FINAL

The Use of Enterprise Architecture to Support the Development of the Next Generation Air Transportation System (NextGen)

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Gerald Friedman (MITRE)
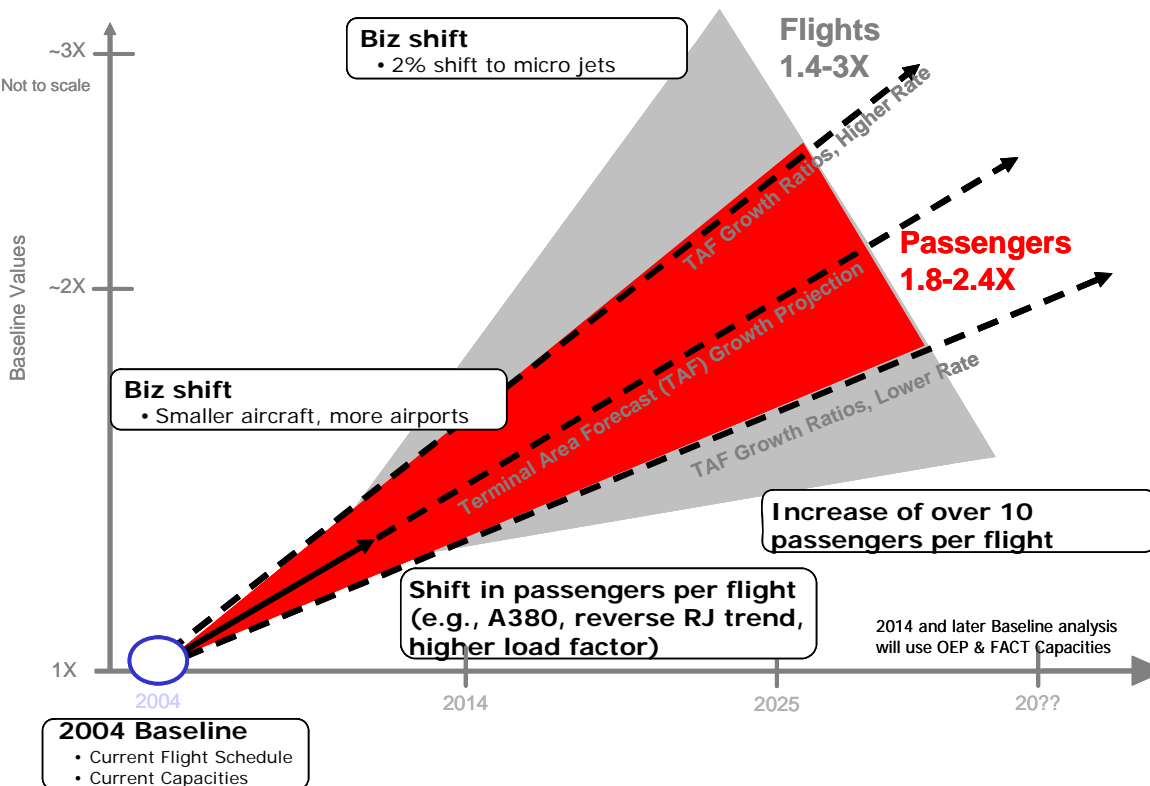*Jay Merkle (FAA)*

25 October 2007

Outline

- **Introduction**

- **Background**

- **Approach**

- **Lessons Learned**

- **Summary**

Why NextGen?

Note: Not to scale

Chart axis label (vertical): Baseline Values

Axis values: ~3X, ~2X, 1X

Biz shift
• 2% shift to micro jets

Flights 1.4-3X

TAF Growth Ratios, Higher Rate

Passengers 1.8-2.4X

Terminal Area Forecast (TAF) Growth Projection

Biz shift
• Smaller aircraft, more airports

TAF Growth Ratios, Lower Rate

Increase of over 10 passengers per flight

Shift in passengers per flight (e.g., A380, reverse RJ trend, higher load factor)

2014 and later Baseline analysis will use OEP & FACT Capacities

Timeline: 2004, 2014, 2025, 20??

2004 Baseline
• Current Flight Schedule
• Current Capacities

- **Growth in volume and complexity of operations**
- **Scalable to encompass a range of possible futures**
- **Broader diversity of:**
  - **Aircraft performance characteristics**
  - **Aircraft capabilities**
  - **Operator business models**
- **Space Operations**
- **Unmanned Aerial Systems**

Transformation is Needed to Accommodate Projected Traffic Levels and Characteristics

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Vision 100 Legislation – JPDO Responsibilities

- **Create and carry out an integrated plan to achieve NextGen**
- **Coordinate goals and priorities for research and development**
- **Coordinate research activities within the Federal Government and across United States aviation and aeronautical firms**
- **Facilitate the transfer of technology from research programs to Federal agencies with operational responsibilities and to the private sector**
- **Create a transition plan for the implementation of NextGen**

> ➢ *Operate in conjunction with relevant programs in specified government agencies*

> ➢ *Consult with the public and ensure the participation of experts from the private sector*

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Scope of NextGen

Next Generation Air Transportation System (NextGen)

- **Envisioned 2025 system and transition from today**
- **Satisfy capacity, efficiency, safety, defense, and security needs**
  - **Responsive to environmental concerns**
  - **Responsive to global harmonization requirements**
- **Planned jointly by public and private sector stakeholders through JPDO**
  - **Civil aviation, National Defense, Homeland Security, and Transiting Spaceflight**

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What is NextGen?

Transformation goals:

- Leadership in global aviation
- Scalable up to 3x increase in capacity
- Ensure our national defense (readiness and homeland security)
- Enhance the environment (noise, air quality)
- Improve safety
- Globally harmonized

Capabilities:

- Network-Enabled Information Access
- Performance Based Operations & Services
- Weather Assimilated into Decision Making
- Layered, Adaptive Security
- Position, Navigation, and Timing Services
- Aircraft Trajectory Based Operations
- Equivalent Visual Operations
- Super Density Arrival/Departure Operations

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Organization Developing the NextGen EA

Organization Developing the Architecture

The NextGen Enterprise Architecture is developed and maintained by the Enterprise Architecture and Engineering Division (EAED) of the Joint Planning Development Office (JPDO), an Executive Office created to support and coordinate the efforts of Government and Private organizations in the development of the Next Generation Air Transportation System as envisioned by the President's "Vision 100" operational concept.
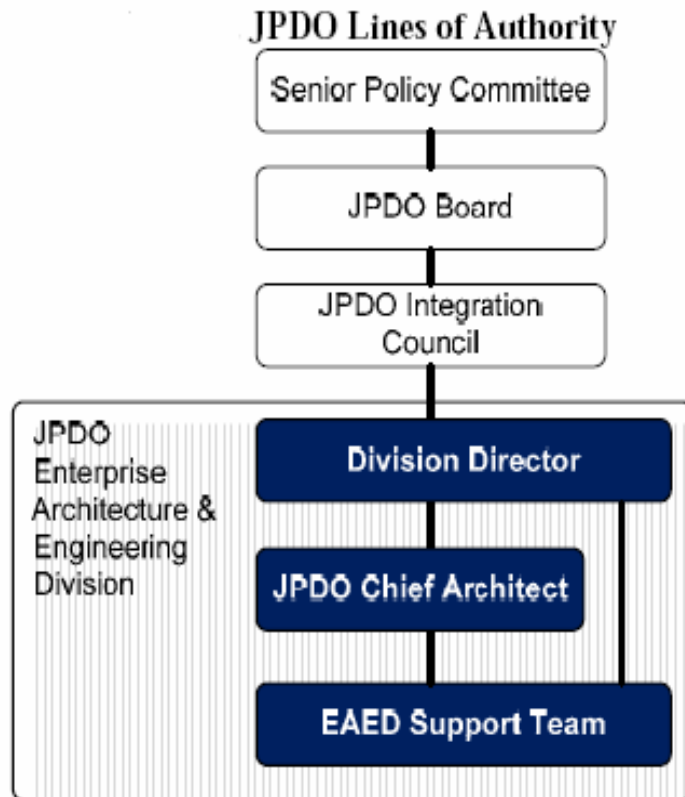
JPDO Lines of Authority

```
              Senior Policy Committee
                        |
                   JPDO Board
                        |
              JPDO Integration
                   Council
                        |
JPDO                    |
Enterprise        Division Director
Architecture &          |
Engineering      JPDO Chief Architect
Division                |
                 EAED Support Team
```

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Roles and Responsibilities

- **Government Leadership**
  - **EAED – Division Director – Mr. Ed Waggoner**
    - **Directs all EAED activities and in charge of all staff that support EAED**
    - **Represents the EAED on the JPDO Integration Council**
  - **EAED – Chief Architect – Mr. Jay Merkle**
    - **Responsible for leading the development, coordination, collaboration, and validation of the NextGen ConOps, EA and IWP.**

- **Booz Allen & Hamilton: JPDO - EAED primary support contractor, primary responsibilities:**
  - **Provide support and guide the development of the EAED concepts and development practices**
  - **Identify architecture-related issues and actions that need to be addressed**
  - **Develop and review architectural-related products**
  - **Manage and implement approved architectural changes**

