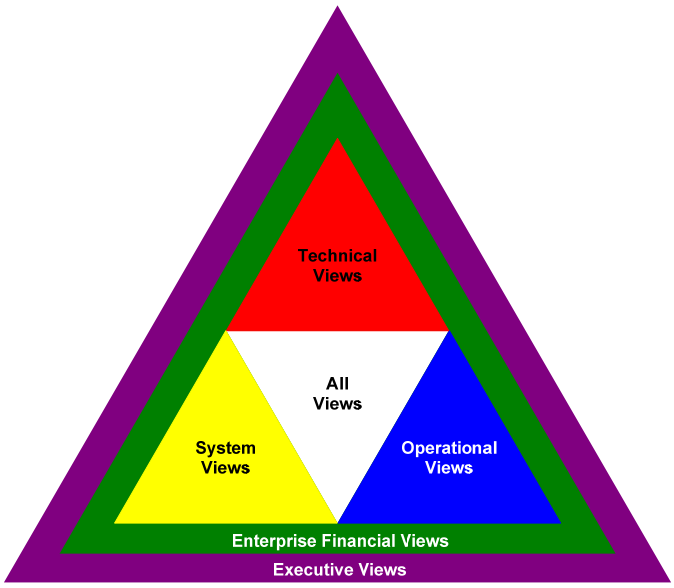
Federal Aviation Administration

National Airspace System Integrated Systems Engineering Framework (NAS ISEF)



Version 3.2

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Version Control

Version	Date	Author	Change Description
1.0	September 30, 2006	SETA-II	Initial
2.0	September 30, 2007	SETA-II	Introduces NAS EA Meta Model. Redefines set of hierarchical elements. Restructures product guides to emphasize NAS EA Meta Model and data-centricity. Restructures AV-1 Template.
2.1	September 30, 2008	SETA-II	Reflects NAS EA Meta Model updates: removal of relationships between Operational Activity and Systems Function Input/Output and Systems Function to Operational Activity Input/Output. Adds new "Actor" architecture element, attributes, relationships, and rules. Adds new "source" and "sink" Systems Function Input/Output attributes and relationships. Reformulates *Rules* and updates *Sample Graphical Models* for each product development guide. Clarifies AV-1 Template treatment of alternative solutions and usage of Architecture Impact Assessment (AIA).
3.0	January 04, 2010	SETA-II	Combines NAS EA Framework Volumes I, II, and III v2.1 into one comprehensive document. Establishes new Framework concepts for how the NAS EA fits into the rest of the ATO and the Agency. Presents a more flexible and less prescriptive set of guidelines for architecture development and analysis.
3.1	June 30, 2011	SE-2020	Updates title of the document to the Integrated Systems Engineering Framework to account for and describe the structure, products, and processes that apply to the development of integrated NAS architecture products and requirement documents at the enterprise-, service unit-, and program-levels. Updates corresponding figures and language, as well as the conceptual metamodel. Includes new section to describe horizontal and vertical integration concepts. Updates Appendix A, to include new product examples, development and integration guidance. Creates new Appendix B, to describe the structure, roles and responsibilities, and processes for managing and controlling the NAS architecture and requirements.
3.2	June 29, 2012	SE-2020	Updates include additional detail describing the development and integration of Enterprise- and Program-level architecture and requirements, edits stemming from organizational and governance changes. Other updates include the removal of references to the Service Unit-level, as well as the Data Elements tables, which are now captured in Appendix A.

Table of Contents

1 INTRODUCTION & BACKGROUND

The National Airspace System (NAS) Enterprise Architecture (EA) continues to mature into a comprehensive, multiyear strategic plan and framework for improving and evolving the NAS from the current portfolio of fielded systems through 2025 and beyond. It describes the services required of the NAS to provide safe and efficient Air Traffic Management (ATM) to the public. Equally important, the NAS Requirements describe what the NAS must do to provide the services and capabilities. The NAS Integrated Systems Engineering Framework (ISEF) evolves the original NAS EA Framework v1.0 to capture the relationship between, and alignment of the NAS Requirements and NAS EA. The alignment enables traceability of Enterprise- and Program-level requirements to the operations and systems that perform them today and in the future, and ensures consistency between the EA and Requirements as the NAS evolves. Creating a stronger relationship between the two disciplines (i.e., requirements definition and architecture modeling) strengthens the set of interrelated program planning documentation required by the *Federal Aviation Administration's* (FAA) *Acquisition Management System* (AMS) that collectively influence the FAA's ability to refine the vision, develop strategies and plans for achieving the vision, make resource decisions, implement strategies, and evaluate performance.

1.1 Purpose and Audience

The ISEF is primarily intended to support the NAS systems engineering community, however, it also serves as a reference to other internal and external stakeholders for communicating the structure, products, value, and processes that apply to the development of integrated architecture products and requirement documents at the Enterprise and Program-levels. The ISEF establishes a common lexicon and defines the structure for organizing and relating architecture and requirement data in a coherent, consistent manner. The ISEF Appendices also provide additional guidance and instruction on creating and managing the products described herein and their value.

1.2 Document Structure

The document is organized as follows:

- Section 2, *Form and Structure*, provides an overview of the ISEF and the structure and processes for developing architectures and requirements
- Section 3, *Enterprise-level processes and practices*, describes key processes and approaches relevant to Enterprise-level architecture and requirements development, updates and approval
- Section 4, *Program-level processes and practices*, describes key processes and approaches relevant to Program-level architecture and requirements development and approval primarily in support of acquisition decisions
- Section 5, *Architecture and Requirements Analysis*, describes the techniques used to analyze the NAS EA and NAS Requirements to enhance decision support
- Appendix A, *Products Development, Integration, and Style Guidance*, presents a set of reference examples, rules, and styles for developing architecture products, roadmaps, and requirements
- Appendix B, *Governance*, presents the structure, roles and responsibilities, and processes for managing and controlling the NAS Requirements and EA.

1.3 Document References

The NAS ISEF references the following documents:

- FAA Acquisition Management System (AMS)
- FAA Capital Investment Plan (CIP)
- FAA Destination 2025
- FAA Systems Engineering Manual (SEM)
- NAS Systems Engineering and Safety (SE&S) Configuration Management (CM) Plan.

2 FORM AND STRUCTURE

The NAS ISEF, depicted in Figure 1, represents an integrated and federated framework to support the development and analysis necessary to guide the FAA towards the future vision of the NAS. It comprises an integrated set of architectural views and requirement documents that represent various perspectives of the NAS over time, in varying degrees of breadth, and detail. The ISEF provides the frame to hierarchically relate and organize the content contained throughout the NAS-related planning and systems engineering documentation maintained at the Enterprise- and Program-levels.

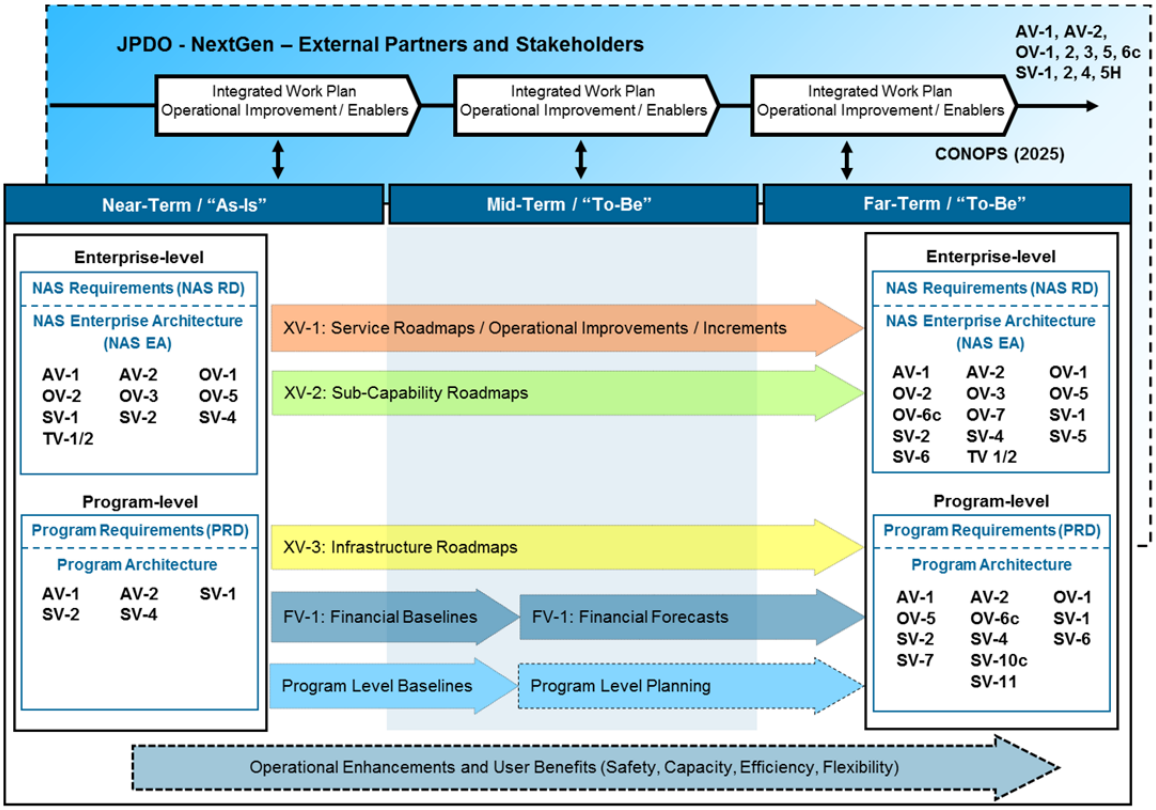


Figure 1: National Airspace System Integrated System Engineering Framework

The NAS ISEF enables transparency and provides line of sight from the NAS goals and objectives described in *FAA's Destination 2025* to the Mission Services, their supporting operational and functional requirements, and the materiel and non-materiel investments (i.e. systems/services, research, development, policy) needed to achieve the full capability. The ISEF also supports investment analysis activities including the analysis of cost, benefits, schedule, and risk factors, and adds an additional level of fidelity to enable the FAA to analyze capability performance and align investments against strategic performance objectives across and between various domains and systems. The following sections further describe the components of the ISEF.

