFM) to exchange flight related information in coordination with aircraft equipage.
- A NextGen comprehensive and integrated equipping strategy developed with industry to identify the necessary requirements for FAA Data Communication services.

8.3 RESEARCH AND DEVELOPMENT ACTIVITIES

The transformation to NextGen requires Research &Development (R&D) Activities to guide the implementation of Enablers. This section presents the set of R&D Activities that have been identified to support the net-centric Enablers. As appropriate, the R&D Activities are aligned with Enablers to describe the dependencies and sequencing necessary to achieve the overall IWP in a timely and efficient manner. The NCI R&D activities are presented in chronological order, within Figure 8-10. Detailed information regarding NCI R&D Activities, including their integration with other IWP elements, is provided in Appendix III, as well as on the interactive JPE, available at www.jpdo.gov.

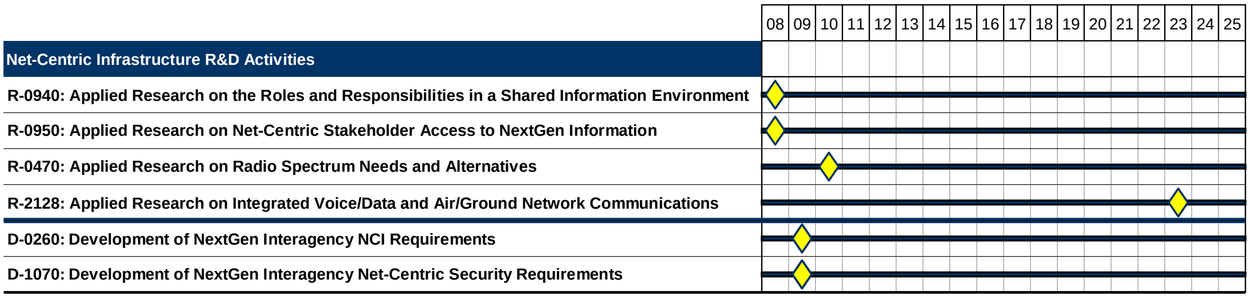

Figure 8-10 NCI R&D Activities Timetable

These R&D items correlate to many of the major Enabler themes in this chapter:

- Future radio communication technologies need to be explored and designed, requiring the implementation of R-0470: Applied Research on Radio Spectrum Needs and Alternatives.
- NextGen information sharing details must be considered and are initially explored through R-0940: Applied Research on the Roles and Responsibilities in a Shared Information Environment and R-0950: Applied Research on Net-Centric Stakeholder Access to NextGen Information.
- Future voice/data integration opportunities must be identified and evaluated and is required in R-2128: Applied Research on Integrated Voice/Data and Air/Ground Network Communications.

The primary R&D challenges are ensuring their implementation within the specified timelines. Those tasked with execution of these R&D activities must make sure they are exploring these areas appropriately and answer the critical stakeholder questions, when the time is right, to move forward on these aspects of NextGen. Otherwise, there could be unnecessary and costly delays to the future deployment of valuable NextGen capabilities.

8.4 POLICY ISSUES

The goal of the NCI environment envisioned for NextGen is to maximize availability of useful information, without compromising safety of operations, national security, and market competition concerns. Policies and governance structures have to be explored to guide development of information access controls, trust relationships, authenticating COI users, and mechanisms for protecting competitive information. In addition, policies should be developed, through cooperation with international partners, for standards and compatibility requirements for secure information exchange and frequency/spectrum requirements. Finally, to the extent that net-derived data and information is critical to safe and secure operations, policies and procedures must be developed for evaluating and certifying the trustworthiness, accuracy, and integrity of information from non-government sources. These policy decisions fall into these groups:

- **Securing and Certifying Information Exchange**: Develop a governance structure and protocols for information exchanges and certification for both Federal and civil information exchange participants and streamlining international regulatory/policy coordination.
- **Frequency and Spectrum Harmonization**: Develop US and international policy for standards and compatibility requirements for frequency/spectrum equipment.
- **Communications Architecture Plans**: Develop strategy for communications services for ground-based, space-based, airborne-based, and/or performance-based architectures.

Figure 8-11 presents the Policy Issues that support NCI. These Policy Issues are intended to encourage targeted stakeholder engagement in solving policy challenges that may impede progress toward NCI Enablers. Depending on the maturity of a given issue, descriptions range from specific policy suggestions to recommendations for further analysis and open discussion. Further information concerning specific Policy Issues, including their integration with other IWP elements, can be found in Appendix IV as well as on the interactive JPE available at www.jpdo.gov.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Net-Centric Infrastructure Policy Issues																		
PI-0024: Secure Information Exchange	P	2008																
PI-0108: Certifying Use of Net-Centric Information	P	2008																
PI-0017: Communications Architecture Plan for Ground, Space, Airborne, and/or Performance-		P	2009															
PI-0073: Frequency/Spectrum - Global Harmonization					P	2012												

Figure 8-11 NCI Policy Issues Timetable

8.5 SUMMARY - NET-CENTRIC INFRASTRUCTURE

The NextGen operational vision requires users to have timely, accurate, secure, comprehensive, and appropriate levels of information. To efficiently and effectively share information among users and systems, NextGen will be enabled by a NCI and related services. The NCI functional area includes advanced, distributed, and integrated digital voice and data networks that are secure, reliable, and flexible to serve the needs of airborne, mobile ground-based, and fixed ground-based users. NCI also includes the management of net-centric information, including common standards, tools, and procedures for information sharing, information security, network core service, and data stewardship. The NextGen vision also includes the enhancement of existing, or development of new enterprise information systems that provide common, consolidated, and integrated information.

Challenges: The scale and technical complexity of NextGen enterprise networking presents a formidable challenge. Creating this information network will require extensive cooperation between the agencies and third parties. The NCI functional area addresses the complex factors necessary to build the framework required to efficiently and effectively share information. It focuses on addressing challenges, such as communication bandwidth, planning, design and integration for optimal data networks, defining an operational concept, an integrated equipping strategy, and synchronization with implementation of NAS automation enhancements. Extensive collaboration with domain experts will be essential for the net-centric governance structure to establish productive working relationships and define the requirements necessary for efficient net centric interoperability. Oversight will be necessary to ensure that R&D Activities are implemented within the specified timelines.