- **MITRE: JPDO EAED FFRDC, primary responsibilities:**
  - **Provide guidance and recommendations to inform the development of engineering products.**
  - **Perform independent technical review and validation of major JPDO engineering products.**
  - **Help ensure products are appropriate in terms of content and structure and will identify integration needs, dependencies and areas requiring alignment among the products**
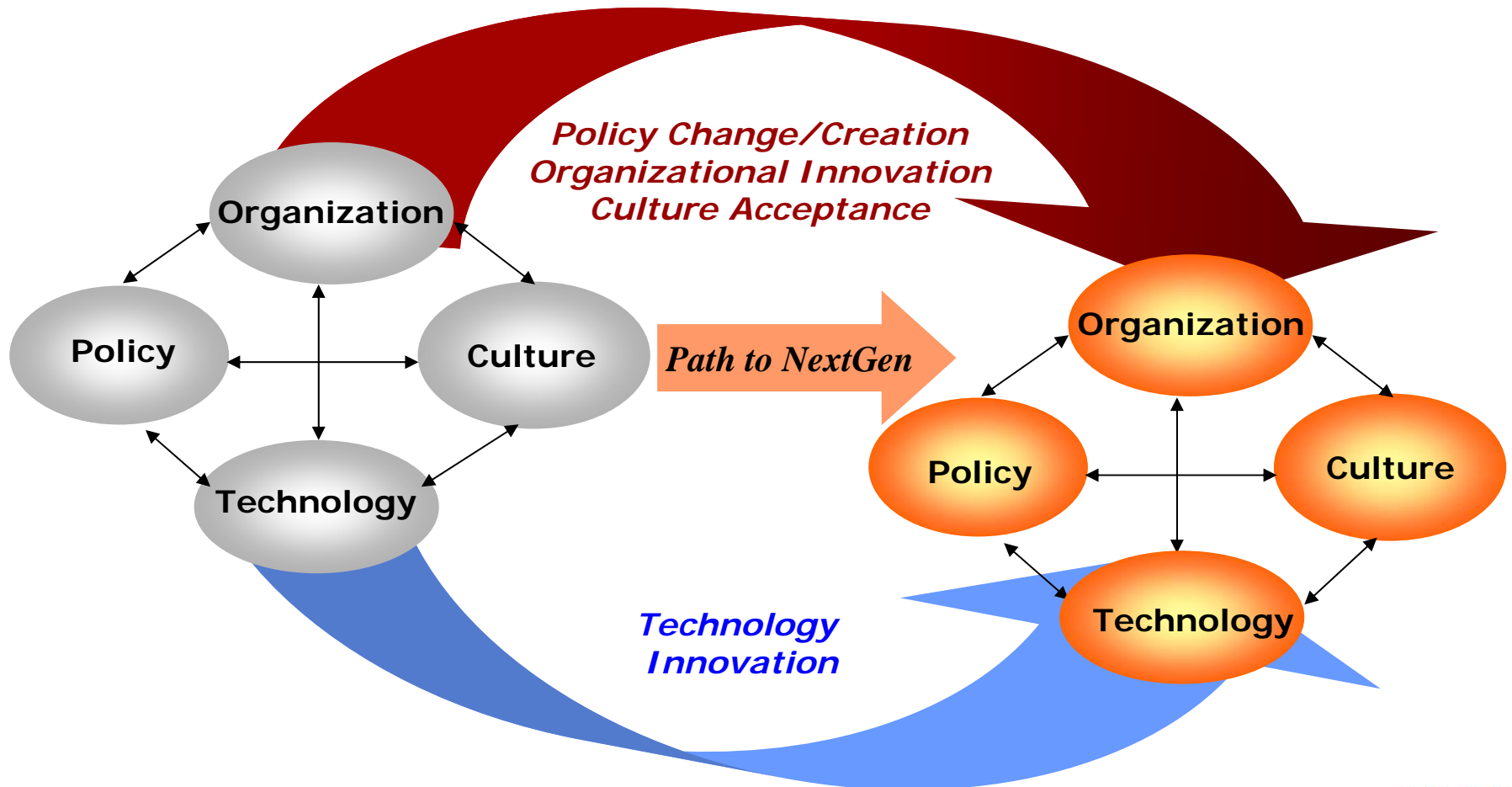
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Approach

System-Wide Transformation

NextGen Requires Innovation Across All Lines of Development

Policy Change/Creation
Organizational Innovation
Culture Acceptance

Organization

Policy

Culture

Technology

Path to NextGen

Organization

Policy

Culture

Technology

Technology Innovation

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Planned Implementation Process
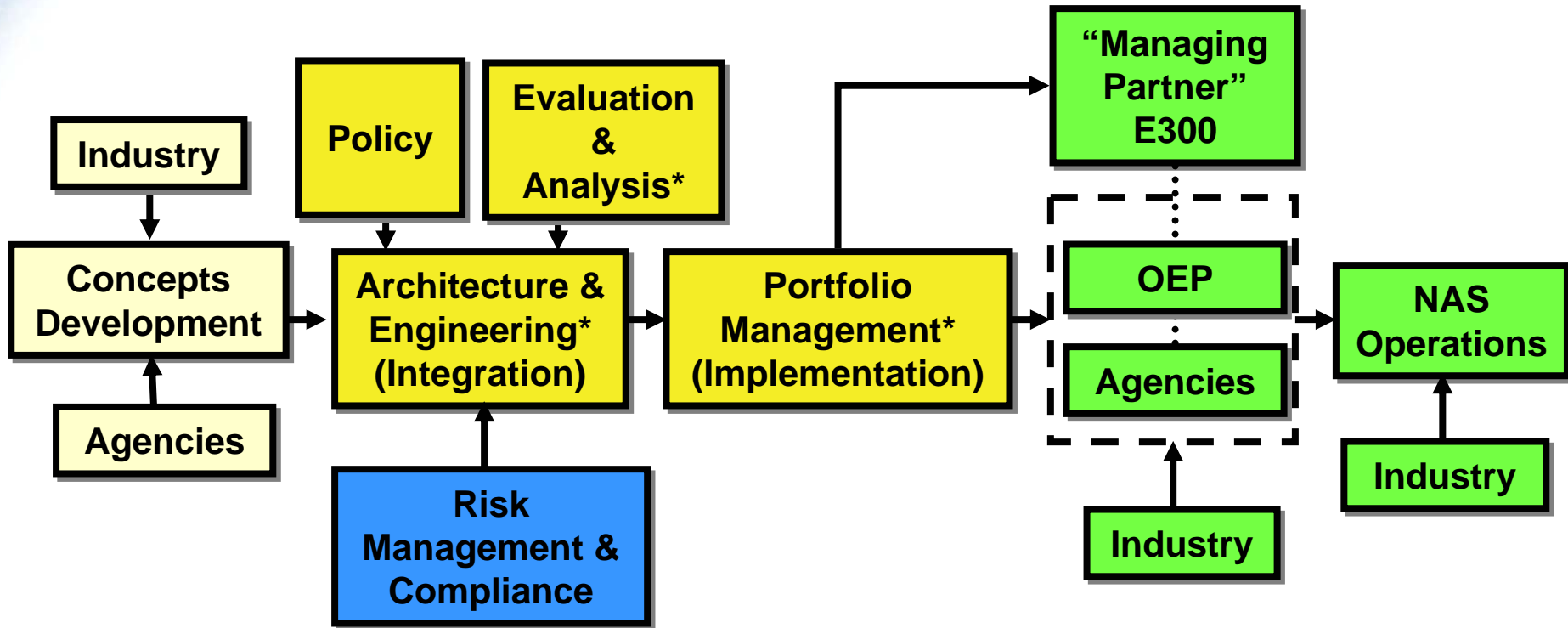
NextGen Planning Products
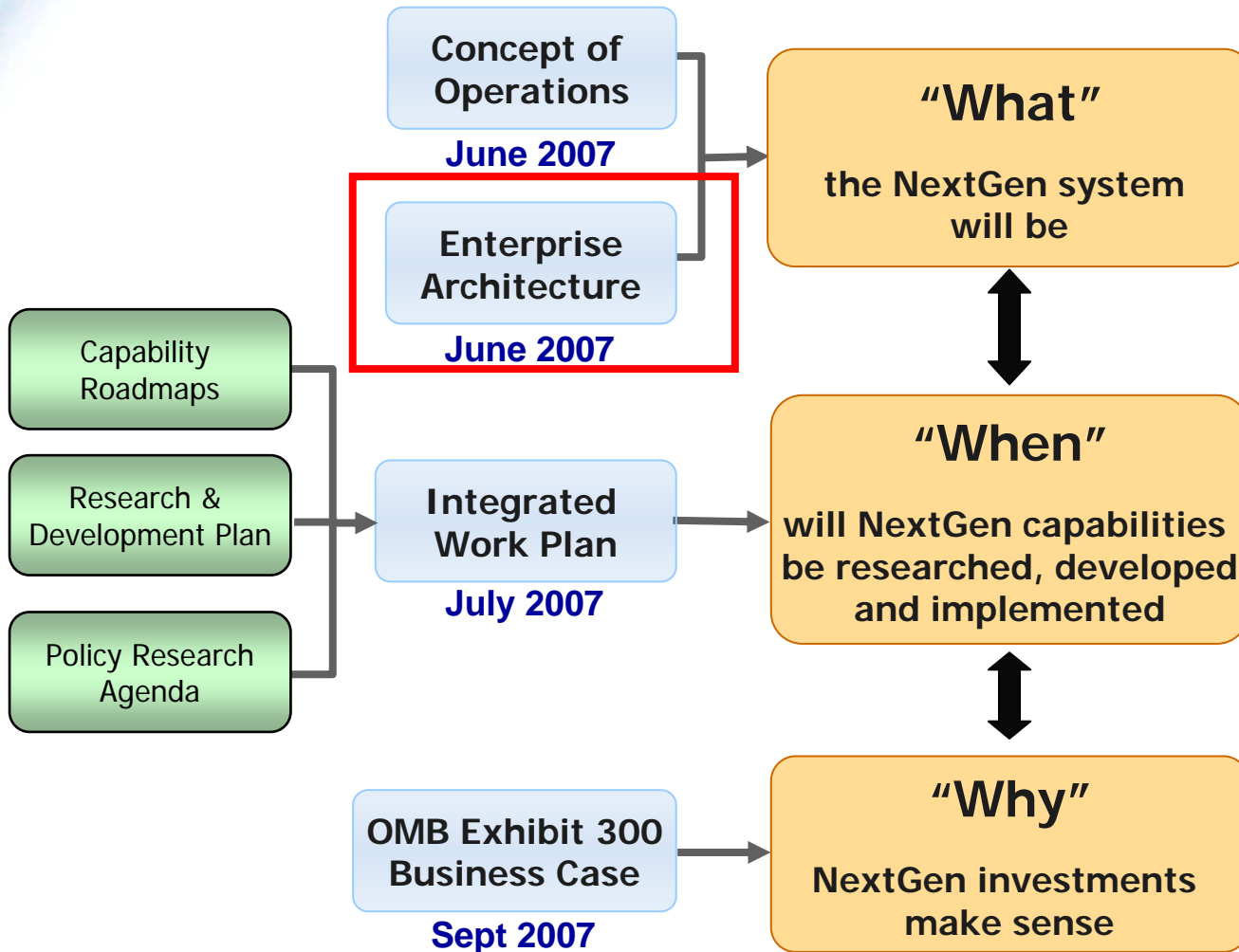
Concept of Operations
June 2007

