JOINT PLANNING & DEVELOPMENT OFFICE (JPDO)

Next Generation Air Transportation System (NextGen)

NextGen Federation Strategy

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1 INTRODUCTION

The Next Generation Air Transportation System (NextGen) is the transformation of the National Airspace System (NAS), including our national system of airports, using 21st century technologies. NextGen is realized through investments in research and development, multiple technologies, operational changes, and the coordinated efforts of the Federal Aviation Administration and the Departments of Transportation, Defense, Homeland Security, and Commerce, as well as NASA, the White House Office of Science and Technology Policy, and the Office of the Director of National Intelligence.

In 2003 President Bush and Congress enacted NextGen under VISION 100 – Century of Aviation Reauthorization Act[1] (P.L. 108-176). Under this initiative, the Joint Planning and Development Office (JPDO) responsibilities include maintaining the NextGen vision and facilitating a public/private partnership to bring NextGen online by 2025. The JPDO is the central organization that coordinates the specialized efforts of the NextGen partner agencies and is the "honest broker" in developing a framework for NextGen planning and development, identifying and prioritizing key multi-agency concerns, and driving consensus in the development of investment choices and decisions.

The primary artifacts driving the transformation are the NextGen Concept of Operations (ConOps), Enterprise Architecture (EA), and the Integrated Work Plan (IWP). These enterprise-level planning documentation, accessible via the JPDO's Joint Planning Environment[2] (JPE), are used to define, depict, and guide the transformation to the future state air transportation system. While the NextGen enterprise-level documentation accounts for the full range of NextGen capabilities and improvements needed to achieve the overarching NextGen vision, it only represents the top-level of the NextGen concept and is not intended to provide the detail that reflects individual partner agency architectures, programs, or investments. As a result, a standard method to relate various levels of information is necessary and can be achieved through the concept of architecture federation[3].

1.1 Purpose and Scope

The purpose of the NextGen Federation Strategy (hereinafter the "Strategy") is to present methods for extending the JPDO's NextGen EA and IWP to achieve architecture federation with the NextGen partner agency architectures. This Strategy describes architecture federation concepts and the approach for implementing, maintaining, and communicating the Federated NextGen that would provide broader and deeper insight into implementing organization's architectures, solutions, and investment data to support decision-making and accountability (i.e. line-of-sight).

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[1] http://www.jpdo.gov/vision_100_law.asp

[2] http://jpe.jpdo.gov

[3] The concept of architecture federation infers both a division of authority, accountability and interdependence between a hierarchy of architectures. See Section 2 for an additional explanation of architecture federation and other federation concepts.

This Strategy encompasses the NextGen EA and IWP at all levels of detail and classification, and defines or references semantic architecture alignments to relevant and accessible NextGen partner agency architectures. Understanding that only portions of the NextGen EA and IWP are meaningful to each partner agency, and that partner agency architectures are at varying levels of maturity, the scope of the architecture federation will be unique to each agency.

1.2 Intended Audience

There are two primary audiences for this Strategy – first, those individuals within the JPDO responsible for developing and governing the Federated NextGen, and second, the partner agencies and stakeholder organizations responsible for producing and consuming the architecture information (e.g., decision makers, program manager, analysts, architects, engineers, etc.).

1.3 Background

The NextGen EA and IWP are two components within the set of NextGen enterprise-level planning documentation used to define, depict, and guide the transformation of the Nation's air transportation system. The NextGen EA depicts the objective-state (i.e. 2025) view of the air transportation system and is a reference for the architecture and engineering community while the IWP describes the integrated planning elements for achieving NextGen. Both serve as a collaboration tool to help coordinate mission objectives and funding priorities across the multiple NextGen government agencies and industry stakeholders.