2.1 Timeframes and Levels

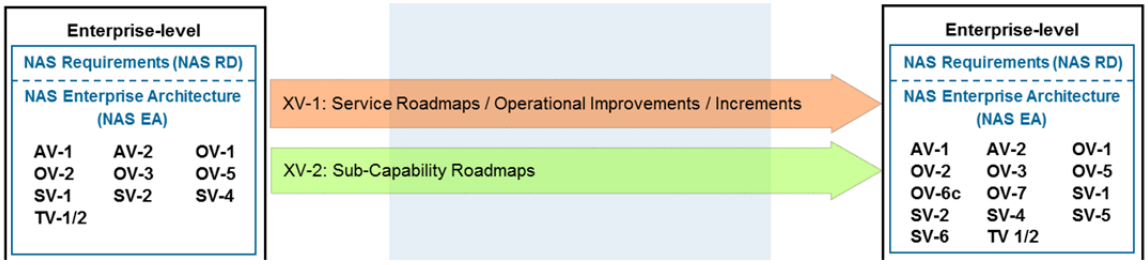
There are three distinct timeframes that appear in Figure 1 i.e., the As-Is, the Mid-Term (To-Be), and the Far-Term (To-Be), each intended to represent the NAS at a particular point in time. The As-Is depicts how the NAS exists today, while the Mid- and Far-Term To-Be states represent how the NAS should/could exist in the future. The As-Is perspective is extremely important in establishing a common basis for management and planning by providing input to gap and impact analysis and the configuration control of the NAS. The To-Be perspectives are equally important by providing a target for aligning current decisions, as well as the basis for more strategic investment/program planning and acquisition.

Within each timeframe there exists a collection of integrated architecture views and requirement statements at different degrees of breadth and abstraction, i.e., Enterprise- and Program-level. Each level establishes a hierarchy of tiered accountability, where at any given level, the architecture views and requirement statements are only developed to the amount of detail necessary to meet the stated objectives, while also establishing a clear reference point for the lower-level decomposition and development. In this parent/child relationship, it is the responsibility of the lower-level to define extensions that provide for higher fidelity and detail.

Each perspective (i.e., the combination of timeframe and level) is described using the architecture views and requirement statements identified within each of the white boxes. The selection and development of products is based on the nature, purpose, scope, and needs of the architects, system engineers, and decision making communities.

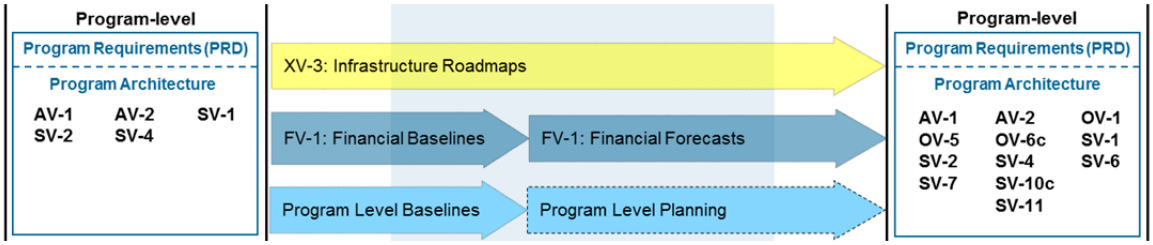
The following sections detail the extent of breadth and abstraction for each level of perspective.

2.1.1 Enterprise-level



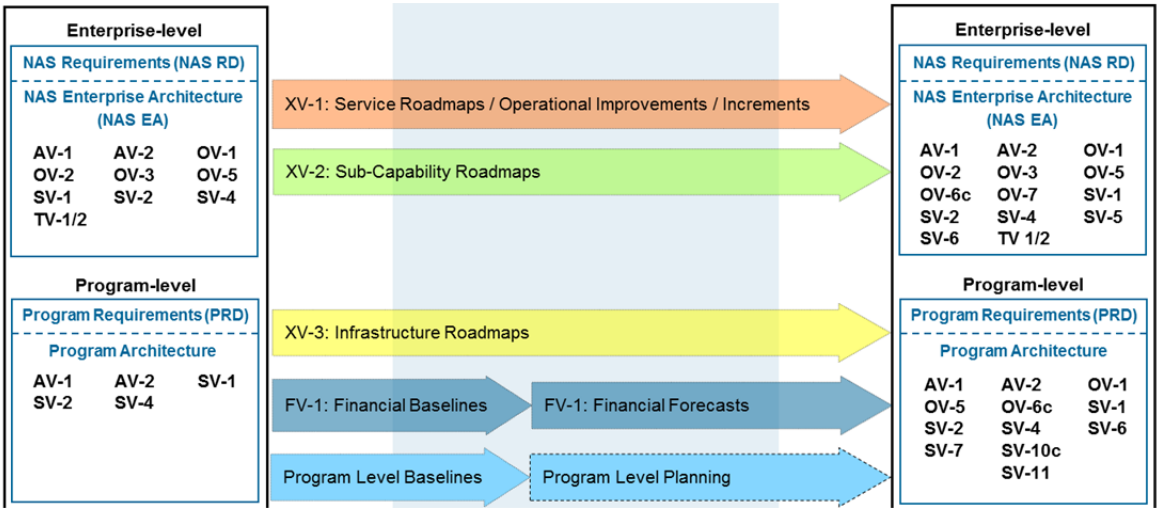
The Enterprise-level covers the entire NAS operational and system environment. It provides a high-level context and is the broadest in scope. The Enterprise-level Requirement Documents capture the operational and functional requirements associated with the NAS Mission Services and decompose each to lower-level requirements that can be allocated to specific NAS portfolios, programs, projects and/or systems. The Enterprise-level architecture views represent modeled interpretations of the NAS Concept of Operations and the NAS Requirements, establishing the context for Program-level architecture development.

2.1.2 Program-level



Program-level Requirement Documents and Architectures are developed as a basis for individual system acquisition within the context of NAS Enterprise-level products. This level may be represented by a single project or system, a portfolio of projects (i.e., a program), or an operational or functional capability. Together, the architecture views and associated requirement documents represent an integrated description of the program, project, system, service, and/or capability.

2.2 Architecture Views



The architecture views identified throughout the ISEF are derived from the Department of Defense Architecture Framework v1.5 (DoDAF). The white boxes in Figure 1 list the set of views required for “As Is” and appropriate ”To Be” architecture development at each of the levels. The list within each box does not preclude the development of other views for any particular architecture. In addition, the NAS Chief Architect may deem other views as necessary or desired to meet a specific business need.

The DoDAF is a tailorable framework, evidenced by the selection and application of required views, as discussed above. Product form, in terms of relevant elements and attributes are tailorable as well. Appendix A, details the choices, adaptations, and modifications made against DoDAF for the products specified for Enterprise- and Program-level development.

2.3 Executive Views

The Executive Views (XV) represent strategic planning roadmaps that depict the evolution and delivery of NAS services, capabilities, benefits, functionality, and investments over time. They are comprised of three related roadmaps: the Service Roadmap, Sub-Capability Roadmap, and the Infrastructure Roadmap.

2.3.1 XV-1 Service Roadmap

The XV-1 or "NAS Service Roadmaps" are a rolling 15-year strategic roadmap that depict the expected evolution and delivery of NAS services, capabilities, and benefits over time. More specifically, it outlines the strategic activities for service and capability delivery to sustain and improve NAS operations towards the target state vision. The Operational Improvements[1] and sustainment initiatives identified on the roadmaps are used to guide, inform, and focus deliberations on NAS capabilities. The Service Roadmaps are updated annually as research and analyses more clearly define the evolution of NAS services. The latest approved version of the NAS Service Roadmaps can be found online at https://nasea.faa.gov/products/sr/main. Figure 2 depicts a sample Service Roadmap for Initiating Trajectory-based Operations.

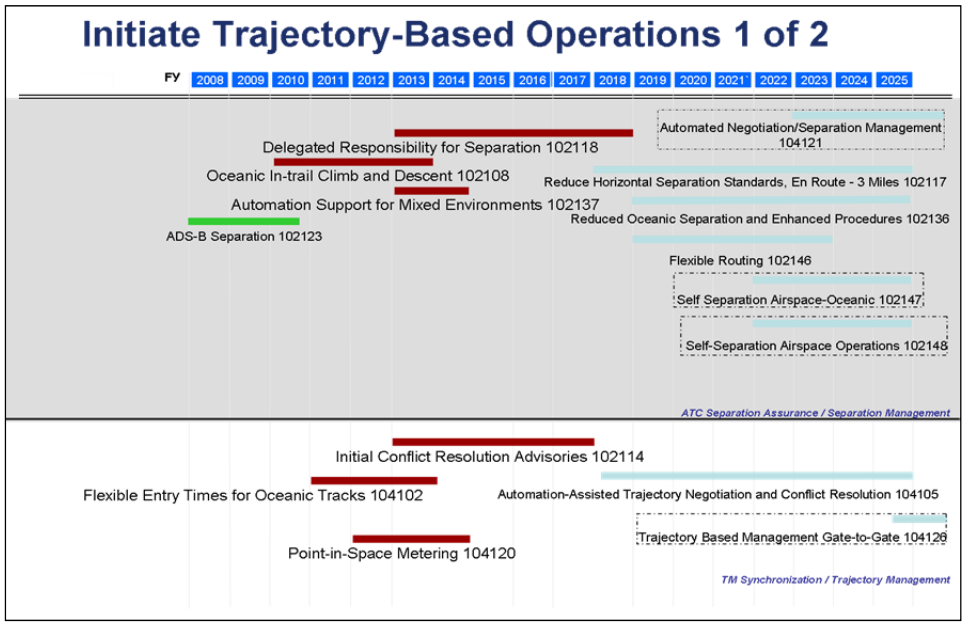


Figure 2: Sample Service Roadmap for Initiate Trajectory-Based Operations

Appendix A lists the XV-1 data elements and their corresponding attributes.

[1] An Operational Improvement is a discrete strategic activity for service and/or capability delivery to improve NAS operations. They are expressed as cross-domain statements comprising sets of anticipated benefits to be realized at some future date.

2.3.2 XV-2 Sub-Capability Roadmap

The XV-2 or "Sub-Capability Roadmap" is a strategic roadmap that depicts the incremental evolution and delivery of NAS functionality over time. It further decomposes the Operational Improvements identified in the Service Roadmap into functionality planned for system/service implementation. Figure 3 depicts a sample Sub-Capability Roadmap for Surveillance in Trajectory-based Operations.