Enterprise Architecture
June 2007

"What"
the NextGen system will be

Capability Roadmaps

Research & Development Plan

Policy Research Agenda

Integrated Work Plan
July 2007

"When"
will NextGen capabilities be researched, developed and implemented

OMB Exhibit 300 Business Case
Sept 2007

"Why"
NextGen investments make sense

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NextGen Annual Cycle

Legislation

NextGen National Plan

Modeling & Simulation

JPDO Develops Plan
With Agencies and Industry
- **Concept of Operations**
- **Enterprise Architecture**
- **Integrated Work Plan**
- **Policy Agenda**

JPDO/Agency Budget Interactions

R&D Plan

Exhibit 300

Adjust Plan

Portfolio Management

JPDO Manages Outcomes Against Plan

Agency Executes Investments

Agency Plans Investments

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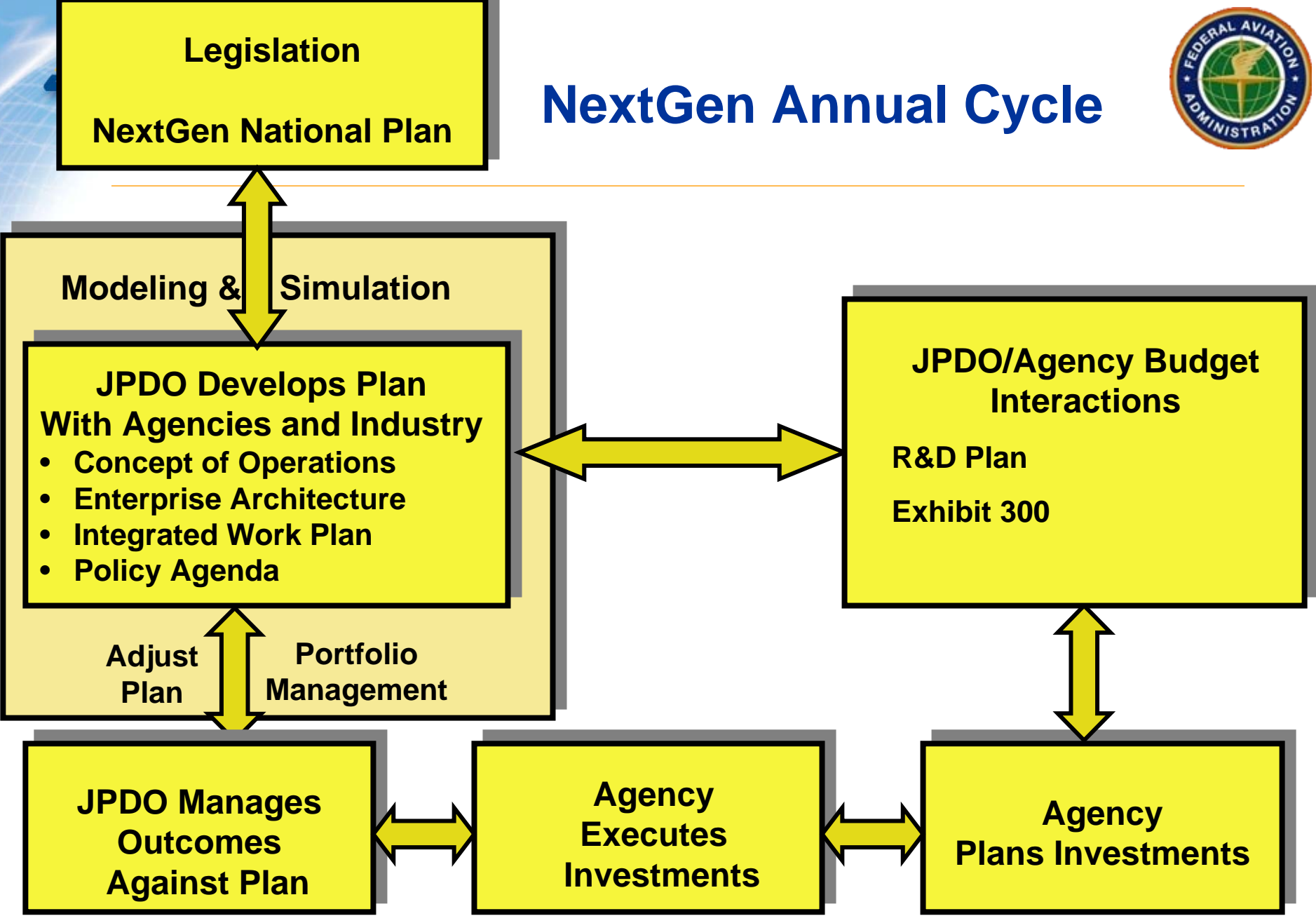
Key NextGen Products from Enterprise Architecture and Engineering

NextGen EA Framework

• Is a combination of the Federal Enterprise Architecture (**FEA**) and DoD Architecture Frameworks (**DoDAF**), products and processes

• The DoDAF OV5 along with the FEA business reference model (BRM) act as the integration mechanism of the two frameworks