The NextGen EA and IWP, accessible via the JPE, account for the full range of activities and actors that plan, govern, operate/maintain, and provide/use air transportation services. The EA focuses on the operational aspects of the NextGen enterprise, depicting the relationships among people, operating centers, activities, and information, and presents a level of detail necessary to strategically align and leverage existing stakeholder operational architectures. The NextGen EA also contains high-level system views that depict generalized system nodes and system entities, and their interconnections within and between nodes. These views illustrate, on a macro scale, the types of NextGen systems and data interfaces that will or should exist. The IWP sequences and describes planning elements (i.e., Operational Improvements, Enablers, Research, Development and Policy activities) that are needed to achieve the NextGen concepts and capabilities described in the NextGen EA.

1.4 Goals

The intent of this Strategy is to respond to the inherent challenges that result from a multi-agency, multi-mission, and multi-level organization tasked with symbiotic decision-making. The goals of this Strategy aim to respond directly to these issues. The goals are:

- Facilitate cooperative decision-making across the NextGen partner and stakeholder organizations and a common understanding of NextGen that is based on the federation of disparate partner agency architectures, solutions, or investments that are related in a meaningful way to the NextGen EA and IWP
- Detail the full spectrum of concepts and capabilities described in the NextGen ConOps using architecture information and artifacts

- Provide NextGen partners and stakeholders with a well-managed standard body of knowledge that is timely, relevant, and accessible
- Increase the agility, reuse, and integration of partner and stakeholder assets by leveraging existing architecture data and/or artifacts.

1.4.1 Objectives

In order to realize these collective goals, there are several objectives tied to the implementation of this Strategy. This Strategy must:

- Articulate the need for architectural alignment between agency architectures, solutions, or investments and the NextGen EA and IWP, and facilitate a formal agreement across the partner agencies to implement and maintain a Federated NextGen
- Provide a framework and process for federating the NextGen EA and IWP that supports autonomous development and tiered accountability, and complements the development of integrated architectures for immature partner agency architectures consistent with NextGen concepts or capabilities
- Provide guidance to partner agencies and stakeholders responsible for producing and consuming the Federated NextGen information
- Establish a process for on-going maintenance of the Federated NextGen
- Leverage existing mechanisms (e.g., the JPDO's JPE) to display and report semantic relationships between agency architectures, solutions, or investments and the NextGen EA and IWP.

1.4.2 Guiding Principles

In order to gain the most reuse out of existing efforts and to minimize the need for additional architecture development, the development of the Federated NextGen is guided by the principles below. The Federated NextGen will:

- Respect the diverse requirements of individual NextGen partner agencies and focus on the associations that cut across organizational boundaries, roles, and responsibilities
- Maximize the use of existing partner or stakeholder organizational architecture efforts regardless of structure and format (i.e. not re-building architectures)
- Utilize a data-centric architecture approach rather than product-centric approach.

2 ARCHITECTURE FEDERATION CONCEPTS DEFINED

The following concepts are important to understanding how architecture federation supports decision-making and tiered accountability; and. enables achievement of the goals and objectives of the Strategy. The following concept definitions come from the Department of Defense Global Information Grid Architecture Federation Strategy[4]; however, where necessary they are adapted to accommodate the uniqueness of the JPDO and NextGen environment.

2.1 Architecture Federation

Architecture federation represents a formal mechanism for relating autonomous and disparate architectures with an overarching, high-level architecture taxonomy in a meaningful way. As such, federation establishes ties between the most general architectural information (e.g., policies, standards, operational activities, systems, etc.) that applies at the highest level across all architectures down to the most detailed architectural information that is unique to each individual organization. This enables developing/owning organizations to maintain their unique architecture and focused perspective while aligning to common information across the greater enterprise. Therefore, architecture federation does not drive the solution, but facilitates information discovery and conversations that lead to solutions.

2.2 Architecture Integration

Architecture integration represents a development method where architecture elements are uniquely identified and consistently used across all products, views and plans. A mature integrated architecture can become its own high-level architecture taxonomy that can guide the identification of elements in lower-level architectures.