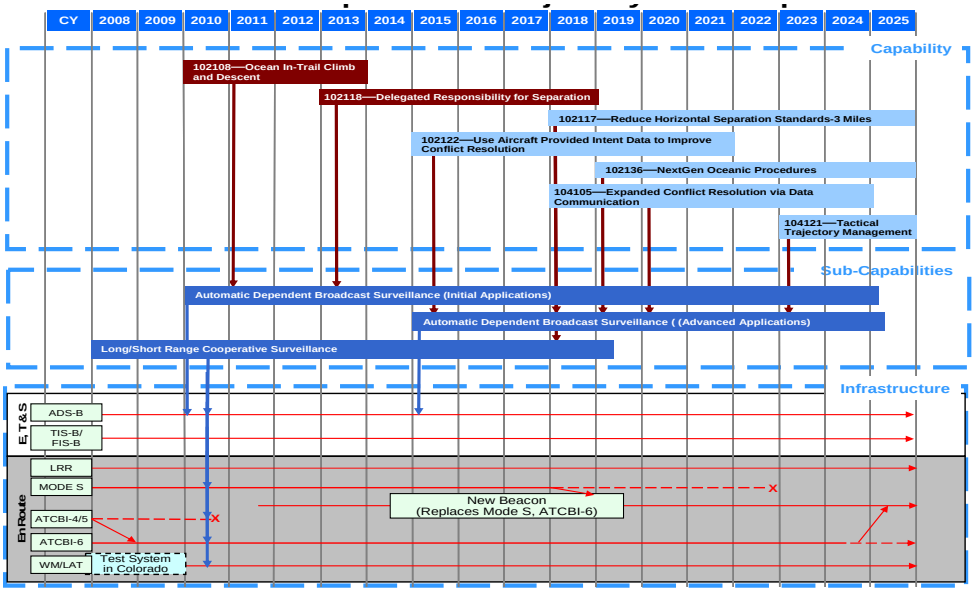


Figure 3: Sample Roadmap for Surveillance Sub-Capabilities in Trajectory-Based Operations

2.3.3 XV-3 Infrastructure Roadmap

The XV-3 or "NAS Infrastructure Roadmaps" are a rolling 15-year strategic roadmap that depict the planned infrastructure improvements and sustainment initiatives, effectively showing the evolution of major FAA programs, projects, and systems in today's NAS infrastructure to meet the target state vision. The Infrastructure Roadmaps contain programmatic and schedule information that define the enabling infrastructure (i.e., actors, systems, services, facilities, and support activities) for ATM service delivery; identify system replacements, convergence and modernization; and the relationships among various infrastructure elements. The Infrastructure Roadmaps also identify key decision points that represent acquisition, strategy, policy, and executive decisions associated with a particular program, project, or system. The decision points indicate the FAA's approval of a particular improvement/sustainment initiative; an investment decision that must precede implementation of an improvement initiative; or the research and/or

analysis that must be conducted before an investment decision or solution implementation. The Roadmaps, combined with funding data, facilitate analysis of cost and schedule tradeoffs, and are used to guide, inform, and focus deliberations on the NAS infrastructure. The latest approved version of the NAS Infrastructure Roadmaps can be found online at https://nasea.faa.gov/products/ir/main. Figure 4 depicts a sample Infrastructure Roadmap for Weather Sensors.

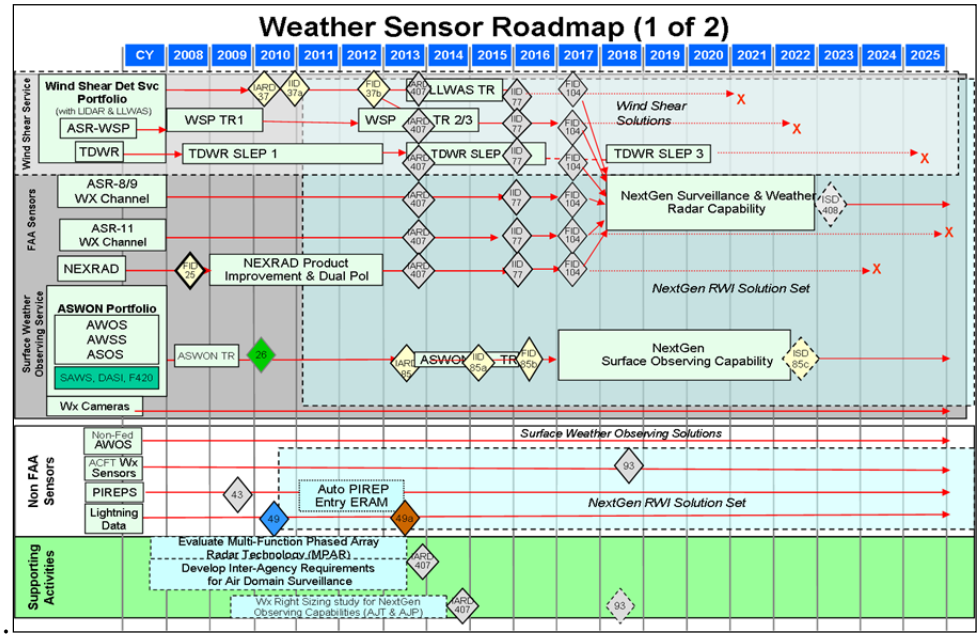


Figure 4: Sample Infrastructure Roadmap for Weather

Appendix A lists the NAS Infrastructure Roadmap data elements and their corresponding attributes.

2.3.4 Relationship between XVs

As previously mentioned, the Executive View (XV) represents strategic planning roadmaps that depict the evolution and delivery of NAS services, capabilities, benefits, functionality, and investments over time. There is an inherent hierarchical relationship between the elements contained within the Service Roadmap, Sub-Capability Roadmap, and the Infrastructure Roadmap. This relationship is depicted in Figure 5 below.

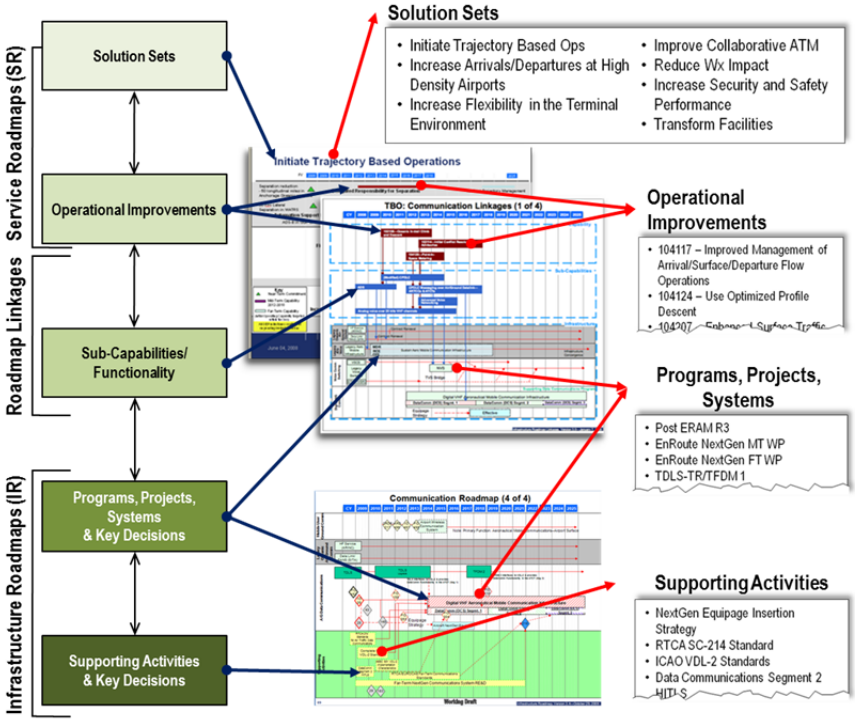


Figure 5 Relationship between XVs

The Service Roadmap is closely linked with the Infrastructure Roadmap through the Operational Improvements, which are organized around seven Solution Sets. A Solution Set is a collection of related Operational Improvements that can be managed as part of the FAA's NextGen portfolio. The Sub-Capability Roadmaps provide the relationship between Infrastructure Roadmap systems and programs to the Service Roadmap Operational Improvements via linkages representing the planned functionalities of implementing programs, systems, and investments. The Infrastructure Roadmaps contain programmatic and schedule relationships between infrastructure elements (i.e., systems, projects, and programs), which are also related and represented in the NAS EA system views.

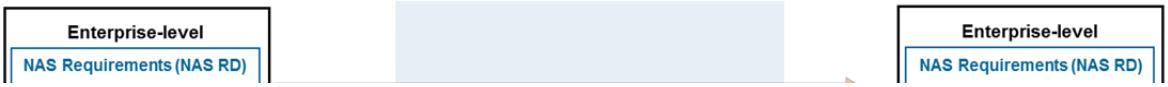
2.4 Financial View

The Financial View (FV) contains forecasted expenditures for funding initiatives (Programs and Projects) identified in the published *FAA Capital Investment Plan* (CIP) and is represented by a single product called the FV-1 or "Funding Profile." The Funding Profile depicts the Facilities and Equipment (F&E) funding for approved and forecasted NAS infrastructure programs. The Funding Profile is closely linked with the Infrastructure Roadmaps, which depicts high-level relationships between the infrastructure elements. This information combined with the Infrastructure Roadmap data enables analysis of the cost and schedule tradeoffs that exist in the budgeting and planning cycle and is used to guide, inform, and focus capital planning deliberations on the NAS infrastructure.

2.5 NAS Requirements Documents

A requirement is an essential characteristic, condition, or capability of a product that shall be met or exceeded to satisfy a contract, standard, specification, or other formally imposed document. A well-written requirments document explains stakeholder needs in a standard format, and provides the criteria against which solutions can be tested and evaluated. All requirements should be traceable to a source (i.e., mission need or higher-level requirement) to ensure compliance with expectations. That bi-directional traceability is created and maintained through allocation, verification, adaptation, and change control techniques.

Requirements documents exist at bothe the Enterprise- and Program-levels within the ISEF. See ISEF Appendix A and Section 4.3 of the NAS System Engineering Manual (SEM) for more guidance on the development and management of requirements within the NAS.



2.5.1 Enterprise Requirements Documents

Enterprise-level requirements are captured in a series of documents that describe the operational and functional requirements for the NAS that are to be met by its systems, equipment, personnel, and procedures. The NAS Requirement Document series (NAS-RD series) exist at both the As-Is and To-Be timeframes.

2.5.1.1 Enterprise System Requirements

The NAS-RD series describe functional requirements that are fielded or will be fielded in the NAS. It also represents the highest level system functions that are enforceable and under configuration control in the current architecture. The NAS-RD series organizes requirements per the NAS Mission Services.

The NAS-RD series is the primary means by which requirements are allocated to the Programs that are responsible for developing systems/services in support of NAS operations. The requirements are structured in a parent-child hierarchy to represent the highest levels of functional requirements to which a program can align their own requirements.