• Establishes a common lexicon and creates a starting point for partner agencies to align and "drill-down" their respective architectures
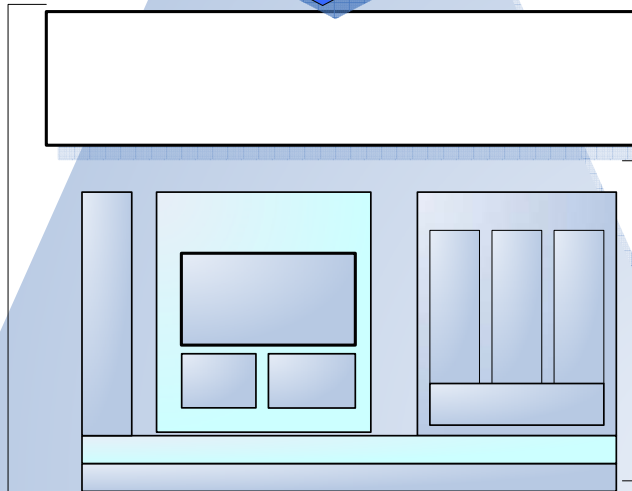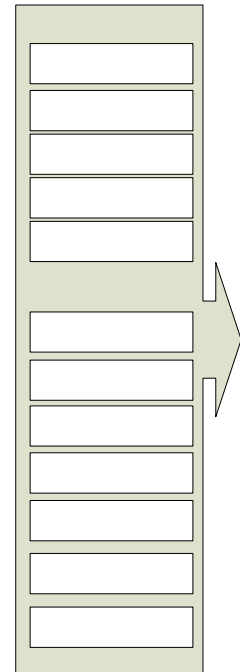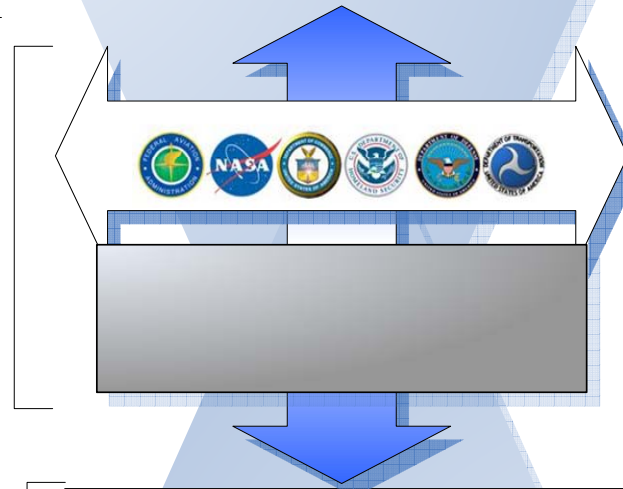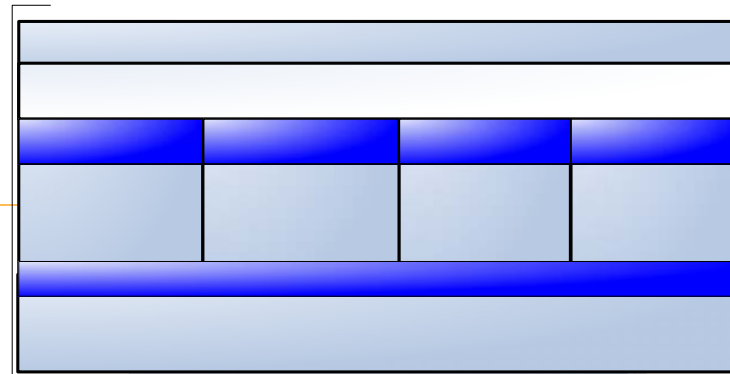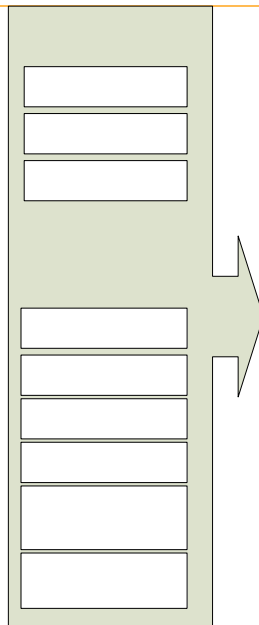
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Use of OMB Federal Enterprise Architecture
Reference Models (FEA RMs)
in Support of NextGen EA

# Proposing a new FEA BRM Line of Business (LOB) called "Air Transportation"

Services for Citizens ← Existing Business Area

Transportation ← Existing Line of Business

- **Space Operations**
- **Ground Transportation**
- **Water Transportation**
- **Air Transportation**

← Existing Sub-functions

The proposed Air Transportation LOB would provide 14 new Sub-Functions based on the OV5 Activity Model

Air Transportation

Weather Operations	Safety Management Operations	Airspace Security Operations
Positioning, Navigation & Timing Operations	Communication Service Management	Air Navigation Operations
Surveillance Operations	Airport Support	Flight Support
Flight Planning & Flight Data Management	Airport Operations	Flight Operations
Aeronautical Information Management	Air Navigation Support	

Proposed Sub-functions

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Additional BRM Revision Proposals

Proposing an additional Sub-Function under existing IT Management Line of Business
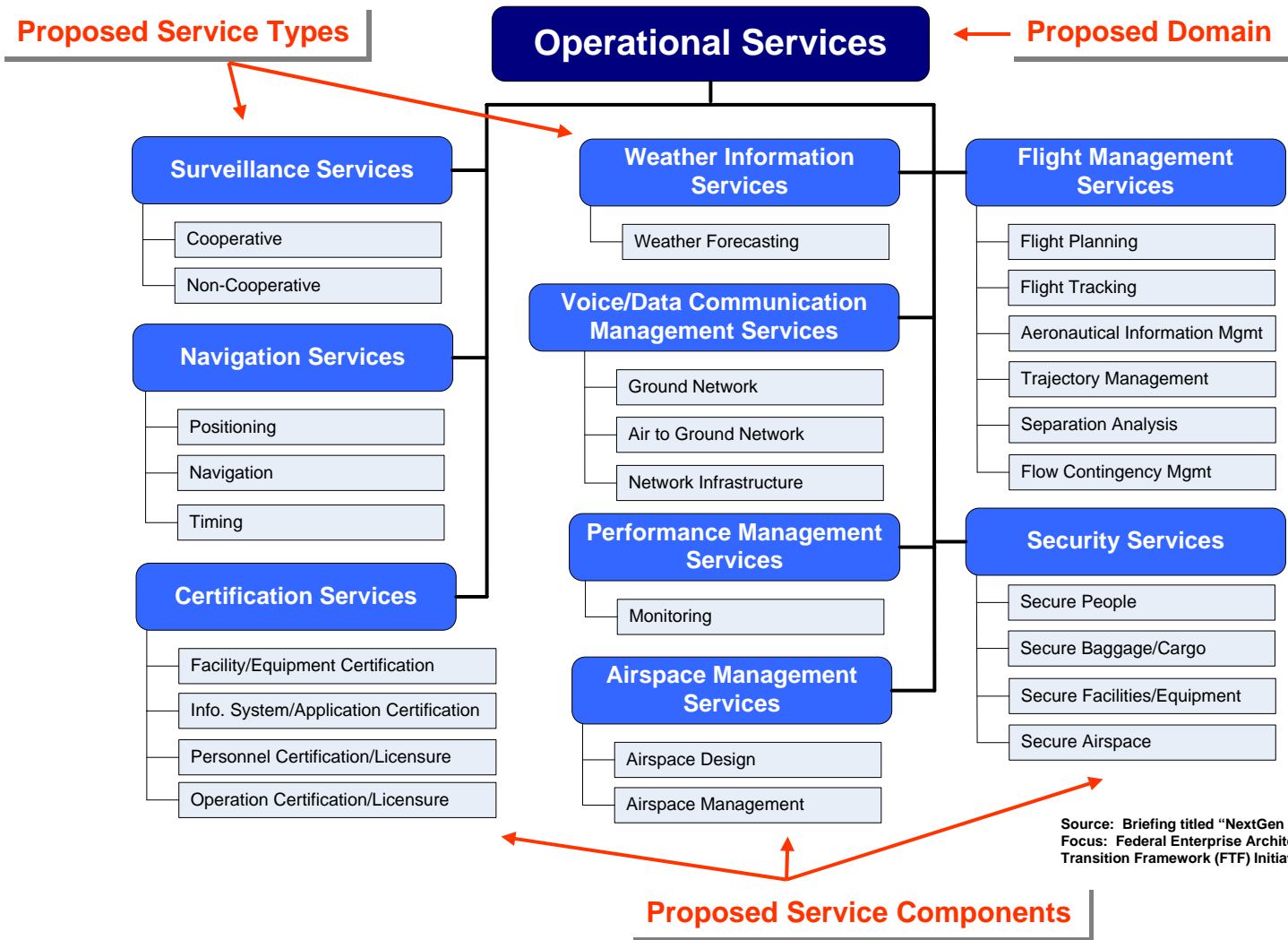

Existing BRM Lines of Business
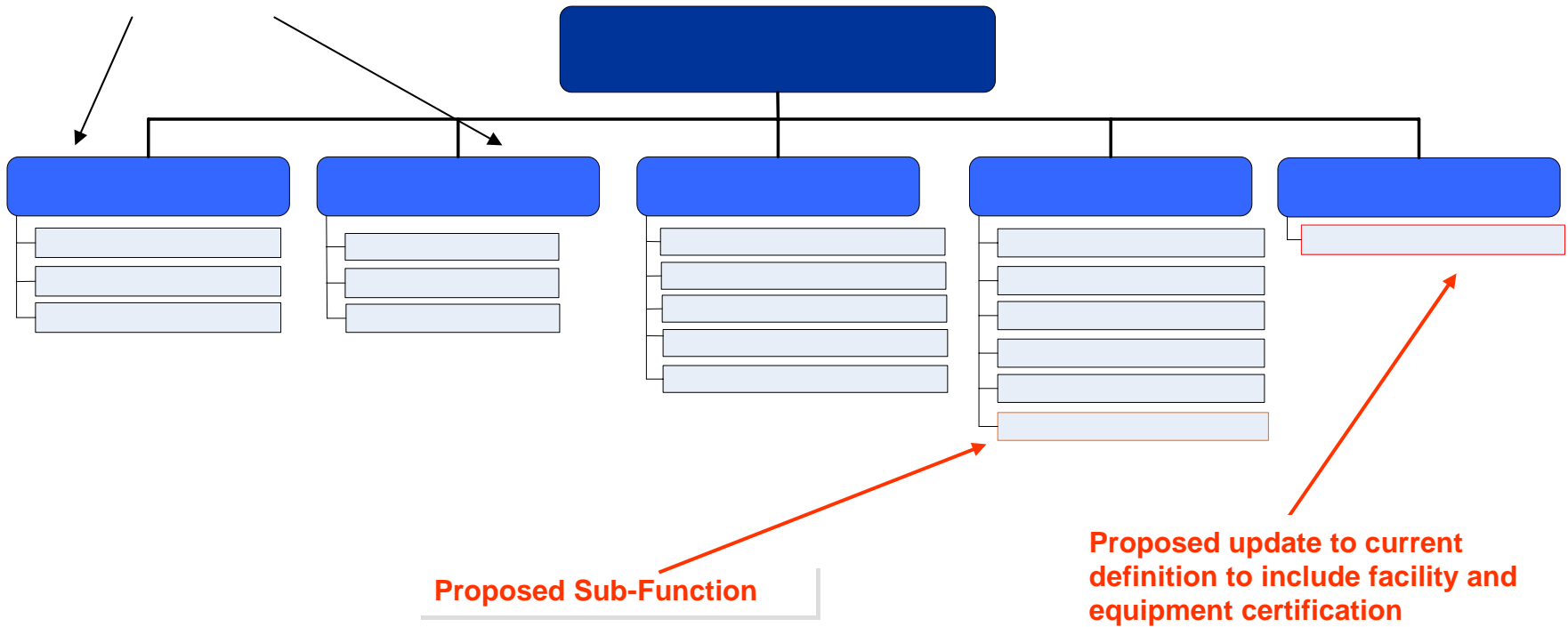
Proposed Sub-Function