Enablers: NextGen operations will be transformed by advanced communication Enablers, including integrated networks, open information sharing, and data communications among aircraft and ground systems. NextGen networks require integrated voice and data network infrastructure along with standardized information and infrastructure services. Standards for certification and interoperability are critical for successful network integration. To openly share information among NextGen Partners using standardized services and networks, standards are also needed that establish formats and protocols specific to the information being shared. Creating this broad range of standards requires a governance structure and organization supported by all NextGen Partners. Improved communications will result from a transformation of special-purpose radio systems to integrated and flexible radio systems, allowing the widespread use of data communications in lieu of voice communications for domestic airspace ATC operations. The backbone of this transformation will come from the implementation of ground voice networks and integrated voice/data networks to support pilot-controller exchanges. ANSPs will provide services to support data exchange of flight information, clearances and instructions, advisories, flight position, and trajectory information necessary for flight operations, as well as information to support situation awareness on security airspaces. Security Service Providers (SSPs) will provide aviation security-related information services, such as airport risks, flight risks, and airspace wavers.

Research and Development Activities: NCI requires R&D Activities to guide the implementation of Enablers. Future radio communication technologies and radio spectrum requirements and alternatives must be explored. Information sharing details and stakeholder roles and responsibilities must be explored, and future voice/data integration opportunities must be identified and evaluated.

Policy Issues: NCI requires the collaboration of many local, state, and Federal government, as well as private organizations. Policies and governance structures must be explored to guide development of information access controls, trust relationships, authenticating COI users, and mechanisms for protecting competitive information. Finally, policies and procedures must be developed for evaluating and certifying the trustworthiness, accuracy, and integrity of information from non-government sources.

9 Positioning, Navigation, and Timing Services

The Next Generation Air Transportation System (NextGen) relies on Positioning, Navigation, and Timing (PNT) Services for the implementation and conduct of many of its basic operations, including trajectory-based operations (TBO). PNT Services enable the ability to accurately and precisely determine current location, orientation, and desired path; apply corrections to course, orientation, and velocity in order to attain the desired position; and obtain accurate and precise time anywhere on the globe within user-defined parameters.

Surveillance Services are critical to the NextGen Capability *Provide Effective Information Sharing Environment*. The goal of this capability is to improve authorized stakeholders ability to provide, discover, and consume timely and accurate NextGen information (e.g. weather, surveillance, aeronautical, and geospatial) in a decentralized, distributed, and coordinated environment through trusted aviation stakeholder partnerships, aligned data policies and standards. PNT Services support this capability by providing NextGen users with a highly-accurate and reliable positioning source, which, when integrated, enables improved surveillance capabilities and reduced separation standards. PNT Services are also needed for other activities in NextGen, such as surveying stationary assets for representation in geospatial information, a fundamental component of navigation.

The full realization of PNT Services is challenged by the need to provide redundant, complementary, and backup systems; augmentation systems; and certification and use of foreign PNT sources and augmentation systems. Other challenges include:

- Ground- and space-based PNT systems are susceptible to intentional and unintentional interference. While the Global Positioning System (GPS) provides the foundation of NextGen PNT Services, appropriate complementary and redundant ground- and space-based systems are also desired to provide an alternative PNT source to mitigate the effects of regional jamming and a backup in the event of GPS failure.

- PNT augmentation systems are of particular concern to the NextGen user. NextGen seeks to minimize user equipage requirements and PNT infrastructure operation and maintenance expenses by maximizing the performance of primary PNT systems. NextGen also seeks to eliminate duplicative government PNT systems and augmentations that do not fit within an overall PNT architecture of primary and backup systems for aviation and non-aviation uses.

- In the global community, aviation users encounter a growing number of space-based PNT sources and augmentation systems of similar, even compatible technologies, performing at similar levels. NextGen PNT Services seeks to allow the aviation user to choose the PNT source of choice, as well as benefit from the performance of multiple-source systems.

Also of importance is the understanding and acknowledgement of the effects of space weather. Ground- and space-based PNT system designs need to mitigate the impacts of space weather events and reduce the susceptibility of NextGen PNT Services to these events.

9.1 INTRODUCTION

This chapter presents the results, timing and dependencies of work efforts necessary to achieve the NextGen vision for PNT Services. PNT Services is one of the foundational elements needed to achieve NextGen trajectory-based and performance-based navigation operations. Aircraft navigation and airspace design have long been constrained by the capabilities and fixed positions of ground-based navigational aids. Routes were tied to the locations of these ground-based aids and constrained the ability of aircraft operators, Air Navigation Service Providers (ANSPs), aircraft, and air traffic controllers (ATC) to plan and execute a flight along the most efficient and effective path. With NextGen PNT Services, routes and flight paths will no longer be constrained to fixed positions. Using complementary aircraft systems that provide required navigation performance (RNP) and area navigation (RNAV), PNT Services allow aircraft to precisely navigate along the most efficient route that meets the needs of the user, the ANSP and the overall National Airspace System (NAS).

Precise timing is a critical requirement for NextGen communication, navigation, and surveillance (CNS) systems. PNT Services also enable the precise synchronization of operations and the reduction of uncertainties associated with disparate timing sources, by providing a common, accurate, and precise timing source for all users.

9.2 PNT SERVICES ENABLERS

The transformation of PNT Services requires the implementation of many Enablers. These Enablers provide the foundation for the realization of OIs and the overall NextGen vision. Enablers must be researched, developed, and implemented in a certain sequence and timing to effectively meet the needs of the OIs they support. Enablers can also support the implementation of other Enablers. To describe these broad needs, the PNT Services Enablers have been aligned into two functional groups as shown in summary in Figure 9-1. The Enabler groups are described in the following sections. Full descriptions of each Enabler, including their integration with other IWP elements, are provided in Appendix II, as well as on the interactive Joint Planning Environment (JPE) available at www.jpdo.gov.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Ground-Based Systems Enablers																		
EN-1039: GBNS - DME Legacy	E	2008																
EN-1065: Ground Based Navigation System (GBNS) - Lighting Systems (Legacy)	E	2008																
EN-1144: Ground Based Navigation System (GBNS) - ILS Legacy	E	2008																
EN-1143: Ground Based Navigation System (GBNS) - eLORAN								E	2015									
EN-1066: Ground Based Navigation System (GBNS) - NextGen Lighting Systems											E	2018						
	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Space-Based Systems Enablers																		
EN-1045: Space Based Augmentation System - WAAS	E	2008																
EN-1160: Space Based Navigation System - GPS Legacy	E	2008																
EN-1041: Space Based Navigation System - GPS Aviation Dual Frequency						E	2013											
EN-1040: Space Based Navigation System - Galileo								E	2015									
EN-1120: GBAS - Local Area Augmentation System (LAAS)										E	2017							
EN-1044: Space Based Navigation System - International GNSS											E	2018						
EN-1042: Space Based Navigation System - GPS Enhanced Accuracy/Integrity Monitoring													E	2020				
EN-1101: Enhanced NextGen PNT Services																	2025	E