Each document in the NAS-RD series represents a timeframe between the current configuration and the target state of the NAS. The requirements contained in each describe what will be operational in the NAS during that timeframe. Segment Integration requirements are included in the NAS-RDs that represent NextGen where appropriate. These requirements provide the means to allocate requirements based on future improvements to programs. Additionally, each document provides a set of design principles that represent common guidelines for programs undergoing implementation.

2.5.1.2 Enterprise Operational Requirements

Operational requirements are conceptual requirements that represent either goals, human activities, or system functions. At the enterprise level, these requirements are developed on an as needed basis in order to show intended improvements to the NAS.

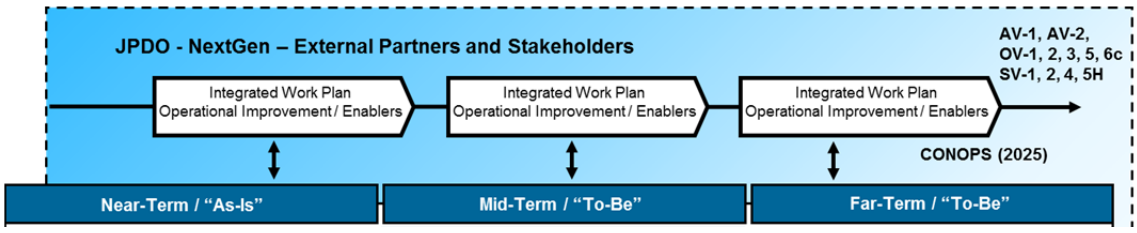
2.5.2 Program Requirements Documents

The program requirements document drives the search for a realistic and affordable solution to mission need during investment analysis. The sponsoring line of business develops a Program Requirements Document (PRD) during concept and requirements definition, which translates the "need" in an Service and Infrastructure Roadmaps into preliminary top-level functional and performance requirements.

2.6 Program-Level Baselines and Planning

The Air Traffic Organization (ATO) Program Management Office (PMO) and the respective program offices are responsible for managing the development and evolution of individual NAS systems within their domains. A program baseline (known as Acquisition Program Baseline, APB) is established at the Final Investment Decision (FID) coincident with approval of an investment program for implementation. The APB contains critical cost, schedule, and performance parameters and their associated values designated for control by the investment decision authority. They relate to the FAA's commitment to satisfying the mission need, achieving needed operational capability, and meeting schedule requirements of interdependent programs.

2.7 JPDO-NextGen — External Stakeholders



The Joint Planning and Development Office (JPDO) is the organization that coordinates the specialized efforts of several federal government stakeholders (i.e., Departments of Transportation, Defense, Homeland Security, and Commerce, and the FAA, National Aeronautics and Space Administration, and the White House Office of Science and Technology Policy) in a public/private partnership to bring the Next Generation Air Transportation System (NextGen) to fruition by the year 2025. The architectural scope of this effort encompasses the broader "curb-to-curb" representation of aviation than that of the NAS' "gate-to-gate" environment, expanding into airport operations and support, FAA and non-FAA weather operations, transportation security and screening, etc. The NAS EA serves as the foundation for

the broader JPDO NextGen EA and Integrated Work Plan (IWP) and therefore shares a strong alignment of architecture views and roadmaps.

2.8 NAS ISEF Conceptual Metamodel

The NAS ISEF Conceptual Metamodel depicted in Figure 6 is intended to support the implementation of the ISEF form and structure. The conceptual model forms the basis for each of the data entities identified in the ISEF, as well as the relationships and required attribution, which are grouped together into seven layers (i.e., Architecture, Requirements, Roadmaps, ConOps, Strategic, Benefits, and Programmatic). The Conceptual Metamodel is further decomposed and represented as a series of logical data models, authored using the UML Class modeling notation.

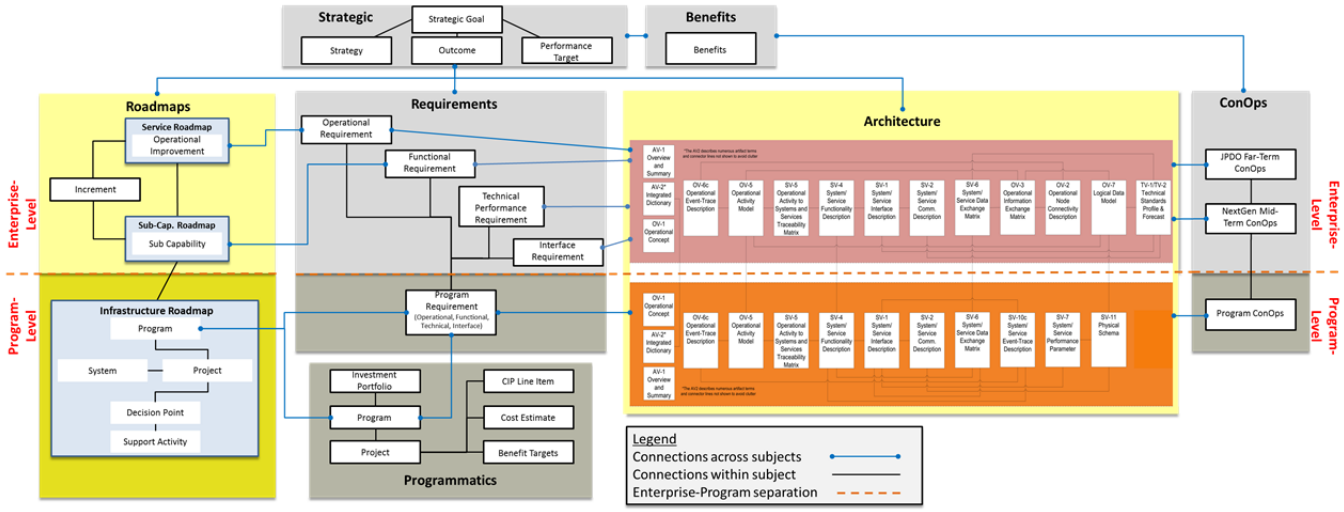


Figure 6: NAS ISEF Conceptual Metamodel

It is important to distinguish between the conceptual and logical metamodel and the model in a repository. The Conceptual Metamodel is a blueprint that describes the kinds of data stored and connected in repositories implemented with technologies like IBM's Rational System Architect and DOORS, and the NAS EA Portal. The metamodel also depicts relationships across data subject areas, and subject areas that may be maintained outside the NAS EA and NAS Requirements purview.

2.9 NAS EA and NAS Requirement Alignment/Integration

The NAS ISEF Conceptual Metamodel establishes the foundation for relating the NAS EA and Requirements data at both the Enterprise- and Program-level, and enabling decision support and reporting capabilities. Integration establishes and enforces horizontal and vertical relationships and inter-dependencies between architecture elements and requirement statements to ensure consistency and transparency across the Enterprise. This concept is depicted in Figure 7.

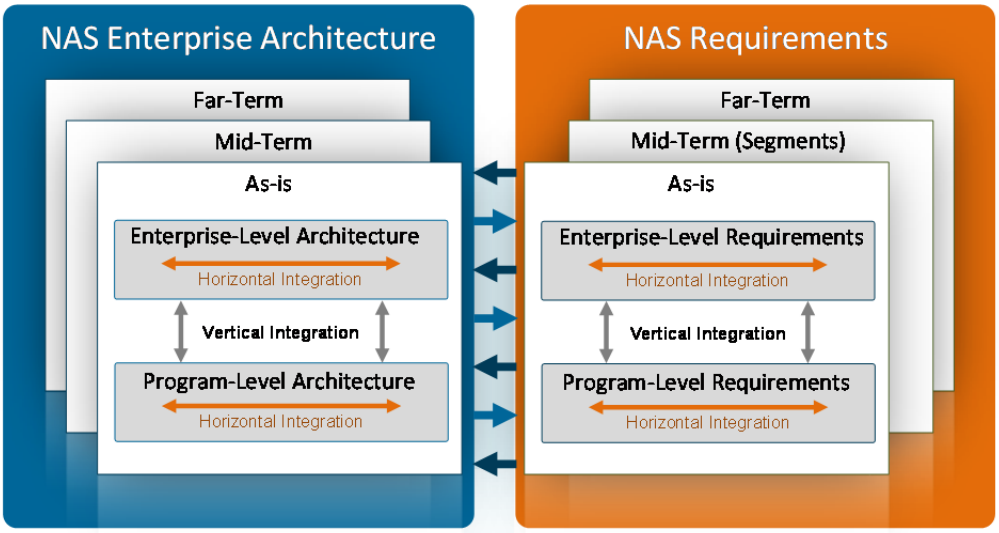


Figure 7: NAS EA and NAS Requirements Alignment/Integration

Figure 7 identifies two key concepts, i.e., horizontal and vertical integration. Horizontal integration means the data elements of the metamodel are uniquely identified and consistently used across all products and views within a singular perspective (i.e., the combination of timeframe and level). Horizontal integration identifies linkages and inter-dependencies of, helps identify opportunities for integration and convergence with, eliminates redundancy and ensures consistency across interrelated architectures and requirements. The concept of horizontal integration as it relates to DoDAF architecture views is depicted in Figure 8, where like elements are uniquely represented across the various applicable views.

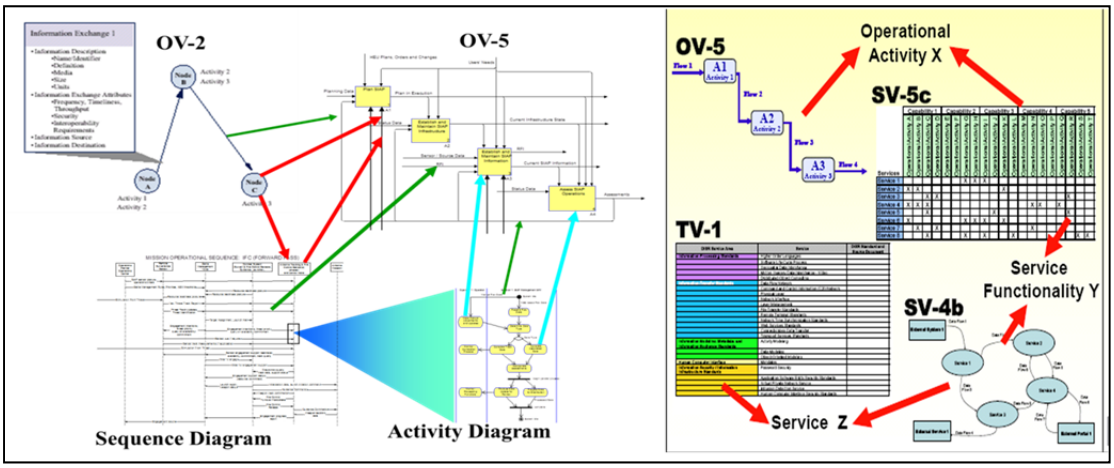


Figure 8: Horizontal Integration of Architectural Views

Horizontal integration also implies that each requirement in the NAS-RD is uniquely defined and aligned to only one of the NAS EA Mission Services and that requirements spanning multiple NAS EA Mission Services are represented within the Support Requirements or Design Principles section of the NAS-RD. Horizontal integration of requirements at the Program-level ensures that requirement statements are unique across each Program Requirement Document (PRD) in order

to eliminate duplication of investment. In addition, the Program-level requirements are aligned to the applicable Program-level architecture views (e.g., SV-1, 4, and 6).