Proposed update to current definition to include facility and equipment certification

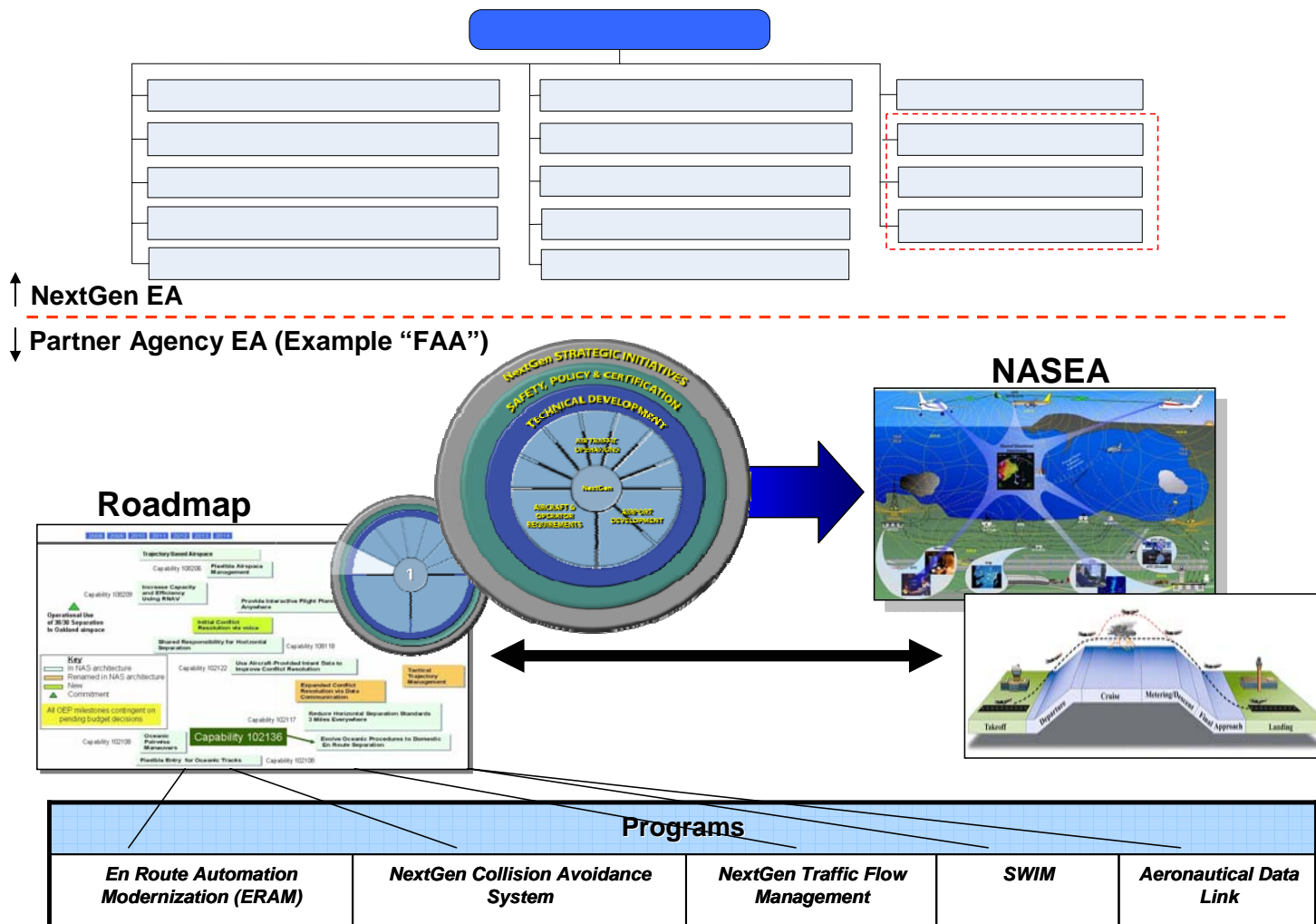**MITRE**

Proposed Extensions to Existing SRM

Proposing a **new** "Operational Services" Domain made up of 9 Service Types and 26 Service Components

Proposed Service Types

Operational Services ← **Proposed Domain**

Surveillance Services
- Cooperative
- Non-Cooperative

Navigation Services
- Positioning
- Navigation
- Timing

Certification Services
- Facility/Equipment Certification
- Info. System/Application Certification
- Personnel Certification/Licensure
- Operation Certification/Licensure

Weather Information Services
- Weather Forecasting

Voice/Data Communication Management Services
- Ground Network
- Air to Ground Network
- Network Infrastructure

Performance Management Services
- Monitoring

Airspace Management Services
- Airspace Design
- Airspace Management

Flight Management Services
- Flight Planning
- Flight Tracking
- Aeronautical Information Mgmt
- Trajectory Management
- Separation Analysis
- Flow Contingency Mgmt

Security Services
- Secure People
- Secure Baggage/Cargo
- Secure Facilities/Equipment
- Secure Airspace

Proposed Service Components

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NextGen EA

Partner Agency EA (Example "FAA")

Roadmap

NASEA

Programs

En Route Automation Modernization (ERAM)	NextGen Collision Avoidance System	NextGen Traffic Flow Management	SWIM	Aeronautical Data Link

Source: Briefing titled "NextGen Enterprise Architecture (EA) Focus: Federal Enterprise Architecture (FEA) & Federal Transition Framework (FTF) Initiatives" by JPDO EAED, dated 10 April 2007.

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Weather Operations

Use of FEA Reference Model in Support of NextGen EA (cont'd)

The JPDO, working in conjunction with the OMB FEA office, will develop an instantiation of the five OMB FEA reference models which will:

- Form the core of the enterprise level of the NextGen EA. The JPDO will apply the reference models to support comparisons of architectures from participating agencies and organizations.
- Help identify gaps and overlaps in capabilities, operations, information and systems.
- Help identify key areas of commonality across the organizations that will require improved integration and coordination.
- Frame and organize the NextGen target (to-be) architecture so that participating agencies can align with its goals and content.
- Ensure traceability from the NextGen target architecture to the FEA reference models to facilitate architecture and investment review.

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Use of the DoD Architectural Framework (DoDAF) to Support the Development of the NextGen EA

Summary of NextGen EA DoDAF Products

DoDAF Product	Purpose
Overview and Summary (AV-1)	The AV-1 gives the reader a condensed overview of the content of the architecture, including information about the reason for developing the architecture, the architectural products that will be developed to support that purpose, the kinds of analyses to be conducted on the products, who will conduct them, and how the results will be used. The AV-1 provides a summary of the vision, mission, architecture products, assumptions and constraints, and tools used in the process of developing the architecture.
Integrated Dictionary (AV-2)	The AV-2 is the NextGen EA's common consistent language, reducing confusion and increasing understanding for partner agencies and stakeholders. It enables the JPDO to collaborate and socialize the NextGen EA with a consistent lexicon formatted in such a way that stakeholders can compare the elements of the NextGen EA to their respective integrated dictionaries and architectures and propose changes if necessary to ensure the community is using terms consistently and as intended.
Community Model (OV-1)	The Community Model (OV-1) is used to provide a high level pictorial description of the major organizational and operational elements of the Next Generation Air Transportation System and how those elements interact with each other and with their environment.
Operational Node Connectivity Description (OV-2)	The operational nodes shown in the NextGen EA represent idealized places or organizations where activities are performed that require and/or produce information. The OV-2 is provided not only to represent the various organizations and places where activities are performed but also to provide a framework for organizing the information exchanges that will be described in detail in the Operational Information Exchange Matrix, OV-3.
Operational Information Exchange Matrix (OV-3)	The OV-3 is the most comprehensive description of operational information flow. It further decomposes the information flows (needlines) identified in the OV-2 into one or more (usually many) specific Information Exchanges and collects the detailed information about each exchange.