Figure 9-1 PNT Services Enabler Timetable

Figure 9-1 shows the overall migration from legacy ground-based navigational aids to a future with primarily space-based navigational aids. This intentional transformation allows aviation users to navigate the NAS without the constraints of fixed navigational points. One notable exception is EN-1143 that provides the ground-based navigation system (GBNS) known as eLORAN or Enhanced Long-Range Navigation. eLORAN provides ground-based radio signals that may serve as a back-up, or alternative to GPS.

The PNT Services Enabler timetable was developed, in part, using the Federal Aviation Administration (FAA) National Airspace System 6.0 Architecture Infrastructure Timetables. These timetables establish the FAA's plans for CNS and avionics Enabler evolution and deployment dates. The PNT Services Enabler timetable was also developed to complement the National PNT Architecture Development, Transition, and Implementation efforts, chaired jointly by the Departments of Defense (DOD) and Transportation (DOT).

It should be noted that the importance of autonomous PNT sensors such as inertial reference units (IRU) is recognized as an important component of PNT. IRUs are not a government-provided PNT service and therefore are not discussed at length in this version of the Integrated Work Plan (IWP).

9.2.1 Ground-Based Systems Enablers

NextGen operations will always require PNT information to perform aircraft operations as well as support ATC decisions. These PNT Services are currently provided, primarily, by ground-based systems. Ground-based systems will always be needed but must evolve to meet the needs of NextGen for more precise, reliable, effective, and efficient services.

Figure 9-2 presents the planned evolution of the ground-based PNT Services Enablers that support NextGen operations. As seen in Figure 9-2, three legacy systems are listed including: EN-1039 that represents the current distance measuring equipment (DME); EN-1065 that represents the current ground lighting systems; and EN-1144 that represents the current instrument landing systems (ILS). These ground-based systems will need to be maintained and operated until new systems are fully deployed and may be continued as a supplement to these new systems. EN-1143 describes the deployment of the eLORAN system. eLORAN is a ground-based system that is an independent and dissimilar complement to space-based navigation systems. When fully deployed, eLORAN is expected to provide a highly accurate, reliable, and nationally available PNT service that can be used by properly equipped aircraft and other mobile platforms. EN-1066 describes the next generation of ground lighting systems that will be more efficient and effective than today's high-maintenance and energy-consuming systems.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Ground-Based Systems Enablers																		
EN-1039: GBNS - DME Legacy	E 2008																	
EN-1065: Ground Based Navigation System (GBNS) - Lighting Systems (Legacy)	E 2008																	
EN-1144: Ground Based Navigation System (GBNS) - ILS Legacy	E 2008																	
EN-1143: Ground Based Navigation System (GBNS) - eLORAN								E 2015										
EN-1066: Ground Based Navigation System (GBNS) - NextGen Lighting Systems											E 2018							

Figure 9-2 Ground-Based Systems Enabler Timetable

9.2.2 Space-Based Systems Enablers

NextGen operations require PNT information that is continuous, precise, accurate, reliable, and available throughout the entire NAS. This PNT information must not be constrained to fixed locations and must be provided to all users on a timely basis. To support this need, the NextGen vision requires the broad implementation of space-based systems to provide PNT Services.

Figure 9-3 presents the planned evolution of the space-based PNT Services Enablers that support NextGen operations. As seen in Figure 9-3, two legacy systems are currently providing PNT Services. EN-1160 is the current GPS provided by the DOD. EN-1045 is the wide area augmentation system (WAAS), provided by the FAA, that supplements GPS with ground-based stations to enhance the accuracy of the GPS signal and provides integrity monitoring of the GPS system. The GPS system is critical to NextGen and needs enhancements to provide greater accuracy, availability, and integrity as described in EN-1041 and EN-1042. EN-1041 describes the required GPS enhancements that provide a second frequency, located in the L5 band, for aviation safety-of-life applications. EN-1042 describes the required GPS enhancements that provide increased accuracy and signal integrity monitoring. Until these more accurate GPS systems are in place, NextGen operations may require the use of additional space-based augmentation systems as shown by EN-1045.

Figure 9-3 also includes the international space-based PNT Services of EN-1040 and EN-1044 that may become part of NextGen operations, depending on the outcome of future Federal policy decisions. Finally, Figure 9-3 presents EN-1101 that is intended to describe future PNT Services that may be needed as demands and conditions evolve over the NextGen implementation life-cycle.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Space-Based Systems Enablers																		
EN-1045: Space Based Augmentation System - WAAS	E	2008																
EN-1160: Space Based Navigation System - GPS Legacy	E	2008																
EN-1041: Space Based Navigation System - GPS Aviation Dual Frequency						E	2013											
EN-1040: Space Based Navigation System - Galileo								E	2015									
EN-1120: GBAS - Local Area Augmentation System (LAAS)										E	2017							
EN-1044: Space Based Navigation System - International GNSS											E	2018						
EN-1042: Space Based Navigation System - GPS Enhanced Accuracy/Integrity Monitoring													E	2020				
EN-1101: Enhanced NextGen PNT Services																	2025	E

Figure 9-3 Space-Based Systems Enabler Timetable

9.3 RESEARCH AND DEVELOPMENT ACTIVITIES

PNT Services are a key component in the transformation to NextGen. While the basic research for GPS has been completed, many Research and Development (R&D) Activities are still needed to support the ongoing evolution of PNT Services. This section presents the R&D Activities that have been identified as necessary to further the development of the Enabler timetables described in Section 9.3. Detailed information describing each R&D Activity, including their integration with other IWP elements, can be found in Appendix III, as well as on the interactive JPE available at www.jpdo.gov.