Vertical integration implies that data elements from the lowest level (i.e., Program-level) are traceable/related to data elements at the highest level (i.e., Enterprise-level), and vice versa. The concept of vertical integration is depicted in Figure 9.

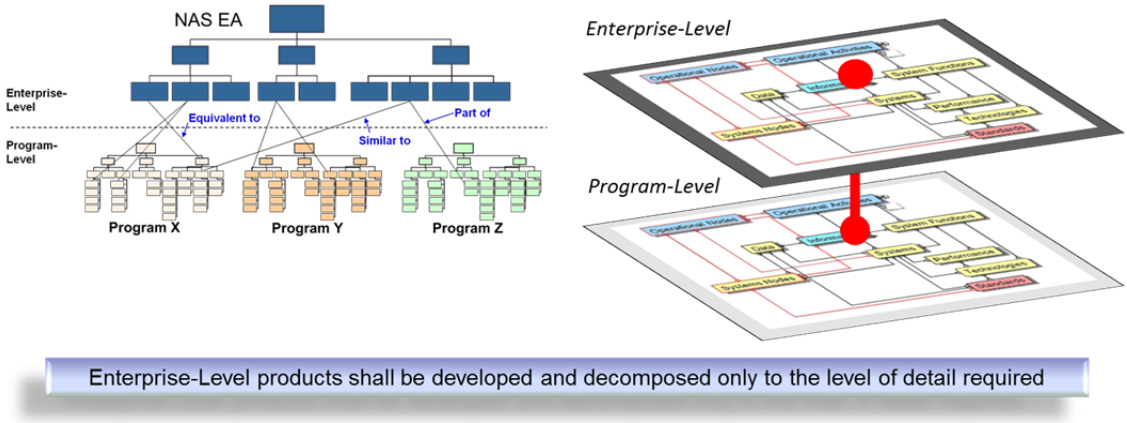


Figure 9: Vertical Integration

Vertical integration is dependent on a parent/child hierarchical relationship, where the most abstract "parent" element(s) are at the top and the less abstract, more concrete "child" elements are below and represent a decomposition of the parent. A child element may serve as a parent when it is decomposed into even more concrete, less abstract child elements. This pattern continues to the point where further decomposition is beyond the scope and intent of the architecture. More specifically, vertical integration ensures that a Program-level architecture and requirements accommodate a top-down/bottom-up alignment with architecture elements and NAS Requirements defined at the Enterprise-level; supports its "parent" in providing NextGen benefits; aligns with NextGen Operational Improvements, addressing corresponding shortfalls; and facilitates prioritization analysis. Per Figure 9, constituent Program-level architecture elements are expected to be vertically integrated with Enterprise-level elements.

The concept of integration (i.e., horizontal and vertical) is implemented in the NAS ISEF through the following common set of principles:

- Vocabularies, taxonomies, and ontologies must be consistent and registered within the NAS EA for visibility, re-use and understandability,
- Each architecture element/requirement will be uniquely titled, defined (including required data attributes) and consistently applied,
- Interfaces, need lines, information and data exchanges will be loosely coupled, backward compatible, self-describing, and offer a low impact to the enterprise if changed ,
- Deployment and use of common IBM Rational System Architect User Properties and DOORS configurations (including pre-populated templates),
- NAS EA products and Requirement Documents shall be developed and decomposed only to the level of detail required to adequately portray enterprise "To-Be" mission capability

improvements and transformation priorities, but detailed enough to guide Program-level development and alignment, and

- Each Program has full authority and responsibility to develop and maintain their portion of the EA/Requirements.

These principles are enforced through the following Enterprise- and Program-level processes and practices described in the following sections. Appendix A also outlines product specific development and integration guidance.

3 ENTERPRISE-LEVEL PROCESSES AND PRACTICES

3.1 Service Roadmap Development & Update

The NAS Service Roadmaps are updated annually in response to changes made to existing NAS Operational Improvements (OI) or the creation of new OIs. The Engineering Services Office (ANG-B) receives coordinated and approved updates from the Office of the Chief Scientist and NAS Lifecycle Integration Office (ANG-D), including changes to titles, descriptions, and initial operating capability date ranges. The output of this process is the updated Service Roadmaps, which are typically completed prior to the annual update of the NAS Infrastructure Roadmaps.

3.2 Infrastructure Roadmap Development & Update

To reflect the FAA's evolving system and infrastructure transition plans, the Infrastructure Roadmaps are updated annually following a three phase process: Analysis and Planning, Updating, and Review/Approval.

3.2.1 Analysis and Planning Phase

Each development cycle begins and ends with Joint Resource Council (JRC) approval of the latest Infrastructure Roadmap update. Approval effectively establishes a new baseline and initiates the next development cycle. Shortly after the establishment of a new baseline, the previous year's activities are evaluated to identify lessons learned and to determine new requirements based on direction/priorities provided by the NAS Chief Architect and NextGen executive leadership, roadmap data analysis findings and recommendations, and other applicable and accepted stakeholder requests and comments collected throughout the year. New requirements may take many forms including process improvements, additional data requirements to support reporting and analysis, the integration of additional data sources, etc.

Planning for the next phase begins after the requirements have been determined and involves the preparation of a risk-adjusted schedule for the remainder of the development cycle, the formulation of kickoff meeting agenda items, the identification and assignment of Domain Leads and Domain Subject Matter Experts (SMEs), the solicitation of participating stakeholders , and the arrangement of meeting logistics. The NAS Chief Architect presents the information at the Infrastructure Roadmap kickoff meeting, effectively communicating the purpose and objectives of the planned update, any new expectations or changes from the previous cycle, as well as the key activities and milestones to the applicable stakeholders (i.e., Domain Leads and SMEs).

3.2.2 Updating Phase

The Updating Phase begins immediately following the Infrastructure Roadmap kickoff meeting. Each Domain Lead updates their Roadmap by coordinating with their relevant roadmap working group consisting of participating stakeholders and assigned Domain SMEs. With Domain SME assistance, Domain Leads schedule and conduct working group meetings to identify changes to the assumptions, existing and planned systems, and their related decision points. The Roadmap team continues to update the roadmap and data iteratively and provides a Review Draft of their individual roadmaps to ANG-B2per the defined schedule.

Once the individual Roadmap Review Drafts are complete, additional time is scheduled to focus on Roadmap integration sessions. Participants in these sessions include the NAS Chief Architect, Domain Leads, Domain SMEs, ANG-D representatives, and Air Traffic Organization (ATO) Program Management Office (PMO) representatives. The integration sessions seek to ensure relationships are accurately created and represented across each of the individual roadmap elements, as well as appropriately integrated with the architecture views and service roadmaps to create additional consistency and line of sight. At the completion of the integration sessions, ANG-B2 collects the individual roadmaps and data to cleanse and consolidate the roadmaps and data into a single package (i.e., Review Draft) that is prepared for review, comment and approval.

3.2.3 Review and Approval Phase

The Review and Approval phase is the last step in the annual maintenance process. The NAS Chief Architect provides successive briefs and baselined versions of the Roadmaps to the Technology Review Board (TRB) and the FAA Enterprise Architecture Board (FEAB) to obtain endorsement. Comments received during the review and briefings are assessed and adjudicated as necessary before the NAS Chief Architect briefs the JRC to obtain final approval. After JRC approval, a new baseline is established and the entire process is repeated, starting with the Analysis and Planning phase for the next annual update cycle.

3.2.4 Process Roles and Responsibilities

Table 1 briefly describes the active roles within the process and their general responsibilities.

Table 1 Roles and Responsibilities for Infrastructure Roadmap Development

Role	Responsibility
Joint Resource Council	Provides final decision for Infrastructure Roadmap baseline
Technology Review Board	Provides technical endorsement of Infrastructure Roadmaps (delegated responsibility by the FAA Enterprise Architecture Board)
NAS Chief Architect	Provides overall orchestration of Infrastructure Roadmap development activity and status reporting
Domain Lead	Coordinates stakeholder collaboration and provides domain, system, and technical expertise for individual Infrastructure Roadmap development and integration (typically ATO Systems Engineering and Safety or Service-Unit personnel)
Stakeholder / ATO PMO	Provides system and technical expertise for individual Infrastructure Roadmap development and integration, and programmatic endorsement (typically ATO Program Office personnel)
Domain Subject Matter Expert	Provides development guidance and assistance to Lead Domain SME (typically contract personnel under direct NAS Chief Architect authority)

3.2.5 Decision Point Status Reporting

Decision point status reporting occurs in parallel with the annual Infrastructure Roadmap maintenance and continues throughout the year to inform architecture analysis and modeling efforts. Once a new Infrastructure Roadmap baseline is approved by the JRC, the progress made toward achieving the Decision Points for that year is continuously tracked by ANG-B2. Table 2 details the different decision types and the criteria used to report Decision Point status.

Table 2: Decision Point Criteria

	AMS Decision Types • Concept and Requirements Definition Readiness Decision • Investment Analysis Readiness Decision • Initial Investment Decision • Final Investment Decision • Baseline Change Decision • In-Service Decision	**Other Decision Types** • Executive Decision • FAA Policy • FAA Strategy • Others
Green	• Satisfactory progress is being made towards reaching the target date as reported through the JRC Readiness Review Minutes	• Satisfactory progress is being made towards reaching the target date based on information provided by the Lead Organization
Yellow	• Progress is being made; however, the target date is at risk of being missed as reported through the JRC Readiness Review Minutes	• Progress is being made; however, target date is at risk of being missed based on information provided by the Lead Organization
Red	• Unsatisfactory progress is being made towards target date • Target date has or is projected to be missed	• Unsatisfactory progress is being made towards target date • Target date has or is projected to be missed

The status of all Decision Points planned for the year, as well as those carried over from the previous year, if any, is reported regularly to a variety of stakeholders during the following meetings to inform resource planning and requirements:

- Weekly Investment Decision Authority (IDA) Meetings, led by the JRC Secretariat,
- Bi-weekly Integration Meetings, led by the Manager of the JRC Investment Process Management Group, and
- Acquisition Quarterly Program Reviews (AQPR), also led by JRC Secretariat.