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Summary of NextGen EA DoDAF Products (cont'd)

DoDAF Product	Purpose
Activity Model – Hierarchy Node Tree (OV-5)	The OV-5 Operational Activity Hierarchy provides a comprehensive structured list of all the operational activities of interest to the architectural description. That is, it shows all the activities that need to be considered to achieve the desired outcomes of the architectural analysis and how high level activities are composed of lower level activities. The NextGen EA OV-5 Hierarchy also shows how the operational activities align within the eight Enterprise Segments and the relevant Activity Services in the Community Model.
Activity Model—IDEF0 (Activity Flow Diagrams) (OV-5)	The OV-5 Activity Flow diagram provides information useful in streamlining, combing, or eliminating activities, and it is helpful for eliminating redundancy. Of the greatest importance is that the OV-5 Activity Flow diagram provides the foundation for the OV-3 and OV-6c diagrams that are necessary to understand issues of information distribution and timing – critical issues for developing a NextGen EA that will provide the performance improvements required by the NextGen Vision.
Operational Event/Trace Description (OV-6c)	The Operational Event/Trace Description provide a time ordered sequence of information exchanges among the operational activities. Because the JPDO will use the architecture as a basis for advising stakeholders on the value and criticality of improving their systems and processes to achieve the goals of NextGen, an understanding of the sequencing of operational activities could provide key insights in support of that guidance.
Operational Activity to Stakeholder Investment Traceability Matrix (SV-5Hybrid)	To assist Stakeholder Communities of Interest in aligning the NextGen EA activities to their respective architectures and Capital Investment Plans, JPDO has deviated from the standard SV-5, Operational Activity to System Function format prescribed by DoDAF. The NextGen SV-5Hybrid relates Operational Activities to the Stakeholder Investments. By relating NextGen EA Operational Activities to Stakeholder Investments, the SV-5Hybrid describes the key relationships between Stakeholder Capital Investment and NextGen Capabilities.

Figure 16: 1st Tier – NextGen Community Model

NextGen Community Model 2nd Tier

Representative Subset of DoDAF Products

NextGen Community Model 3rd Tier – Air Navigation Support

05/25/07 Version 2.0

Enterprise Segment Activity Inventory (ESAI)
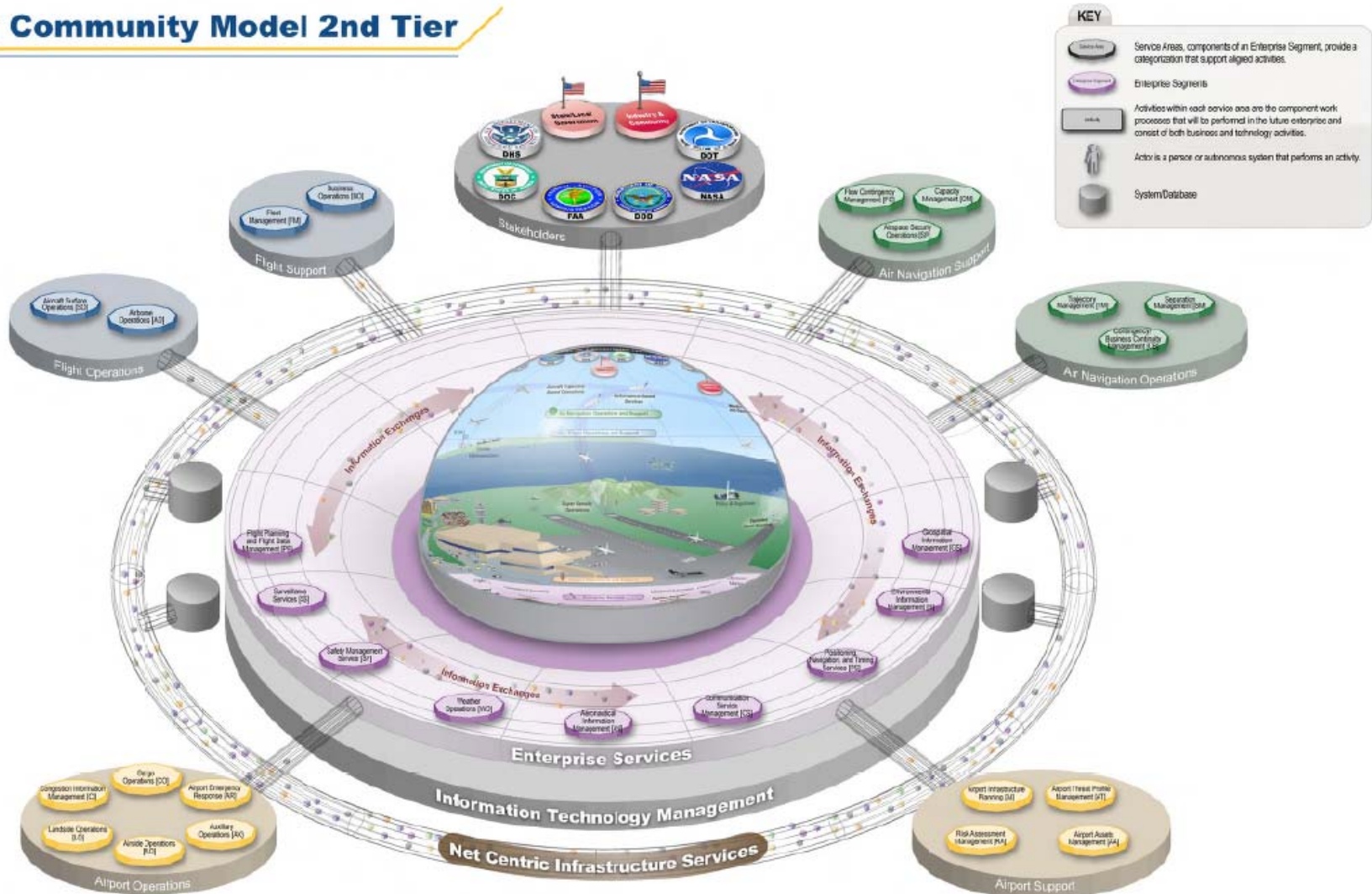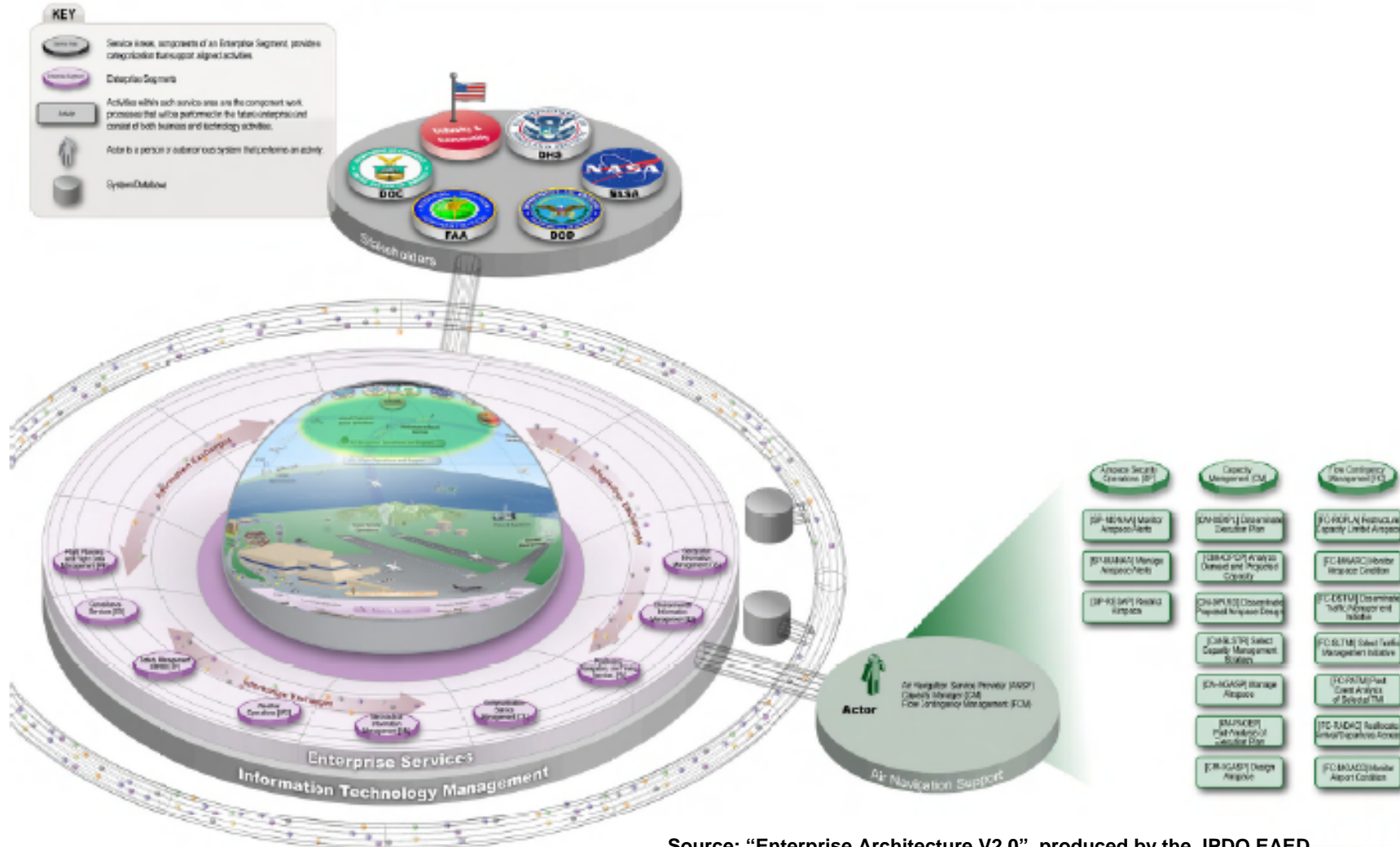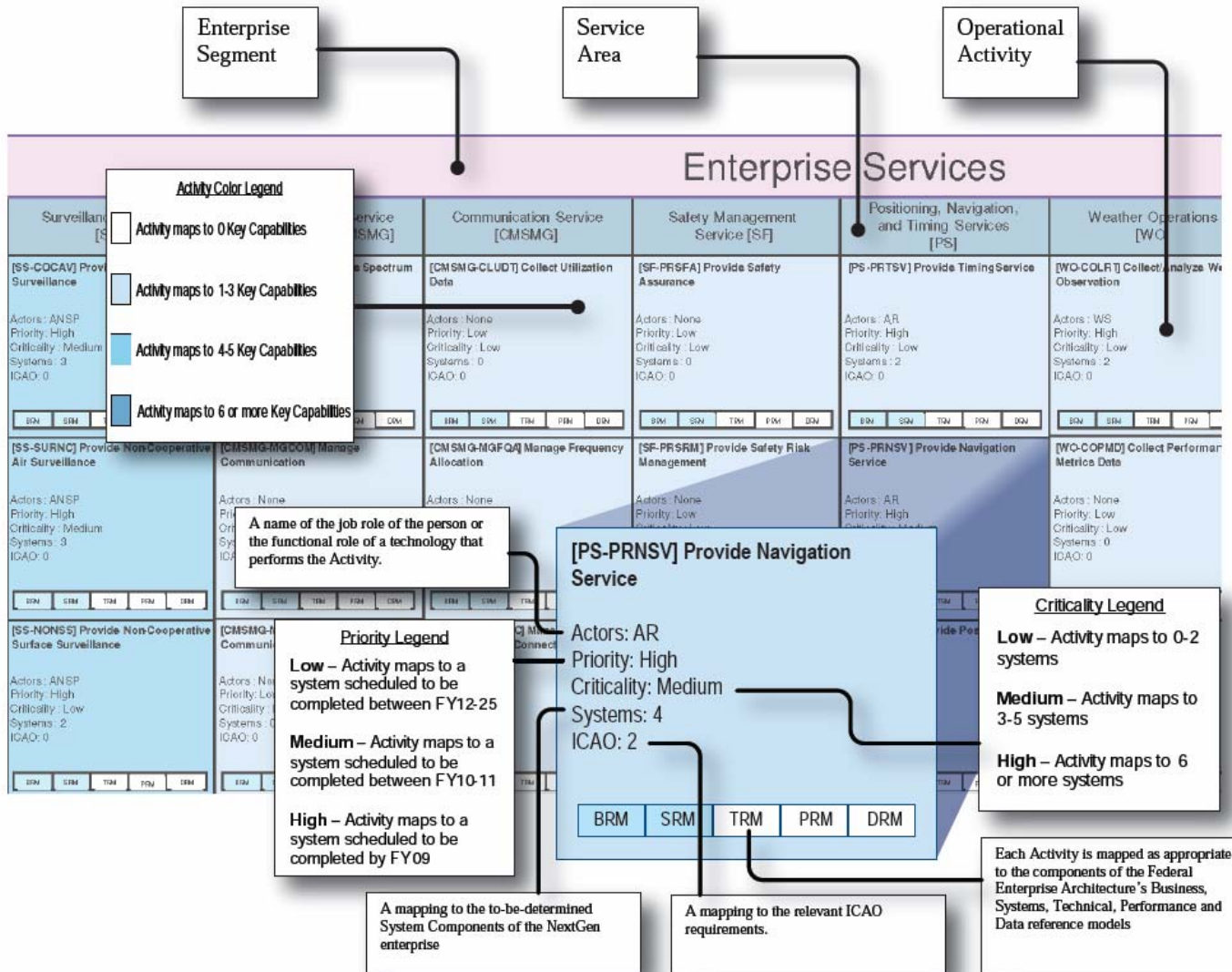
Source: "Enterprise Architecture V2.0", produced by the JPDO EAED, dated 22 June 2007.