Figure 9-4 shows the planned evolution of the R&D Activities needed to support NextGen PNT Services Enablers. These activities have been drawn, primarily, from the NextGen FY 2009 – FY 2013 R&D Plan and the national PNT Architecture for 2025. PNT Services research primarily focuses on the exploration of dissimilar technologies to space-based systems, in order to mitigate the effects of GPS interference. Low-frequency technology and inertial measurement unit technology will feed the PNT backup strategy, architecture strategy, and ultimately the resultant PNT systems that are supporting NextGen operations. Key development activities include determining the usage of foreign PNT sources and augmentations such as, the European Galileo and the European Geostationary Navigation Overlay Service (EGNOS) and the Russian Global Navigation Satellite System (GLONASS), to name a few.

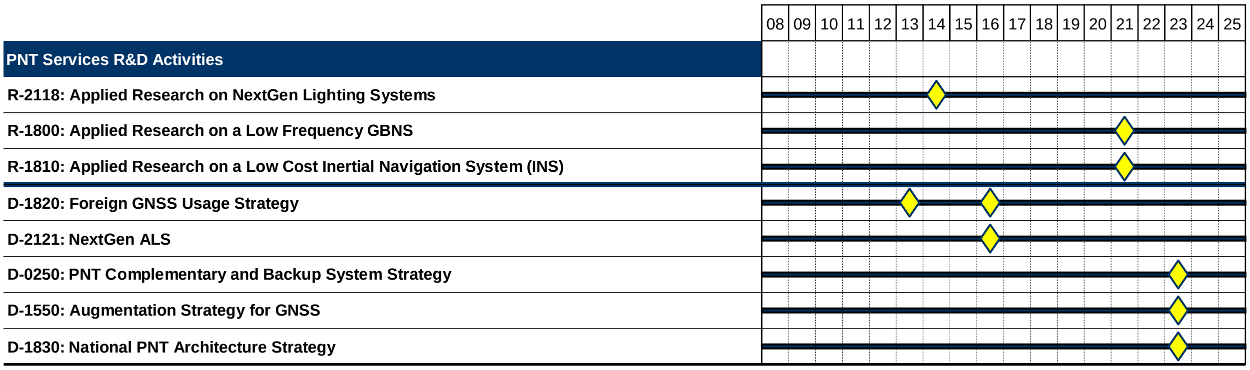

Figure 9-4 PNT Services R&D Activities Timetable

9.4 POLICY ISSUES

NextGen Communication, Navigation and Surveillance (CNS), and automation capabilities rely on the availability of high-performance PNT Services. Thus far, the U.S. GPS has been that source. GPS was developed, funded, and implemented by DOD for military applications but has since evolved into a joint military and civilian system. Although GPS is DOD-operated, on-going requirements, system enhancements, and funding are managed by the National Space-Based PNT Executive Committee (PNT ExComm). The PNT ExComm manages GPS and U.S. Government augmentations to GPS, consistent with national policy, to support and enhance U.S. economic competitiveness and productivity, while protecting national security and foreign policy interests.

GPS is composed of a constellation of satellites, ground stations, data links, and associated command and control facilities and provides the Standard Positioning Service (SPS) for civil use. Augmentation systems are used to enhance SPS to provide better accuracy, availability, integrity, and continuity. Similar systems are being developed by China, Europe, India, Japan, and Russia. The U.S. has coordinated, or is in the process of coordinating, with these nations to ensure interoperability, compatibility, and availability of system and receiver equipment standards.

PNT Services performance, including GPS modernization, sustainment and performance guarantees, must support NextGen communication, navigation, and surveillance/air traffic management (CNS/ATM) performance requirements for both normal and non-normal operations. PNT deployment schedules must be synchronized with related avionics equipage and other CNS/ATM infrastructure with stable schedules. Additionally, government performance guarantees need to reflect actual system performance. Backup PNT capabilities must be defined and implemented to support safe transitions during failures of critical system components. NextGen requires an integrated approach for CNS/ATM automation capabilities and, consequently, an integrated approach to PNT infrastructure.

Funding policies and commitments must be in place to ensure scheduled deployment and continuous sustainment of services. This may require that a larger portion of GPS funding come from agencies other than the DOD, to include a general fund.

Moreover, international cooperative agreements need to support compatibility between U.S. and foreign satellite PNT systems, and standards must be coordinated to ensure equipment manufacturers and operators can take advantage of hybrid solutions. This will also aid in keeping infrastructure costs in check and minimize dissimilar requirements for avionics between regions.

Figure 9-5 presents the Policy Issues that support PNT Services. These Policy Issues are intended to encourage targeted stakeholder engagement in solving policy challenges that may impede progress toward PNT Services Enablers. Depending on the maturity of a given issue, descriptions range from specific policy suggestions to recommendations for further analysis and open discussion. Further information concerning specific Policy Issues, including their integration with other IWP elements, can be found in Appendix IV as well as on the interactive JPE available at www.jpdo.gov.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
PNT Services Policy Issues																		
PI-0120: PNT Performance Requirements	P 2008																	
PI-0022: GPS Policy to Support Civil NextGen PNT Requirements			P 2010															
PI-0075: PNT Services - Global Harmonization						P 2013												

Figure 9-5 PNT Services Policy Issues Timetable

9.5 SUMMARY - POSITIONING, NAVIGATION, AND TIMING SERVICES

NextGen will be more flexible, responsive, and unconstrained using satellite-based and ground-based systems that provide accurate and universal PNT Services. The PNT Services functional area enables aircraft and ground equipment to accurately and precisely determine current location, orientation, time, and path anywhere on the globe. With this information, aircraft can apply the corrections necessary to maintain a desired position and path. Accurate and precise PNT Services also enable improved surveillance capabilities, reduced separation standards, and the synchronization of operations. The decommissioning of current ground-based navigation systems, along with the improved operations from enhanced PNT Services, will result in significant cost savings.

Challenges: The implementation of NextGen PNT Services faces great challenges within the topics of redundant, complementary, and backup systems; augmentation systems; and certification and use of foreign PNT sources. Key areas of consideration will be how to mitigate the effect of interference and the definition of backup capabilities to support safe transition during failures of critical system components.