2.3 Architecture Taxonomy

An architecture taxonomy is the high-level architecture that serves as the organizing framework used to describe the scope of the enterprise and where any particular architecture fits within the federation. It serves as the reference point for lower-level architectures to establish semantic alignment (i.e., mapping) of architecture terms and definitions, programs, or investments and creates a common lexicon used throughout the enterprise.

2.4 Tiered Accountability

Tiered accountability establishes a hierarchy of architectures; providing a parent/child relationship structure for accountability by distributing architecture development responsibilities and enabling autonomy. The basic concept behind tiered accountability is that at any given tier the architecture is developed to the amount of detail necessary to meet the stated objectives while also establishing a clear reference point for lower-level architectures. It is the

[4] http://www.bta.mil/products/BEA/products/GIG_Architecture_Federation_Strategy_v1_21.pdf

responsibility of the child organization to define extensions and provide higher degrees of fidelity and detail. Where commonalities exist, there is the opportunity to identify, leverage, and possibly share information. Tiered accountability combined with architecture alignment creates a clear line-of-sight that supports decision-making, whether related to compliance, portfolio management, gap/overlap analysis, etc.

2.5 Semantic Alignment

Semantic alignment of lower-level architecture elements with elements of the high-level architecture taxonomy is the basis of architecture federation. Semantic alignment refers to the relationship strength specified between the definitions of the two elements, for example “is equivalent to”, “is similar to”, “is part of”, ”no relationship”. These relationship types provide the alignment and interface points within the federated architecture.

2.6 Federation Governance

Federation governance defines the structure of the federation, the roles and responsibilities of the participating members, as well as the processes for evaluating and granting waivers, and resolving disputes.

3 NEXTGEN FEDERATION APPROACH

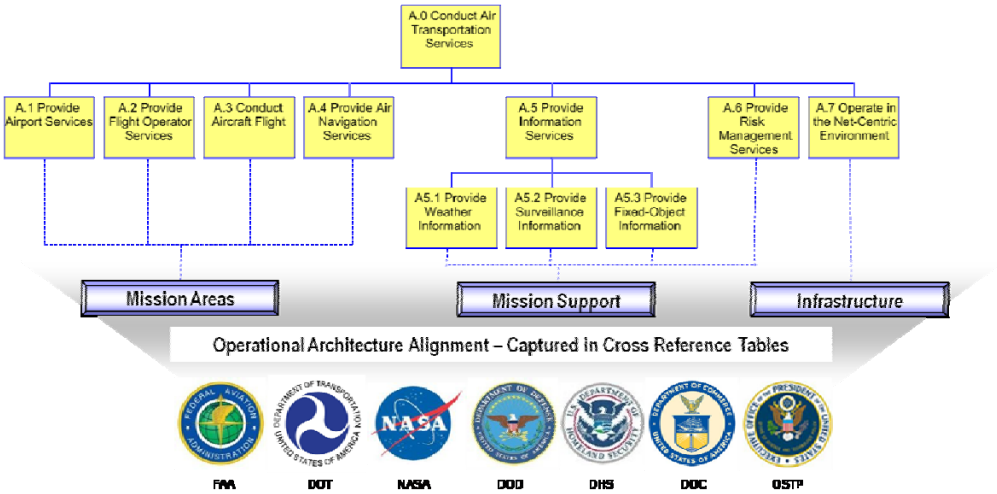
Federating the NextGen EA and IWP is not a single event, but rather a methodology that will influence the continued development and linking of partner agency architectures, solutions or investments to the NextGen EA and IWP. The following sections describe how the federation concepts described in Section 2 apply to the Federated NextGen and the different scenarios for achieving the Federated NextGen.

3.1 Federated NextGen Taxonomy, Tiers, and Semantic Relationships

NextGen Taxonomy and Tiers. The JPDO's NextGen EA and IWP serve as the high-level taxonomy, or organizing framework, used to describe the scope of NextGen and facilitate the semantic alignment of partner agency architectures, solutions, or investments.