Air Navigation Support

Flow Contingency Management [FC]	Capacity Management [CM]	Airspace Security Operations [SP]
[FC-MOACD] Monitor Airport Condition Actors: FM Priority: Low Criticality: Low Systems: 0 ICAO: 1 SFM SFM TRM PFM DFM	**[CM-DGASP] Design Airspace** Actors: CM Priority: High Criticality: Medium Systems: 4 ICAO: 2 SRM SRM TRM PRM CRM	**[SP-RESAP] Restrict Airspace** Actors: AN,SC Priority: Low Criticality: Low Systems: 0 ICAO: 1 PRM SRM TRM PRM CRM
[FC-RADAC] Reallocate Arrival/Departures Access Actors: FM Priority: Low Criticality: Low Systems: 0 ICAO: 3 SFM SFM TRM PFM DFM	**[CM-MGASP] Manage Airspace** Actors: CM Priority: High Criticality: Medium Systems: 4 ICAO: 1 SRM SRM TRM PRM CRM	**[SP-MANAA] Manage Airspace Alerts** Actors: AN,SC Priority: Low Criticality: Low Systems: 0 ICAO: 0 PRM SRM TRM PRM CRM
[FC-PATMI] Post-event analysis of selected TMI Actors: FM Priority: Low Criticality: Low Systems: 0 ICAO: 2 SFM SFM TRM PFM DFM	**[CM-PAOEP] Post-analysis of Execution Plan** Actors: CM Priority: Low Criticality: Low Systems: 0 ICAO: 1 SRM SRM TRM PRM CRM	**[SP-MONAA] Monitor Airspace Alerts** Actors: AN,SC Priority: Low Criticality: Low Systems: 0 ICAO: 0 PRM SRM TRM PRM CRM
[FC-SLTMI] Select Traffic Management Initiative Actors: FM Priority: Low Criticality: Low Systems: 0 ICAO: 1 SFM SFM TRM PFM DFM	**[CM-SLSTR] Select Capacity Management Strategy** Actors: CM Priority: Low Criticality: Low Systems: 0 ICAO: 0 SRM SRM TRM PRM CRM	
[FC-DSTMI] Disseminate Traffic Management Initiative Actors: FM Priority: Low Criticality: Low Systems: 0 ICAO: 2 SFM SFM TRM PFM DFM	**[CM-DPARD] Disseminate Proposed Airspace Design** Actors: CM Priority: Low Criticality: Low Systems: 0 ICAO: 2 SRM SRM TRM PRM CRM	
[FC-MNARC] Monitor Airspace Condition Actors: FM Priority: Low Criticality: Low Systems: 0 ICAO: 1 SFM SFM TRM PFM DFM	**[CM-DEXPL] Disseminate Execution Plan** Actors: CM Priority: Low Criticality: Low Systems: 0 ICAO: 2 SRM SRM TRM PRM CRM	
[FC-RCPLA] Restructure Capacity Limited Airspace Actors: FM Priority: Low Criticality: Low Systems: 0 ICAO: 1 SFM SFM TRM PFM DFM	**[CM-ADPCP] Analyze demand and projected capacity** Actors: CM Priority: Medium Criticality: Low Systems: 1 ICAO: 8 SRM SRM TRM PRM CRM	

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Air Navigation Support FEA RM Alignment

Figure 52: Air Navigation Support FEA RM

Air Transportation

Air Navigation Support

- Airspace Security Operations
- Capacity Management
- Flow Contingency Management

The Air Navigation Support Segment provides the short and long-term planning aspect for ensuring the safe, secure, and efficient access to the airspace. As depicted in figure 13, this segment is primarily categorized under the Air Transportation Line of Business. It describes the activities associated with the prevention and countering of external attacks on aircraft and other airborne vehicles, the planning and design of the airspace, and the monitoring of current airspace conditions to reallocate if necessary. The following table further describes the Air Navigation Support Segment and identifies how each activity aligns to the other architectural layers of the NextGen EA Reference Architecture.

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Figure 53 - 4 Air Navigation Support Activity Model Diagram

Agencies' Investments to NextGen Operational Activities (SV-5H)

Use of the OMB Federal Transition Framework (FTF) in Support of the NextGen EA

FTF As Alignment Mechanism

The FTF is a catalog of government-wide initiatives, providing agencies with an information source to support EA planning and improve the efficiency and effectiveness of investments to realize service improvements and cost savings. The JPDO envisions the NextGen ATS FTF catalog item as a mechanism for ensuring that the relevant NextGen segments and capabilities of the NextGen EA are incorporated into the JPDO partner agency's respective target architectures, transition plans, and capital planning processes.

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Benefits of Use of FTF in Support of NextGen EA Effort

- Increased partner EA agency alignment with NextGen EA
- Increased sharing and reuse of common, cross-agency business processes, service components, and technology standards
- Increased agency collaboration

Additionally, partner agencies can use the FTF as follows:

- Obtain consistent, complete, and detailed information about NextGen ATS more quickly to inform EA and capital planning efforts
- Make more informed decisions about investments
- Improve the effectiveness (i.e., performance) and efficiency (i.e., cost and schedule) of investments.