Enablers: NextGen PNT Services require the evolution of the Global Positioning System (GPS), including satellites transmitting dual-frequency civil signals, enhanced position and timing accuracy, and more robust integrity monitoring. It also requires a comprehensive GPS back-up capability.

Research and Development Activities: A national PNT architecture and strategy that includes a backup strategy to guide NextGen PNT Services is needed. Approach and runway lighting systems also need improvements to reduce their costs and increase effectiveness.

Policy Issues: NextGen requires national and international policies that define the performance, responsibilities, and standards to be used across all PNT service providers.

10 Surveillance Services

Surveillance Services provides one of the foundational elements needed to support Next Generation Air Transportation System (NextGen) trajectory-based and performance-based navigation operations. It is also critical for defense and security operations within the National Airspace System (NAS). Surveillance Services provides the ability to detect, identify, track, and monitor the movements of cooperative and non-cooperative targets. Cooperative surveillance relies primarily on the self-reporting of aircraft or vehicle position information to other aircraft, vehicles, and ground-based systems. It also involves retaining and broadcasting this information to NextGen users. Non-cooperative surveillance is needed for sovereign air security and law-enforcement as well as monitoring aircraft, ground vehicles, and other moving objects not equipped for cooperative surveillance.

Surveillance Services represent a major investment for NextGen that will be implemented incrementally over time. It involves a complex array of equipage, ground systems, communication, processes, and procedures that must be accomplished in a cooperative and synchronized manner to achieve national air surveillance and data/information integration. The Federal Aviation Administration (FAA), Department of Homeland Security (DHS), Department of Defense (DOD), Department of Commerce (DOC), and other air safety and security partners must wholly integrate surveillance and data/information requirements to accommodate both the projected increase in aircraft volume as well as the safety and security of the NAS.

Surveillance Services is critical to the NextGen Capability *Provide Effective Information Sharing Environment*. The goal of this capability is to improve authorized stakeholders ability to provide, discover, and consume timely and accurate NextGen information (e.g. weather, surveillance, aeronautical, and geospatial) in a decentralized, distributed, and coordinated environment through trusted aviation stakeholder partnerships, aligned data policies and standards.

Numerous challenges and issues must be addressed and resolved to successfully establish NextGen Surveillance Services including:

- Determine a formal, institutionalized, interagency mechanism for responsibility, management, funding, and ownership for integrated national surveillance. A lack of networking and integration among FAA, DHS, DOD, DOC, Office of the Director of National Intelligence (ODNI), the Policy Board for Federal Aviation (PBFA), and other air safety and security partners is expected to result in duplication, gaps, and inefficiency that will impede or prevent the achievement of the integrated surveillance capabilities envisioned in the NextGen ConOps.
- A capability is needed to provide surveillance at all times, in all altitudes, and in all weather environments that will allow detection of potential air threats with sufficient time to assess the potential threat and develop an appropriate response. Surveillance Services must be sufficiently integrated to improve the ability and response time needed for operational decisions, which involve safety and security concerns, at maximum distances from areas of interest.

10.1 INTRODUCTION

This chapter presents the results, timing, and dependencies of work efforts necessary to achieve the NextGen vision for Surveillance Services. Surveillance Services is one of the foundational elements needed to achieve NextGen trajectory-based and performance-based operations.

NextGen Surveillance Services refers to the ability to detect, identify, track, and monitor aircraft, ground vehicles, and other objects in the air and on the ground. Surveillance data is provided by both cooperative and non-cooperative surveillance data sources. Cooperative surveillance relies primarily on the self-reporting of aircraft or vehicle position data to other aircraft, vehicles and ground-based systems. Cooperative surveillance data is envisioned as the primary source of aircraft position and intent within NextGen operations. It will be used to support trajectory and separation management functions as well as safety, security, and ground operational needs. Non-cooperative sensor data will also provide aircraft or vehicle positions from non-cooperative targets.

Users throughout the air transportation system need surveillance information to support a wide range of missions. The FAA requires this information to administer the NAS, DHS for transportation security, DOD for homeland defense, and DOC for weather forecasting. NextGen Partners are investing considerable resources, time, and energy to develop surveillance capabilities in support of surveillance needs within their own core domains. Currently, Department of Transportation (DOT) and the FAA are concentrating on fielding Automatic Dependent Surveillance-Broadcast (ADS-B) that can provide NextGen cooperative surveillance capability. DHS and DOD are expending resources to support air surveillance, and DOD and DOC are funding Research & Development (R&D) Activities on future radar and surveillance sensor systems.

The NextGen vision for trajectory-based and performance-based operations requires Surveillance Services that improve the accuracy, latency, integrity, and availability of surveillance information to enable:

- Reduced separation standards
- Comprehensive tracking of aircraft and vehicles operating on the airport surface, within the Air Navigation Service Provider (ANSP) responsible airspace, and in sovereign airspace to minimize the risk of collisions and maximize the use of airspace
- Precise four dimensional trajectory (4DT) information including aircraft intent and conformance monitoring
- Flexible assignment of multiple NextGen surveillance sources to any operational position at any time, to enable more flexibility in assigning airspace to each position as needed to support distributed decision making
- Adaptive flexible spacing and sequencing of aircraft on the ground and in the air.

There are many new functions that will be made possible by NextGen Surveillance Services Enablers. These include full air situational awareness, dynamic Special Use Airspace (SUA) management, en route de-confliction, and full self-separation. Surveillance information is envisioned to be provided through a net-centric infrastructure (NCI), allowing all certified users including ANSPs, security providers, flight operators, and other communities of interest (COI) the appropriate level of access to data in a secure manner. This improved precision, access, and timeliness of information will allow distributed decision making on a real-time basis during normal operations, abnormal events, or system-wide crises.

10.2 SURVEILLANCE SERVICES ENABLERS

The transformation of Surveillance Services requires the implementation of many Enablers that will provide the foundation for many Operational Improvements (OIs) and the overall NextGen vision. To describe these broad needs, the Surveillance Services Enablers have been aligned into three functional groups as shown in summary in Figure 10-1. The Enabler groups are described in the following sections. Full information on each Enabler, including their integration with other IWP elements, is provided in Appendix II, as well as on the interactive Joint Planning Environment (JPE) available at www.jpdo.gov.