The NextGen EA Operational Activity Node Tree (i.e. OV-5) provides the overarching operational taxonomy for describing the planning, governance, operations, provisioning and management activities organized around Mission Areas, Mission Support, and Infrastructure. Figure 1 notionally depicts the Federated NextGen EA architecture taxonomy using the NextGen EA OV-5 as the reference point for the partner agencies to establish semantic alignment for NextGen operational activities.

Figure 1. Federated NextGen Operational Taxonomy



The operational activities identified in the NextGen EA OV-5 are the primary mechanisms for evaluating and establishing federation with partner agency architectures. They represent the lowest level of activities within the NextGen EA and serve as a natural reference point for establishing alignment between different architectures.

The NextGen IWP Enablers, Policy Items, and R&D planning elements provide the overarching taxonomy for describing (in functional terms) the enabling materiel and non-materiel solutions. The enabling solutions are high-level (mission) functional requirement statements aligned to offices of primary responsibility whose responsibility it is to refine the identified functionality into detailed requirement statements and align resources to implement the functionality. Figure 2

notionally depicts the Federated NextGen Enabling Solution taxonomy using the NextGen IWP planning elements as the reference points for partner agencies to establish semantic alignment.

Figure 2 Federated NextGen Enabling Solution Taxonomy

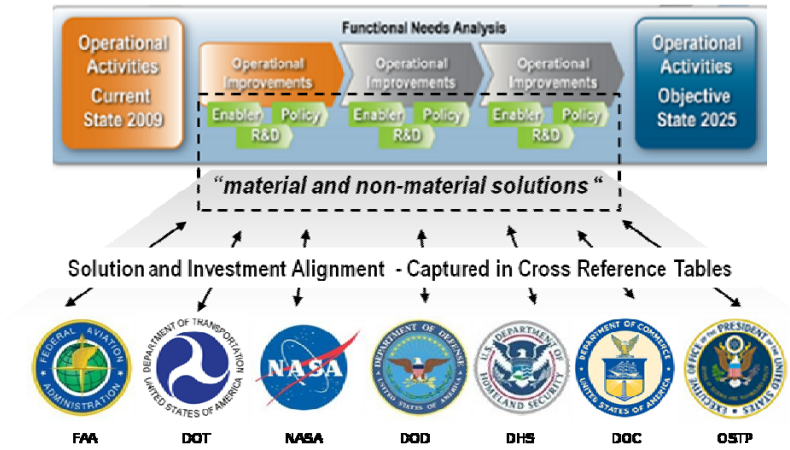


Figure 1 and Figure 2 depict the tiers within the Federated NextGen, where the NextGen EA and IWP are the parent taxonomies and the partner agency architectures, solutions, and investments are the children. This tiered structure supports the NextGen Federation Strategy objective of autonomous development responsibility at the partner agency-level and complements the development of JPDO-led integrated architecture efforts that further detail concepts or capabilities at the NextGen-level.

NextGen Semantic Relationships. Alignments between the partner agency architectures, solutions, and investments and the NextGen EA and IWP follow the semantic relationship types defined in Table 1. An agency-specific Cross Reference Table captures the alignment information and is maintained by the IAED team and published annually in the JPDO's JPE. The Cross Reference Table includes the specific partner agency architectural entity, solution, or investment, the NextGen EA or IWP entity, and the nature of the alignment based on the semantic relationship type (E-equivalent, S-similar, P-part, N-none) as seen in Appendix A.