Status reporting includes the following data for each Decision Point:

- Location on roadmap
- Identification (Identifier, Name, Domain, Related Domains, Type, CY Target Date, Owner)
- Description
- Status detail, including state (Active, Completed, Deleted, or Replaced)
- Impacts, if any, expected to occur if decision is not achieved.

3.3 Sub-Capability Roadmap Development & Update

The Sub-Capability Roadmap Development process extends from the Updating phase of Infrastructure Roadmap development integration sessions. As described above, these sessions result in a set of Integration Worksheets that are interpreted into graphical form in accordance with the Sub-Capability Roadmap (XV-2) and Figure 3 of this document.

3.4 Funding Profile Maintenance

The Funding Profile update is another activity that extends from the annual Infrastructure Roadmap development and update process. ANG-B2 compares the most recently published CIP (usually released in March of every year by the ATO Office of Strategic Planning) against the approved baseline version of the Infrastructure Roadmaps to determine if there are any differences or variations between the funding streams and the expected funding needed to satisfy the implementation plans, as depicted in the roadmaps. Any identified variations are captured as Deltas. The Delta information is provided to the respective Infrastructure Roadmap Domain Lead to verify and validate, as well as inform Roadmap updates. The Roadmap team then develops an updated Forecast for funding based again upon their roadmap. Finally, the current CIP outlays, the Deltas, and the updated Forecasts are assembled in the format expressed in Section 2.4 of this document and are used as input into the FAA's annual budget request.

3.5 Enterprise-Level Architecture Development and Maintenance

The Enterprise-level Architecture development and maintenance process follows a similar three phased approach as described in the Annual Infrastructure Roadmap Maintenance process, however depending on the scope of development the process can be applied to an individual product or an integrated set of products that describe a particular timeframe.

3.5.1 Analysis and Planning Phase

This phase begins immediately following the establishment of an approved baseline or at the completion of a development phase, but prior to the review and approval phase. ANG-B2 architects perform analytical techniques (as described in Section 5), as well as review collected stakeholder feedback to determine new requirements for development. New requirements, including development schedules, required stakeholder involvement, and resource allocation are reviewed with the NAS Chief Architect for approval prior to initiating development. Scheduling focuses on the tasks described in following phases and includes periods for architecture review and comment, comment adjudication, architecture revision/development, and architecture approval. Resource allocation focuses on identifying and organizing resources, particularly architecture development personnel.

3.5.2 Update and Development Phase

Once the development scope is approved, ANG-B2 architects coordinate and collaborate with the appropriate stakeholders to review existing data or collect new architecture data to be used for additional analysis and modeling. Coordination with other architects and stakeholders iteratively continues until the data is conditioned and interpreted accurately for incorporation into the architecture views (or data repository).

Product(s) development and updates generally occur in parallel to the data collection and analysis steps. Development may consist of architecture modeling following industry-accepted modeling techniques (e.g., IDEF, BPMN, UML, etc.) and activities to ensure horizontal and vertical integration of the products (i.e., data). The output of these collaborative development activities is a product or set of products ready for review and comment.

3.5.3 Review and Approval Phase

The Review Draft of the product (or set of products) is published to the NAS EA Portal and released to a broader NAS EA team for review and comment. Comments collected during this period are evaluated and resolved, including clarifying comments with their originators and documenting the disposition. Based on the comments and NAS Chief Architect direction, the ANG-B2 architects may revise the views or identify a need to build new views.

The NAS Chief Architect successively presents the Final Draft version of the architecture is to the TRB and the FEAB for review and comment. Comments submitted by either Board are disposed and adjudicated. Once all comments are resolved and approved changes are implemented, the NAS Chief Architect briefs the JRC to obtain final approval. An approved baseline is established and published to the NAS EA Portal, the content of which serves as the definitive context for vertical integration with Program-level architectures.

3.5.4 Process Roles and Responsibilities

Table 3 briefly describes the active roles in the process and their general responsibilities.

Table 3: Roles and Responsibilities for Enterprise-level Architecture Development

Role	Responsibility
Joint Resources Council	Acts as authority for the establishment of NAS EA baselines
FAA Enterprise Architecture Board	Provides endorsement of Enterprise-Level architectures
Technology Review Board	Provides technical review and endorsement of Enterprise-Level architectures
NAS Chief Architect	Provides overall orchestration of Enterprise-Level architecture development
Architecture Developers	Provides technical expertise for the development and revision of Enterprise-Level architecture views
Stakeholder	Provides technical review and comment of Enterprise-Level architecture views

3.6 Enterprise-Level Requirement Development

Enterprise-level requirement development largely follows the process prescribed by the FAA's System Engineering Manual (SEM) Section 4.3 – Requirement Management.

3.6.1 Planning Phase

The planning process begins after the most recent versions of the documents are approved. This process consists of reviewing stakeholder feedback to determine the necessary enhancements to the NAS-RD series in order to fully describe the requirements and its scope, as well as to make it easier to derive Program-level requirements. Resources are allocated based on the nature of the enhancement and the timeframe addressed by the updates.

Segment Integration requirements are also generated during this phase. They represent the requirments of the Operational Improvements, and are allocated to Portfolios and Programs. These requirements are mapped into the appropriate segment of the NAS-RD series, and contain schedule data based on the expected decision points of the programs to which they are allocated.

3.6.2 Updating and Development Phase

This phase starts when enhanced versions of the NAS-RD series of documents are released. The updated documents are made available to stakeholders for review and comment for a given period of time. Once the comment phase is complete, the Requirements Integration Manager will review the feedback, and adjust the documents as necessary. Dispositions on the status of the comments will be provided by the Requirements Integration Manager to the stakeholders.

Since the initial baseline, the NAS-RD series of documents is updated annually to ensure that it stays aligned with the current and future NAS. Updates to the current requirements baseline document are be submitted via NAS Change Proposals (NCP) submitted to the NAS Configuration Control Board (NAS CCB).

Updates to the requirement documents for future timeframes start with a review and comment period open to FAA stakeholders. Once the comment period ends, the requirement engineers examine and resolve comments, including clarifying comments with their originators and documenting disposition.

3.6.3 Approving Phase

Changes to existing As-Is requirements are approved when the NAS CCB accepts the submitted NCP. The requirements for future timeframes are approved by the TRB, followed by the FEAB. Additional comments from either Board may be submitted for disposition and adjudication. Once the comments are resolved, the JRC establishes the updated NAS-RD documents as the Enterprise-level requirements baseline for the NAS.

3.6.4 Process Roles and Responsibilities

Table 4 lists the relevant roles and responsibilities that are involved in the Enterprise-level Requirements development process.

Table 4 Roles and Responsibilities for Enterprise-level Requirements Development

Role	Responsibility
Joint Resources Council	Provides the highest level approval decision for a baseline NAS-RD
FAA Enterprise Architecture Board	Provides endorsement of NAS-RD
Technical Review Board	Provides review and compliance assessment for the NAS-RD
NAS Systems Engineering Services Director	Provides Systems Engineering approval and assessment for the NAS-RD
Requirements Integration Manager	Coordinates the enterprise level development, approval recommendation, and updating cycle of the NAS-RD
Domain Lead	Provides subject matter domain expertise to the various NAS-RD domain areas
Stakeholder	Provides technical review and comments to the NAS-RD

3.7 Enterprise-level Architecture and Requirements Alignment/Integration

During the updating and development phases of both the requirements and architecture development processes, steps are taken by the NAS Chief Architect (ANG-B2) and The Requirements Integration Manager (ANG-B1) to ensure the enterprise-level requirement statements and appropriate architecture products remain aligned. This involves input and review from ANG-B1 and ANG-B2 personnel and Subject Matter Experts (SME) to establish linkages

between the two sets of products. The identified linkages are ultimately captured within the approved and licensed architecture and requirement development tools (e.g., IBM Rational System Architect and DOORS), and posted to the NAS EA Portal per publication business rules.

4 PROGRAM-LEVEL PROCESSES AND PRACTICES

4.1 Architecture and Requirements Products by Acquisition Phase

Program-level requirements and architecture development primarily occur during the earliest phases of the FAA's AMS lifecycle, specifically: Concept and Requirements Definition (CRD), Initial Investment Analysis (IIA), and Final Investment Analysis (FIA). Program system engineers, requirement analysts, and architecture developers must produce a minimum set of documentation during each phase to support the next decision in the lifecycle (subject to tailoring based on investment scope and acquisition category). These requirements depicted in Figure 10 are outlined in the JRC Investment Decision Authority (IDA) Readiness Checklist and described below.

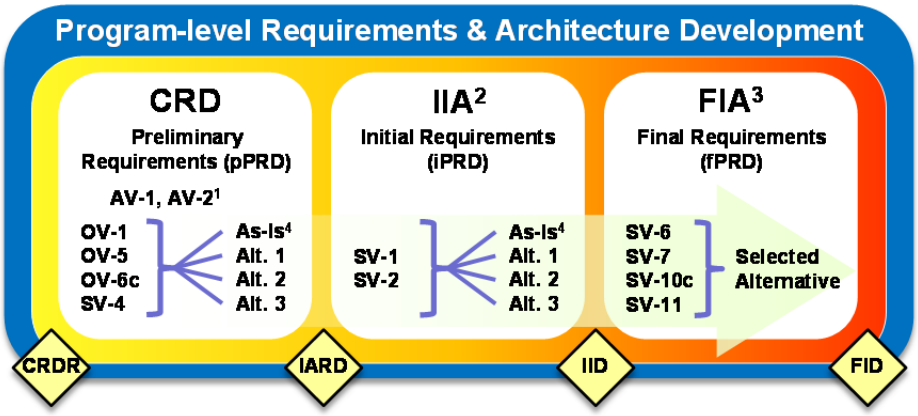


Figure 10: Required Architecture and Requirement Products per Acquisition Phase

4.1.1 CRD Phase (For As-Is and Each Alternative)

Per the AMS, Program-level requirements and architecture development begin with Concept and Requirements Definition Readiness Decision (CRDR) and the CRD phase. In this phase, a Functional Analysis is performed, a range of alternatives is identified, and concept(s) of use and preliminary program requirements (pPRD) are developed. Each solution within the range of alternatives, including the current, or "As Is," is represented, at minimum, by the following products.