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Non-Cooperative Surveillance Enablers																		
EN-1017: Non-Cooperative Surveillance Legacy LRR	E 2008																	
EN-1020: Non-Cooperative Surveillance Legacy ASR-8	E 2008																	
EN-1021: Non-Cooperative Surveillance - Legacy ASR-9	E 2008																	
EN-1406: Airport Surveillance Video			E 2010															
EN-1002: Non-Cooperative Surveillance - GSE				E 2011														
EN-1003: Non-Cooperative Surveillance Information Service					E 2012													
Cooperative Surveillance Enablers																		
EN-1018: Cooperative Surveillance - Legacy Mode S.	E 2008																	
EN-1019: Cooperative Surveillance - Legacy ATCBI-6	E 2008																	
EN-1024: Cooperative Surveillance - PRM Level 1	E 2008																	
EN-1700: Cooperative Surveillance - ADS-C	E 2008																	
EN-1404: Cooperative Surveillance - PRM Level 2		E 2009																
EN-1405: Cooperative Surveillance (Multilateration)		E 2009																
EN-1023: Cooperative Surveillance - ADS-B Out Level 1			E 2010															
EN-1400: Cooperative Surveillance - ADS-B IN/TIS-B/FIS-B Level 1			E 2010															
EN-1005: Cooperative Surveillance - Ground Equipment					E 2012													
EN-1006: Integrated Cooperative Surveillance Information - Level 1					E 2012													
EN-1500: Cooperative Surveillance - ADS-B Out Level 2							E 2014											
EN-1503: Cooperative Surveillance - ADS-B IN/TIS-B/FIS-B Level 2							E 2014											
EN-1506: Integrated Cooperative Surveillance Information - Level 2								E 2015										
EN-1501: Cooperative Surveillance - ADS-B Out Level 3													E 2020					
EN-1504: Cooperative Surveillance - ADS-B IN/TIS-B/FIS-B Level 3													E 2020					
EN-1507: Integrated Cooperative Surveillance Information - Level 3													E 2020					
EN-1502: Cooperative Surveillance - ADS-B Out Level 4																		2025 E
EN-1508: Integrated Cooperative Surveillance Information - Level 4																		2025 E
Integrated Surveillance Enablers																		
EN-1022: Air Surveillance - Legacy ASR-11	E 2008																	
EN-1025: Airport Surface Surveillance - Legacy ASDE-X	E 2008																	
EN-1402: Integrated Surveillance Strategy	E 2008																	
EN-1049: Integrated Surveillance Information Service Level 1					E 2012													
EN-1401: Backup Surveillance System							E 2014											
EN-1510: Integrated Surveillance Information Service Level 2								E 2015										
EN-1511: Integrated Surveillance Information Service Level 3													E 2020					
EN-1512: Integrated Surveillance Information Service Level 4																		2025 E

Figure 10-1 Surveillance Services Enabler Timetables

The Surveillance Services Enabler timetable was developed with the following considerations:

- The primary source of reference material was the FAA's National Airspace System 6.0 Architecture Infrastructure Timetables. These timetables established the Communications, Navigations, Surveillance, and Avionics Enabler evolution and deployment dates.
- The FAA's NAS-Wide ADS-B Program and the Air Domain Surveillance and Intelligence Integration (ADSII) plan were also leveraged for capability rollout and evolution.
- Using the compilation of these sources in junction with the OIs, an incremental rollout of Enablers was derived. The incremental rollouts reflect the level of availability, capability, and maturity. Level 1 provides existing, initial, and limited availability and capability. Levels 2 through 4 provide enhancements, with Level 4 envisioned as complete maturity.

It should be noted that the timetables were developed without an integrated national surveillance mechanism. The expected initial availability dates for the Enablers within this timetable are preliminary dates. The refinements of the dates are pending a DOD response to the JPDO Senior Policy Committee (SPC) to define and establish an integrated national surveillance mechanism.

10.2.1 Non-Cooperative Surveillance

Non-Cooperative Surveillance of aircraft is the determination of its three-dimensional position in space without the aircraft actively participating. Non-Cooperative Surveillance is needed for air traffic control (ATC), air traffic management (ATM), airspace security, and law-enforcement as well as monitoring aircraft, ground vehicles, and other moving objects not equipped for cooperative surveillance. Non-Cooperative Surveillance must complement ATC/ATM needs as a part of the overall surveillance system, particularly when required cooperative surveillance capability is unavailable.

Figure 10-2 shows the planned evolution of the Enablers that will support Non-Cooperative Surveillance. To provide Non-Cooperative Surveillance in the near-term, current legacy systems must be maintained and enhanced to adapt their surveillance data to be sent through the NCI for improved tracking and data networking. These legacy systems include EN–1017 that provides long-range radar (LRR), EN–1020 that provides the airport surveillance radar Model 8 (ASR-8), and EN-1021 that provides airport surveillance radar Model 9 (ASR-9). To provide position reports on ground vehicles and other moving objects not equipped for cooperative surveillance, EN-1002 that provides Non-Cooperative Surveillance of Ground Service Equipment (GSE), and EN-1406 that provides airport surveillance video, will provide visual information and geospatial data to airport surface and perimeter surveillance systems. With the information from the three legacy radar systems coupled with EN-1002 and EN-1406, integrated non-cooperative position reports will become available through EN-1003, the first level of a Non-Cooperative Surveillance information service, by 2012.

Non-Cooperative Surveillance Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-1017: Non-Cooperative Surveillance Legacy LRR	E	2008																
EN-1020: Non-Cooperative Surveillance Legacy ASR-8	E	2008																
EN-1021: Non-Cooperative Surveillance - Legacy ASR-9	E	2008																
EN-1406: Airport Surveillance Video			E	2010														
EN-1002: Non-Cooperative Surveillance - GSE				E	2011													
EN-1003: Non-Cooperative Surveillance Information Service					E	2012												

Figure 10-2 Non-Cooperative Surveillance Enabler Timetable

10.2.2 Cooperative Surveillance

Cooperative Surveillance relies primarily on the self-reporting of aircraft or vehicle surveillance information to other aircraft, vehicles, and ground-based systems. This type of surveillance is considered the routine and preferred method of detection because of the additional information self-reporting provides. The NAS has evolved air surveillance for Instrument Flight Rules (IFR) and Visual Flight Rules (VFR) flight following that depends on cooperative aircraft avionics to support surveillance data collection systems including secondary surveillance radar and ADS-B. NextGen envisions Cooperative Surveillance as fundamental to sustain the ANSP mission.