Table 1. Semantic Relationship Types

Relationship Type	Description	Relationship Strength
Is Equivalent to	A partner agency's architecture element is considered "equivalent to" a NextGen EA or IWP element if the descriptions of both are identical. (i.e., Same Scope, Same Content)	**Strongest**
Is Similar to	A partner agency's architecture element is considered "similar to" a NextGen EA or IWP element if the descriptions are the same but differ in scope, the element is described or implemented differently by two or more partner agencies, or two or more partner agencies accomplish the same element functionality with different definitions. (i.e., Different Scope, Same Content)	**Next Strongest**

Relationship Type	Description	Relationship Strength
Is Part of	A partner agency's architecture element is considered "part of" a NextGen EA or IWP element if the description of the partner agency's element achieves part of the NextGen element functionality or another partner agency's architecture element also has a "part of" relationship with the same NextGen EA or IWP element. (i.e., Different but similar Scope and/or Different but similar Content)	**Relatively Weak**
No Relationship	A partner agency's architecture element has no relationship to any NextGen EA or IWP element. (i.e., No relationship can be established due to a gap in the NextGen EA, IWP or the element falls outside of scope.)	**None**

3.2 Establishing the Federated NextGen

The following sections present different scenarios that describe foreseeable situations for establishing the Federated NextGen. This scenario-based approach provides flexibility and accommodates the uniqueness and varying maturity levels of partner agency architectures.

3.2.1 Scenario 1: Federation with Partner Agencies that have Existing Architectures

The JPDO IAED team in collaboration with the partner agency architects will work with the partner agencies to identify and determine the semantic relationships of relevant architecture information, solutions or investments with the NextGen EA and IWP. The team will use the relationship types described in Table 1 to determine the semantic relationship between the partner agency's Operational Activities (or business functions, etc.) and the Operational Activities defined in the NextGen EA and the system/solution descriptions and plans with the NextGen IWP planning elements. This information will be captured in the Agency-specific Cross Reference Tables.

3.2.2 Scenario 2: Federation during NextGen IWP Data Validation and Maturity Process

On an annual basis, the JPDO IAED team will collaborate with partner agencies to validate, enhance and update the IWP data elements for which they have been identified as Office of Primary Responsibility. The IAED team will also coordinate with the JPDO's Interagency Portfolio and Systems Analysis (IPSA) Division and partner agencies to identify partner agency planning elements and commitments (e.g. programs, investments, resources, etc.) within the five-year budget window that align to the planning elements defined in the NextGen IWP. This information will be captured in the Agency-specific Cross Reference Tables.

3.2.3 Scenario 3: Federation during NextGen Mission Segment/Capability Architecture Development

The NextGen EA is developed following a segmented approach, with varying levels of operational and system architecture decomposition and development that are directly related to the annual organizational priorities or initiatives of the JPDO Senior Policy Committee, Division Directors, and Working Groups[5]. These initiatives are generally strategic in nature (e.g., NextGen far-term concept or capability development, etc.) and require the coordinated efforts of multiple NextGen partner agencies and stakeholders. Examples of recent JPDO priorities and/or developments include the establishment of the Net-Centric Operations Division, the development of an Air Traffic Management-Weather Integration Plan, and the development of the Integrated Surveillance ConOps and EA.

As strategic interagency efforts are initiated, the JPDO IAED team will coordinate with the appropriate Working Groups or Study Teams, and partner agency representatives to collect relevant architecture information, definitions, roadmaps, system/service inventories, etc. that may already exist and relate it back to the contents of the NextGen EA and IWP. The collected information combined with the deliverables of the Working Group or Study Team serve as the foundation for the development of the NextGen Mission Segment/Capability architecture and the Federated NextGen.

The Working Groups and/or Study Teams, and partner agency representatives review and validate draft Mission Segment/Capability architecture artifacts and semantic alignments to ensure accurate representation of their information. In addition, architecture artifacts allow agency representatives can analyze and use the NextGen Mission Segment/Capability architecture artifacts as a starting point for further architectural extension and semantic alignment.