- Overview and Summary Information (AV-1)[2]
- Integrated Dictionary (AV-2)[3]
- High-level Operational Concept Graphic (OV-1)
- Operational Activity Hierarchy Model (OV-5)
- Operational Event-Trace Description (OV-6c)
- System/Service Functional Hierarchy Model (SV-4)

[2] The AV-1 is relevant to all the products for all alternative solutions.

[3] The AV-2 may be segmented by alternative solutions.

The OV-1 summarizes the concept(s) of operation/use, and the OV-5, OV-6c, and SV-4 play critical roles in organizing and understanding preliminary requirements. All architecture elements (e.g., Operational Activities, System Functions, Data Elements, etc.) used in these products are defined, and relationships between them identified, in the AV-2. The AV-1 summarizes the entire architecture effort.

4.1.2 IIA Phase (For As-Is and Each Alternative)

The Investment Analysis Readiness Decision (IARD) ends the CRD phase and initiates the IIA phase in which the pPRD is refined to create an initial requirement documents (iPRD), comprehensive alternative analyses are performed, and lifecycle cost estimates are produced. For each alternative, the following additional products are developed and integrated with the products developed during CRD.

- Continued maturation of CRD Phase architecture products, as necessary
- System/Service Interface Description (SV-1)
- System/Service Communications Description (SV-2)

Architecture elements modeled in SV-1 and SV-2 are defined in the AV-2 and additional element-to-element relationships are captured. With system components and allocations to functions understood architecturally, additional requirements can be defined. Comparing solution architectures contributes directly to comprehensive alternative analyses and trade studies. Further, cost figures applied against various architecture elements form the foundation for lifecycle cost estimating. Finally, the AV-1 is updated in preparation for the Initial Investment Decision (IID).

4.1.3 FIA Phase (For As-Is and Selected Alternative)

Providing a down-select from alternative solutions to one preferred solution, IID ends the IIA phase and initiates the Final Investment Analysis (FIA) phase where the investment analysis team develops the final program requirements (fPRD). The following complementary architecture products are developed during FIA.

- Continued maturation of CRD and IIA Phase architecture products, as necessary
- System/Service Data Exchange Matrix (SV-6)
- System/Service Performance Parameters Matrix (SV-7)
- System/Service Event-Trace Description (SV-10c)
- Physical Schema (SV-11)

Development of SV-6, SV-7, SV-10c, and SV-11 provides data exchange, system interface, functional sequencing, and physical data structures contribute to final requirements definition in preparation for Solution Implementation. Definitions of SV-11 data elements and their relationships to other architecture elements are populated in the AV-2. Finally, the AV-1 is updated to reflect the efforts undertaken during FIA in preparation for Final Investment Decision (FID) and entry into the Solution Implementation phase.

4.1.4 Special Considerations

The DoDAF contains additional products which may be prescribed for program-level development in addition to or as replacements for the products listed above. The decision to add, remove, or replace products is made jointly between the NAS Chief Architect and the Program Manager or designee. In addition, program-level architectures representing "legacy" system efforts (e.g., Baseline Change, SLEP, Technical Refresh, etc.) are generally limited to AV-1, AV-2, SV-1, SV-2, and SV-4 for As-Is only.

4.2 Program-Level Architecture Development Process

This section focuses on Program-level architecture development (may also be represented by an individual Project) supporting the FAA AMS decision-making process, from initial concept development to the start of solution implementation. ANG-B2 Architects primarily serve in an advisory role to the Program going through the AMS; however, the NAS Chief Architect may decide to engage ANG-B2 Architects in the actual architecture development depending on the size of the program and the availability of program resources to develop the required architecture products.

4.2.1 Architecture Development

The process for Program-level architecture development follows a similar three phased approach as the Enterprise-level architecture development and maintenance process, and reflects the activities and decisions related to the development of architecture products, as well as the horizontal and vertical integration of the products (including integration with Program-level Requirement Documents), and their review and approval. Figure 11 illustrates the process with a notional timeline that starts and ends with an AMS decision.

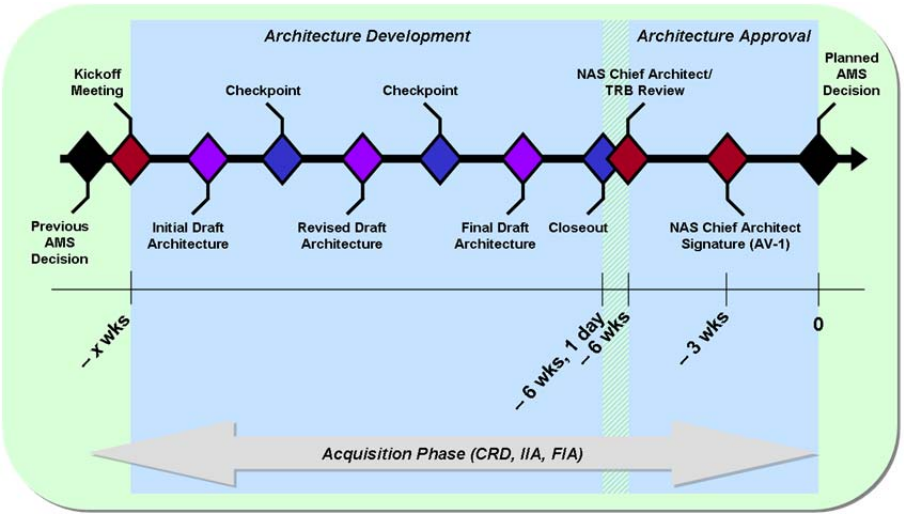


Figure 11: Program-level Architecture Development and JRC Decision – Notional Timeline

Analysis and Planning Phase. This stage begins immediately following a CRDR Decision, an IARD, or an IID and is executed within the subsequent CRD, IIA, and FIA phases, respectively. ANG-B2 Architects coordinate an architecture development kickoff meeting with the NAS Chief Architect and Program-level Architect. Prior to the kickoff, ANG-B2 Architects prepare a recommended architecture product set for development and a proposed high-level development

schedule. The proposed schedule is developed from the planned AMS decision date, working backwards to the kickoff meeting. The typical product set recommendation includes the architecture products in Figure 10 above per AMS phase. However, the NAS Chief Architect may approve tailoring of the product set. Through tailoring, products from the prescribed list may be removed, and other relevant products added depending on a particular program's needs and constraints.

At the kick off meeting, ANG-B2 Architects, the NAS Chief Architect, and Program-level Architect review the recommended product set and proposed schedule. They raise and deliberate issues not resolved during kickoff coordination as well as discuss any needs or constraints not previously coordinated. Finally, the NAS Chief Architect and Program-level Architect agree on the schedule and product set, effectively initiating architecture development.

Development Phase. Architecture development occurs immediately following the kick off meeting and continues up to 6 weeks prior to the planned AMS decision. Within this timeframe, a set of delivery and checkpoint milestones is identified for architecture development. A development milestone, shown as a purple diamond in Figure 11, indicates when the architecture is ready for ANG-B2 Architect review and comment (including quality assurance/control)), per the agreed upon development and checkpoint milestones. In most cases, there should be at least three development milestones per AMS phase; an initial draft; at least one revised draft; and final draft architecture. A checkpoint milestone (blue diamond) gives the Program-level Architect the opportunity to consult with ANG-B2 Architects and the NAS Chief Architect about product status and discuss issues and actions regarding architecture development and integration. Also, the checkpoints indicate to the Program-level Architect when the review results may be expected from the Enterprise Architect against the developed products.

ANG-B2 Architects review the Program-level architecture products against a set of development and integration criteria and submit review comments in the form of a Comment/Resolution table to the Program-level Architect for resolution. The ANG-B2 Architects may also collect change recommendations from the Program-level Architect against the Enterprise-level architecture to be vetted during its updating cycle. After multiple iterations of product development, review, and comment, the Program-level Architect provides a Final Draft of the architecture to ANG-B2. The Final Draft includes all agreed-upon architecture products for the Final Draft milestone unless otherwise waived by the NAS Chief Architect. At this point, ANG-B2 Architects prepare for Closeout.

The Closeout milestone is a special checkpoint because it effectively ends architecture development for the phase and initiates the Architecture Approval stage. The ANG-B2 Architects prepare for Closeout by finalizing a descriptive state of the architecture. This includes the comments concerning the Final Draft architecture, highlighting the proposed resolutions, as negotiated with the Program-level Architect, regarding all remaining open comments. Closeout becomes formal once the ANG-B2 Architects deliver the architecture to the NAS Chief Architect for review and approval.

Review and Approval Phase. This phase begins immediately after the Closeout checkpoint with Program-level Architect delivery and presentation of the entire architecture package to the NAS

Chief Architect and the Technology Review Board (TRB) to ensure the architecture accurately reflects the current and desired technical content for standards, systems, and infrastructure. Ideally, the review occurs over a 3-week period. The TRB provides its recommendations and observations to the Program-level Architect and NAS Chief Architect for resolution. The NAS Chief Architect signs the AV-1 no later than 3 weeks before AMS decision. The AV-1 becomes the official document representing the entire architecture for the phase, indicating to the Joint Resources Council that all AMS requirements relevant to Program-level enterprise architecture development have been met. Once the Program receives its AMS decision to proceed, ANG-B2 baselines the Program-level architecture and publishes the architecture package either to the NAS EA Portal (for FID only) or Program Architecture Locker (for IARD and IID).

4.2.2 Process Roles and Responsibilities

Table 5 briefly describes the active roles in the process and their general responsibilities.

Table 5: Roles and Responsibilities for Program-level Architecture Development

Role	Responsibility
Program-Level Architect	Coordinates and develops program-level architecture development (En Route and Oceanic Services; Terminal Services; System Operations Services; Technical Operations Services)
NAS Chief Architect	Approval authority for all NAS Program-Level architectures (NextGen and Operations Planning Services)
ANG-B Architects	Provides development guidance and assistance to Program Office Program-Level architecture efforts (Typically contract personnel under direct NAS Chief Architect authority)
Technical Review Board	Provides review and compliance assessment of all NAS Program-Level architectures (delegated responsibility by the ATO Enterprise Architecture Board)

4.3 Program-Level Requirement Development

This section focuses on Program-level requirement development in support of the FAA's AMS decision-making process. The Program Requirement Document (PRD) establishes the operational framework and performance baseline for an investment program. It is the basis for evaluating the readiness of products and services of an investment program to become operational.