Figure 10-3 shows the planned evolution of the Enablers that will support Cooperative Surveillance. There are three major multi-level Enabler groups within Cooperative Surveillance:

- **ADS-B OUT:** The cooperative ADS-B OUT capability will progress through four successive levels over a 15-year period, from 2010 through 2025, and include EN-1023, EN-1500, EN-1501, and EN-1502.
- **ADS-B IN:** In a similar approach, the cooperative ADS-B IN services, including Traffic Information Service-Broadcast (TIS-B) and Flight Information Services-Broadcast FIS-B, will progress through three successive levels over a 10-year period, from 2010 through 2020, and include EN-1400, EN-1503 and EN-1504.
- **Integrated:** NextGen envisions the integrated collection and dissemination of all cooperative surveillance information progressing in four levels. Beginning with EN-1006 that provides the first level of integration in 2012, additional levels are described by EN-1506, EN-1507, and EN-1508 that form the fully integrated Cooperative Surveillance Information Service by 2025.

Cooperative Surveillance Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-1018: Cooperative Surveillance - Legacy Mode S.	E	2008																
EN-1019: Cooperative Surveillance - Legacy ATCBI-6	E	2008																
EN-1024: Cooperative Surveillance - PRM Level 1	E	2008																
EN-1700: Cooperative Surveillance - ADS-C	E	2008																
EN-1404: Cooperative Surveillance - PRM Level 2		E	2009															
EN-1405: Cooperative Surveillance (Multilateration)		E	2009															
EN-1023: Cooperative Surveillance - ADS-B Out Level 1			E	2010														
EN-1400: Cooperative Surveillance - ADS-B IN/TIS-B/FIS-B Level 1			E	2010														
EN-1005: Cooperative Surveillance - Ground Equipment					E	2012												
EN-1006: Integrated Cooperative Surveillance Information - Level 1					E	2012												
EN-1500: Cooperative Surveillance - ADS-B Out Level 2							E	2014										
EN-1503: Cooperative Surveillance - ADS-B IN/TIS-B/FIS-B Level 2							E	2014										
EN-1506: Integrated Cooperative Surveillance Information - Level 2								E	2015									
EN-1501: Cooperative Surveillance - ADS-B Out Level 3													E	2020				
EN-1504: Cooperative Surveillance - ADS-B IN/TIS-B/FIS-B Level 3													E	2020				
EN-1507: Integrated Cooperative Surveillance Information - Level 3													E	2020				
EN-1502: Cooperative Surveillance - ADS-B Out Level 4																	2025	E
EN-1508: Integrated Cooperative Surveillance Information - Level 4																	2025	E

Figure 10-3 Cooperative Surveillance Enabler Timetable

10.2.3 Integrated Surveillance

The vision of NextGen is to move beyond the distinctions of cooperative and non-cooperative surveillance by integrating multiple types of surveillance data and information. Figure 10-4 shows the planned evolution of the Enablers that will support Integrated Surveillance. The first step is to complete the Integrated Surveillance Strategy described by EN-1402 and supported by the National Integrated Surveillance Plan described by PI-0009. This strategy is needed to define the security levels, criteria, and approval processes that will guide the sharing of complementary cooperative and non-cooperative surveillance data among public (DOD, DHS, DOT/FAA, DOC) and private entities. Content of this strategy is closely linked to multiple Surveillance Services Policy Issues. Maintaining current legacy technology through EN-1022: Air Surveillance – Legacy ASR-11 and EN-1025: Airport Surface Surveillance – Legacy Airport Surface Detection Equipment Model X (ASDE-X) provides an initial foundation of providing an Integrated Surveillance Service.

Surveillance performance requirements can vary depending upon many factors. Surveillance coverage, along with achieved performance for specified airspace volumes and surface regions at airports, enables conduct of a designated OI. Both full-capability and complementary surveillance must meet their respective performance and coverage requirements needed to support increasing traffic demands while maintaining safety and security.

Integrated Surveillance Enablers	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EN-1022: Air Surveillance - Legacy ASR-11	E	2008																
EN-1025: Airport Surface Surveillance - Legacy ASDE-X	E	2008																
EN-1402: Integrated Surveillance Strategy	E	2008																
EN-1049: Integrated Surveillance Information Service Level 1					E	2012												
EN-1401: Backup Surveillance System							E	2014										
EN-1510: Integrated Surveillance Information Service Level 2								E	2015									
EN-1511: Integrated Surveillance Information Service Level 3													E	2020				
EN-1512: Integrated Surveillance Information Service Level 4																	2025	E

Figure 10-4 Integrated Surveillance Enabler Timetable

10.3 RESEARCH AND DEVELOPMENT ACTIVITIES

The transformation to NextGen requires specific R&D Activities that will guide the planning and development of Surveillance Services. These R&D Activities were primarily drawn from the NextGen R&D Plan for FY 2009 – FY 2013, which was developed prior to the DOD Lead Service Office establishment or the influence of a national interagency mechanism for surveillance; therefore, they have a heavy emphasis on ATM near-term R&D. Timetable timelines, key performance factors, and decision points will be developed and regulated through the oversight of the interagency mechanism for surveillance integration, which is pending the SPC's established recommended solution.

The Surveillance Services R&D Activities are presented in chronological order in Figure 10-5. A major research area is the trade-offs in determining the available sources of surveillance data and their appropriateness in terms of accuracy, timeliness, and complementary capability for different operator and facility functions. R&D Activities include evaluation of the capability to determine the correct mix of surveillance sensors and whether a multi-function sensor is practical and optimal for NextGen purposes. The research identifies the needs for both cooperative and non-cooperative surveillance in security and ATM for an investment decision by 2014. Detailed information describing each R&D Activity can be found in Appendix III as well as on the interactive JPE available at www.jpdo.gov.