3.3 Maintaining and Governing the Federated NextGen

As discussed in Section 3.1 above, each tier of the Federated NextGen is responsible for managing its own architecture and planning data while also making those architectures and data visible, accessible, and understandable to other members of the federation. Each tier has roles and responsibilities that it must perform to make the Federated NextGen function as intended. Table 2 outlines the high-level roles and responsibilities of each tier to the Federation.

[5] The JPDO Working Groups consist of government officials and industry representatives. Each Working Group specializes in developing one of NextGen's key capabilities. The list of Working Groups can be found online at http://www.jpdo.gov/whoswho.asp#workinggroups

Table 2. Roles and Responsibilities

JPDO Responsibilities to the Federation
- coordinate with each partner agency to review the agency's Cross Reference Table to identify potential changes or recommendations to strengthen semantic alignment, and follow the JPDO's Change Management processes to adjudicate the proposals - maintain a lexicon of commonly used terms - make partner agency Cross Reference Tables and Matrices visible, accessible, and understandable to members of the federation to enable traceability through the levels and across the NextGen EA and IWP - develop and maintain the JPE in which the Federated NextGen is implemented and maintained - develop high-level taxonomy, meta model and categorization schemes and report changes in order to ensure partner agency architectures can align in a meaningful way - will work with OMB to establish and maintain NextGen as an initiative in the FTF Catalog, and ensure the Catalog represents the most recently published NextGen EA information (e.g., policies, standards, performance metrics, operational and materiel solution types, etc.) - define additional guidance for federating partner agency architectures - responsible for the day to day Federated NextGen management and administration, communication and outreach, and reporting - establish governance structure and processes for evaluating and granting waivers, and resolving disputes
Partner Agency Responsibilities to the Federation
- report changes in architecture or transition plan content to the JPDO to inform updates and/or edits to the Cross Reference Table, NextGen EA or IWP - propose modifications to the NextGen EA and IWP to increase/strengthen alignment between tiers - use the taxonomy and categorization schemes provided by the JPDO to map architectures, solutions and investments to the NextGen EA and IWP - make the partner agency architectures, solutions, and investments visible, accessible, and understandable to members of the federation - align relevant EA segments to the NextGen catalog item in the FTF

4 FEDERATED NEXTGEN REPOSITORY

Any successful federation effort is dependent upon making architecture artifacts visible and accessible to analyst, planners, and decision makers at all levels of the enterprise. This Strategy repeatedly states that each partner agency's semantic alignment information is captured in a Cross Reference Table that will be maintained by the IAED.

As the JPDO and partner agency representatives agree upon the alignment, the Cross Reference Table will be made available through the JPDO's JPE, providing ready access to NextGen stakeholders. Additionally, some elements of an agency's architecture, solutions, or investments may be stored for alignment purposes as an attribute within the JPE to ensure a NextGen concept or capability is fully described a the enterprise-level; however, the intention is not to replicate the agency's architecture or data.

Appendix A. Agency-specific Cross Reference Table

A Cross Reference Table will be created and maintained for each partner agency that is federated with the NextGen EA and IWP, and will include the specific partner agency architectural entities, the NextGen EA and IWP entities, and the nature of the alignment based on the semantic relationship type (E-equivalent, S-similar, P-part, N-none).

Table 3. Notional Partner Agency Cross Reference Table

FAA Cross Reference Table							
From: FAA NAS EA			**To: NextGen EA**				
Entity Type	Entity Number (if applicable)	Entity Name	Mapping Relationship	Entity Type	Entity Number (if applicable)	Entity Name	Comments
Operational Activity	A.3.1.1.1.2.1	Collect Schedule Information	Part of	Operational Activity	A.3.1	Select Operational Flight Plan	
Operational Activity	A.3.1.1.1.2.2	Analyze Schedule Information	Part of	Operational Activity	A.3.1	Select Operational Flight Plan	
Operational Activity	A.3.1.1.1.2.3	Submit Flight Schedule Information	Part of	Operational Activity	A.3.1	Select Operational Flight Plan	