4.3.1 Requirements Development Process

Program-level requirements are structured and organized in the format described by the Program Requirements Template, which is one of the Acquisition Planning and Control Documents within the AMS. The program requirement document is written to be solution agnostic, and therefore should be implementable as developmental, non-developmental, or commercial acquisitions. Appendix A provides a reference to the Program Requirements template.

Development Phase. The sponsoring program develops a pPRD during the CRD phase, which translates the operational or functional need identified through EA analysis into preliminary top-level functional and performance requirements. During initial investment analysis, a more detailed iPRD is developed from the pPRD, as preliminary requirements are evaluated against the cost, benefits, schedule, and risk of various alternatives and brought into balance with an affordable solution to mission need.

The investment analysis team, which includes the program office, develops an fPRD during final investment analysis, which undergoes a formal approval process from the JRC. This document defines the concept of use and performance requirements which the investment program intends to achieve and forms the basis for evaluating the readiness of resultant products and services to be fielded for operational use within the FAA. Any requirements not in the fPRD are returned to the sponsoring program office for disposition.

If a particular program imposes a requirement upon another program in their pPRD or fPRD, that requirement will be managed via a Service Level Agreement (SLA) between the two program offices. Through the SLA, the program office imposing the requirement and will include the requirement in their documentation, while the program office receiving the requirement will have a process in place for managing the assigned requirement. Appendix A provides a template for developing this SLA.

After a successful FID, the program develops a System Specification derived from the fPRD, and is included with a Request for Offers to prospective contractors who wish to bid on the procurement of the investment program.

Approval Phase. The requirements approval phase begins upon delivery of the applicable requirement products (Functional Analysis, pPRD, iPRD, fPRD) to the NAS Requirements Services Division (ANG-B1). Typically, this occurs several months prior to the scheduled AMS decision point. A review process is conducted internally within ANG-B1 to ensure that the Program Requirement Document has successfully met all the SEM, AMS, and ANG-B1 evaluation criteria, including alignment to the NAS-RD series, integration with NAS-RD series and other program requirements, and conformance to AMS requirement guidelines. An ongoing part of this process includes coordinating with the program office throughout the AMS phases to keep current with changes to the requirement documents as well as resolving any outstanding issues. Once a Program Requirement Document is determined to have satisfied all ANG-B1 evaluation criteria, it is formally approved by the NAS Engineering Services Director (ANG-B), indicating to the Joint Resources Council, that all AMS requirements relevant to Program-level requirement development have been successfully met.

4.3.2 Process Roles and Responsibilities

Table 6 lists the relevant roles and responsibilities that are involved in the Program-level requirement development process.

Table 6 Roles and Responsibilities for Program-level Requirements Development

Role	Responsibility
NAS Engineering Services Director	Provides Systems Engineering approval and assessment for the PRD
Requirements Integration Manager	Provides program level development guidance along with coordinating the review and approval of the PRD
Domain Lead	Provides subject matter domain expertise and serves as the primary reviewer of the PRD
Program-level Requirements Engineer	The primary developer of the PRD for the program office

4.4 Program-level Architecture and Requirements Alignment/Integration

While the two disciplines are performed separately, Program-level requirements inherently drive the corresponding Program-level architecture models; creating a symbiotic relationship and a requirement for the two system engineering products to be consistent. To emphasize the integration and consistency of Program-level requirement documents and architecture products, additional coordination and collaboration activities are inserted throughout the two processes described in Sections 4.2 and 4.3 above, and include:

- **Joint Kick Off Meetings** – This meeting is intended to provide a general overview of both Enterprise architecture and requirements development concepts; provide scoping decisions related to the program's decision points; and, provide development guidance and schedules, including instructions for accessing available tools. Meeting participants include the Program office representatives, NAS Requirements and Integration Manager (ANG-B1), NAS Chief Architect (ANG-B2), and support personnel.
- **Integration Checkpoint Meetings** – This meeting is intended to gain insight on development and integration progress; provide a forum for questions/answers; gather data for larger enterprise initiatives; and provide comments and feedback to avoid large scale fixes towards the end of the effort. Meeting participants include the Program-level Requirements Engineer, Program-level Architect, and representation from ANG-B1 and ANG-B2.
- **Product Integration Review and Analysis** – This activity is performed by ANG-B1 and ANG-B2 personnel in parallel to quality assurance/control reviews to assess the level of horizontal and vertical integration of Program-level architecture products and requirement documents. The result of this activity is a Program Integration Summary Report that is used to inform the Technical Interchange Meeting. A template for this report is provided in Appendix A.
- **Technical Interchange Meeting** – This meeting is intended to provide ANG-B1, ANG-B2, and the Program Manager and representatives an opportunity to discuss horizontal and vertical integration findings and recommendations; provide QA/QC comments for the developed draft sets of products; and provide recommendations for enhancements to finalize each sets of products.
- **Joint Closeout Meeting** – This meeting is intended to provide ANG-B1 and ANG-B2 an opportunity to make any final comments or recommendations against the final phase products. Furthermore, the purpose of this meeting is to gain approval for Program-level products (including signatures) and provide favorable notification to the JRC Secretariat (adhering to the JRC close out process).

These activities augment existing development review and coordination processes described in Sections 4.2 and 4.3, and supplement them by providing a joint ANG-B1 and ANG-B2 perspective early and often throughout the development process. The intended purpose is to make sure Program-level requirement engineers and architects collaborate with each other, the PRD and architecture products are aligned (either manually or within available approved and licensed architecture and requirement development tools), and horizontal and vertical integration is also occurring. Details regarding the mechanics of the activities are presented at the Joint Kick Off meetings with the Program office representatives.

5 ARCHITECTURE AND REQUIREMENT ANALYSIS

With the ISEF, the FAA has an effective framework to organize and relate the significant collection of information describing the NAS, enabling transparency and the ability to horizontally and vertically traverse the collection of architecture elements and requirement statements. The enterprise inventory of information (including Enterprise- and Program-level) depicted in Figure 12, can be condensed, analyzed, and interpreted to enhance decision making and communications across the stakeholder community.

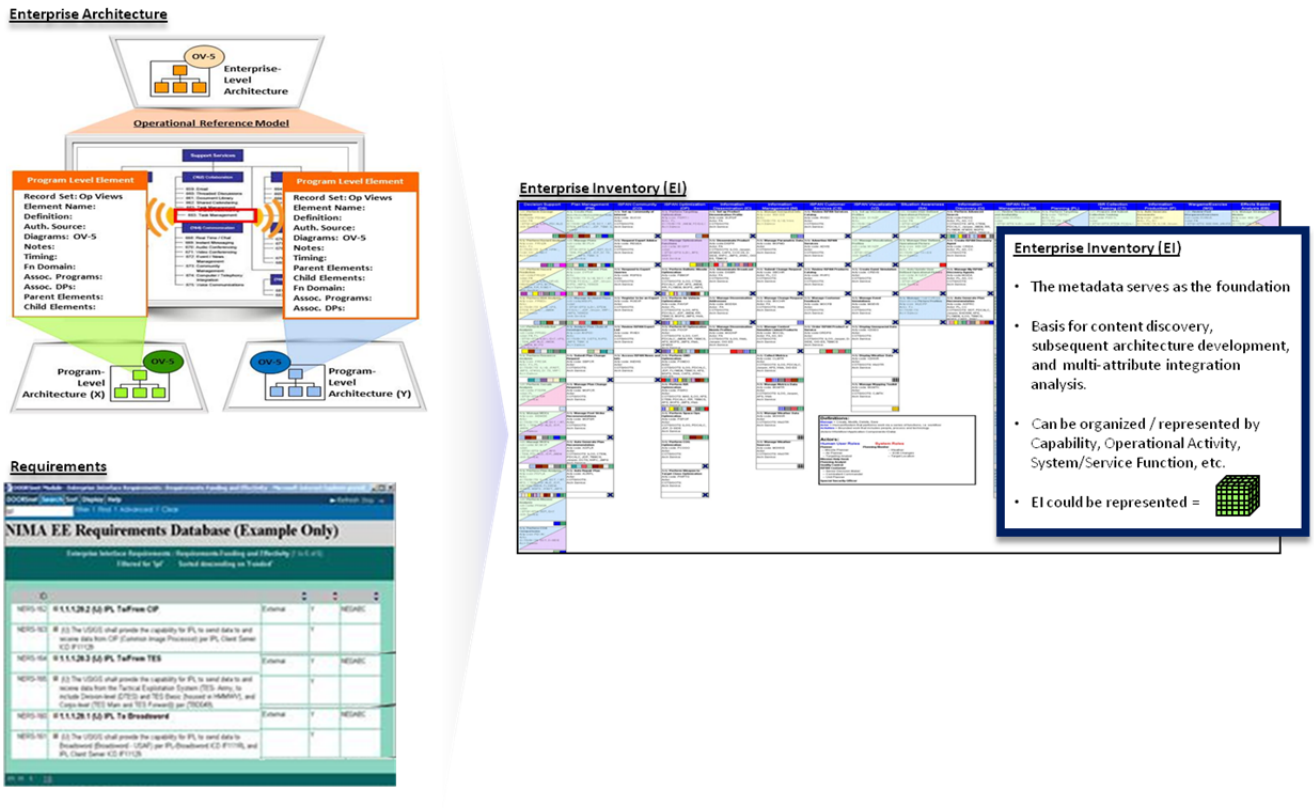


Figure 12: Enterprise Inventory to Support Analysis

The information can also be organized/represented by any element described in the conceptual metamodel to support various analytical techniques and applications. Examples of analytical techniques include, but are not limited to the following:

- ***Integration Analysis*** to identify elements with the same or similar names, definitions, etc. in order to assess interdependencies and opportunities for collaboration/convergence, consistency and reuse, as well as how well elements vertically integrate from the Program-level to the Enterprise
- ***Multi-attribute Analysis*** can be applied against the data attributes to evaluate alternatives identified at the Enterprise- and Program-levels (e.g., trade-offs) and adds an additional level of fidelity to enable the FAA to analyze capability performance and the NAS trade space against strategic performance objectives

- ***Gap Analysis*** to identify functional gaps and verify to-be architecture and requirements to ensure they address the mission need and shortfalls recognized from its corresponding As-Is architecture and requirements
- ***Dependency/Impact Analysis*** to identify architectural elements and requirements that may be impacted as a result of funding cuts, schedule slippages, etc.
- ***Coverage Analysis*** to identify the extent by which NAS goals and objectives are satisfied through requirements allocation and acquisition.

These techniques apply to every level of the NAS (i.e., Enterprise and Program) during and after architecture and requirement development. They also support traditional planning disciplines including strategic planning, portfolio and project management, capital planning and investment control, cost/benefit/risk modeling, etc.