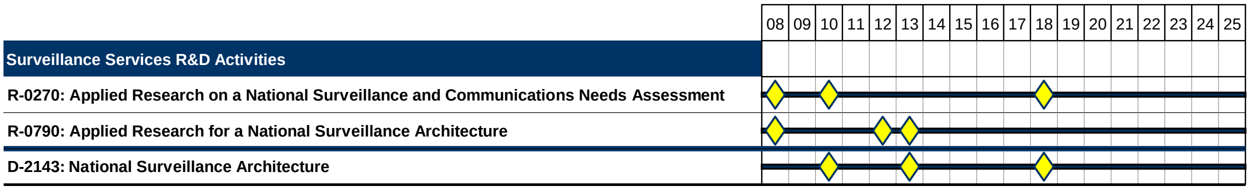

Figure 10-5 Surveillance Services R&D Activities Timetable

10.4 POLICY ISSUES

To improve and integrate Surveillance Services in support of NextGen operations – cooperative and non-cooperative – current policies must be modified or new policies established, standardizing data sharing and appropriate situational usage of surveillance systems. The JPDO Federal Partners will need to reach a coordinated decision to address the functional requirements and financial responsibilities of the provision and use of surveillance equipment and services. Independent agency efforts to address the various agencies' respective needs and roles will likely be inefficient. Figure 10-6 shows the planned evolution of the Policy Issues that will support NextGen Surveillance Services. Further information concerning specific Policy Issues, including their integration with other IWP elements, can be found in Appendix IV, as well as on the interactive JPE available at www.jpdo.gov.

The first step toward integrated national surveillance services will be to complete the National Integrated Surveillance Plan, which will define security levels, criteria, and approval processes that will guide the sharing of complementary cooperative and non-cooperative surveillance data among public and private entities. This plan should ensure that DOD, DHS, DOT/FAA, DOC, and aircraft operators collaborate on policies regarding surveillance data collection and distribution, as well as requirements for data security, accuracy, timeliness, identification, and authorization; network security; and access requirements.

Beyond the initial technical and management plans, a National Surveillance Strategy will be necessary to address potential coverage gaps between cooperative and non-cooperative surveillance. With the adoption of ADS-B as the primary cooperative surveillance technology, the interagency agreement must determine how non-cooperative surveillance technologies will be used during cooperative system failures and whether planned non-cooperative architectures of DHS and DOD will satisfy FAA ATM performance requirements during such failures. In addition to these core plans and strategic decisions, NextGen plans will need to address how we can better protect data shared over-the-air, including ADS-B and Data Communication identification information that could be manipulated for unauthorized tracking or misinformation by "phantom controllers". The FAA will need to better utilize non-cooperative surveillance systems, beyond homeland security purposes, to address vulnerabilities of cooperative ATM surveillance systems.

Finally, global cooperation in the air domain necessitates the development for streamlined US and international coordination to assure harmonization of standards, compatibility for surveillance data sharing processes, and equipment.

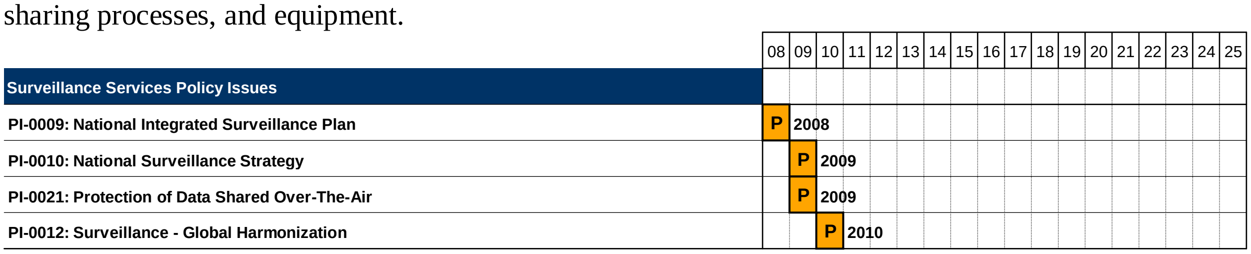

Figure 10-6 Surveillance Services Policy Issues Timetable

10.5 SUMMARY - SURVEILLANCE SERVICES

The NextGen Surveillance Services functional area provides the ability to detect, identify, and monitor the movements of cooperative and non-cooperative targets. Cooperative surveillance involves the self-reporting of aircraft or vehicle surveillance information to other aircraft, vehicles, and ground-based systems. It also involves the processing and dissemination of this information to NextGen users. Non-cooperative surveillance is needed for air sovereignty and security, as well as monitoring aircraft, ground vehicles, and other objects not equipped for cooperative surveillance. Surveillance Services represents a major investment of complex equipage, ground systems, communications, processes, and procedures that must be implemented, over time, by many NextGen Partners in a cooperative and synchronized manner.

Challenges: There are two main challenges in providing NextGen Surveillance Services. In the near-term a formal, institutionalized, interagency mechanism for responsibility, management, funding, and ownership must be established to support the development of the integrated national surveillance capability. In addition, by 2015-2025, a 24/7 surveillance capability is needed, for all altitudes and in all weather environments, that will allow detection of potential air threats with sufficient time to assess the potential threat and develop an appropriate response.

Enablers: Legacy cooperative and non-cooperative radar systems must be maintained, replaced, and updated to support a net-centric integrated surveillance environment. An integrated surveillance strategy is needed to provide the governance and guidance for the development of an integrated national surveillance capability. The full implementation of ADS-B is needed for complete cooperative surveillance.

Research and Development Activities: To provide an integrated national surveillance capability, research is needed to determine the required characteristics of national surveillance and associated communications needs. Research will include determining needed surveillance data sources and their accuracy, timeliness, and compatibility with different operator and facility functions.

Policy Issues: A key near-term Policy Issue is the completion of the National Integrated Surveillance Plan that will define security levels, criteria and approval processes to facilitate the sharing of complementary cooperative and non-cooperative surveillance data among public and private entities. With the adoption of ADS-B as the predominant cooperative surveillance technology, an interagency agreement is needed to determine how non-cooperative surveillance technologies may be used during cooperative system failures. It is also necessary to determine whether the non-cooperative architectures of the DHS and DOD will satisfy FAA ATM performance requirements during such failures.