Source: "Joint Planning and Development Office – Program Management Plan V1.0 for the Enterprise Architecture and Engineering Division", produced by the JPDO EAED, dated 22 June 2007.

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Usage of FTF in Support of NextGen EA

Publish (September 07)
- FTF catalog published
- Identity relevant Cross Agency Initiatives that must be included in Agency EA

Assess (Feb/March 08)
- Agency submit EA self-assessments to OMB
- OMB reviews & assesses EA and Transition Strategy for relevant cross-agency initiatives

Verify (September 08)
- Agency FY10 budgets submitted to OMB
- OMB verifies to ensure EA Transition Strategies reflect relevant cross-agency initiatives

Architecture
- ◆ FTF Publication
- Incorporate NextGen ATS into Agency-level EA
- Self-assess Agency EA alignment with NextGen ATS
- ◆ FTF Assess

Investment
- Align Agency budget submission with agency-level EA and NextGen ATS
- ◆ Verify

Implementation
- Align relevant Agency programs and investments with NextGen ATS

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	Scenario 1 Incorporate NextGen ATS into agency-level EA	Scenario 2 Self-assess EA alignment with NextGen ATS	Scenario 3 Align agency budget submission with agency-level EA and NextGen ATS	Scenario 4 Align agency IT programs with NextGen ATS
Agency Steps	• Review FTF Catalog to determine the applicability and scope of the NextGen ATS for your agency. • Update EA Program Plan to incorporate tasks to develop or update agency EA work products. • Update target EA to reflect NextGen ATS. • Conduct gap analysis between current and target architecture to identify gaps in current implementation of the NextGen ATS. • Update EA Transition Strategy to incorporate tasks, activities, and milestones to close gaps between the current and target architecture. • Submit revised EA work products and EA Transition Strategy to OMB with annual EA assessment submission package.	• Review OMB EA Assessment Framework and instructions to define requirements for the development and submission of agency EA self-assessment materials. • Refer to FTF Catalog to define NextGen ATS requirements for integration with agency EA and the EA Transition Strategy. • Conduct self-assessment of agency EA work products, EA Transition Strategy and implementation results relative to NextGen ATS requirements and assessment guidance. • Prepare self-assessment score and submission materials for NextGen ATS and incorporate into agency EA self-assessment package. • Submit agency EA self-assessment package to OMB.	• Develop IT investment portfolio in accordance with agency policy and procedures. Portfolio should reflect programs and projects defined by the EA Transition Strategy to implement agency EA including the NextGen ATS as described in the FTF Catalog. • Select projects to be included in the IT investment portfolio in accordance with agency policy and procedures. Select factors should include alignment with agency EA including the NextGen ATS. • Submit IT investment portfolio to OMB as part of the agency budget submission.	• Conduct regular control and evaluate actions as part of the CPIC process to review the alignment of current programs with agency EA and EA Transition Strategy including the NextGen ATS. • Develop recommendations and corrective actions to re-align programs with agency guidance and the NextGen ATS as described in the FTF Catalog. • Update individual program plans to incorporate recommendations and corrective actions. • Update IT investment portfolio to reflect recommendations and corrective actions.

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Lessons Learned

Before All Else, Articulate the Goals, Objectives and Purposes of the EA and Communicate to All Stakeholders

① Know why you are building the architecture

② Decide on the architecture scope

③ Decide what information you need to include

④ Decide how you want to display the information

⑤ Build the models you need to display the information, and analyze them

⑥ Make recommendations and decisions
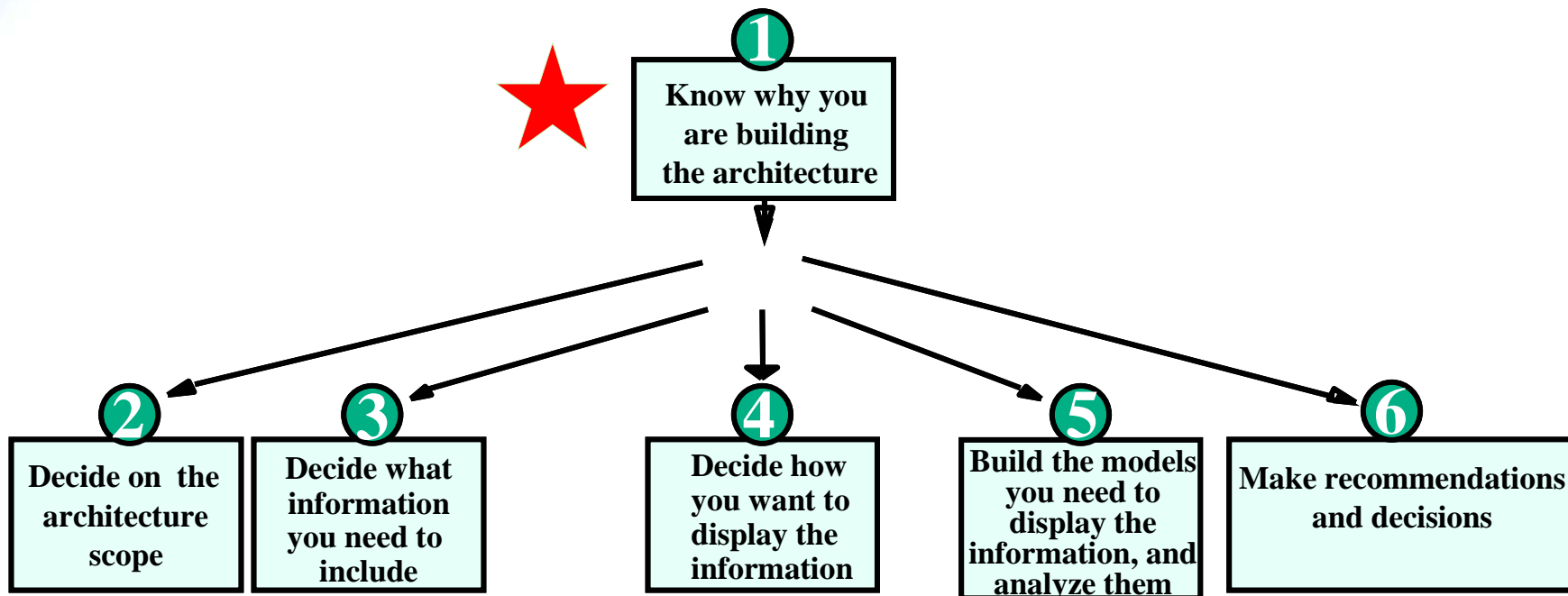
Clearly and explicitly articulate and communicate the purpose of the EA!

➢ Identify and clearly articulate the goals, objectives and purpose of the EA
➢ Articulate what issues need to be analyzed
➢ Specifically identify who needs the analysis
➢ What decisions need to made based on the analysis

Articulated and Effective Governance is the Foundation of the EA Effort

- ## Governance
  - **Defines how decisions are made, who has the authority and who is accountable**
  - **Determines or exerts guiding influence over program policy, principles, architecture, strategy, and investment and prioritization**
  - **Determines process by which stakeholders articulate their interests and their input is absorbed**

- ## Governance Framework
  - **The plan and processes that describe the authority structures, roles, and responsibilities that must be implemented to effectively govern**

An EA Program without articulated, effective governance places the entire EA program at significant risk

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Development and Use of a Communication Strategy

- **A "How to Engage" or "Rules of Engagement" Guide developed for use by external stakeholders for aligning their enterprise life cycle processes and EA related activities. This guidance would be a communication vehicle that would articulate:**

  - **The enterprise life cycle and schedule of the JPDO as it relates to the development and release of the EA, budget and R&D guidance.**
  - **The pertinent roles, bodies and associated governance structures that stakeholders will need to be cognizant of and interact with on an on-going basis.**

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Additional Lessons Learned

- **A substantive, explicitly articulated and meaningful Operational Concept Graphic (OV-1) is critical**
- **Issue of Utility – the importance of the Overview and Summary (AV-1)**
  - **Significant challenge faced by architects is the issue of utility of the EA**
    - **Identifying the communities who need the EA**
    - **Ensuring the info is in the proper form to be of use**
- **Federation DMZ**
  - **Need flexibility to manage multiple practices and levels of maturity i.e., need a DMZ**
- **Relating the EA to decision making**
  - **Coordinating Federal and Industry Business Case Practices**
- **Closing the Design**
  - **Issue of how to cope with long planning horizon i.e., target = 2025…**

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Summary

Summary

- **NextGen is complex system with many public and private stakeholders that must smoothly, promptly, and capably integrate with the changes in the global air transportation system.**
- **EA is the foundation and means for articulating the vision and successfully integrating the activities of these diverse stakeholders in achieving NextGen**

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Questions

Backup

An Enterprise Level Focus on NextGen

- **Transformation of the Nation's Air Transportation System requires:**
  - New policies **to create the right relationships and behaviors,**
  - Modernization **of infrastructure to reduce cost and set the stage for a new level of performance, and**
  - R&D **to create new functionality and capability that takes advantage of a modernized infrastructure**
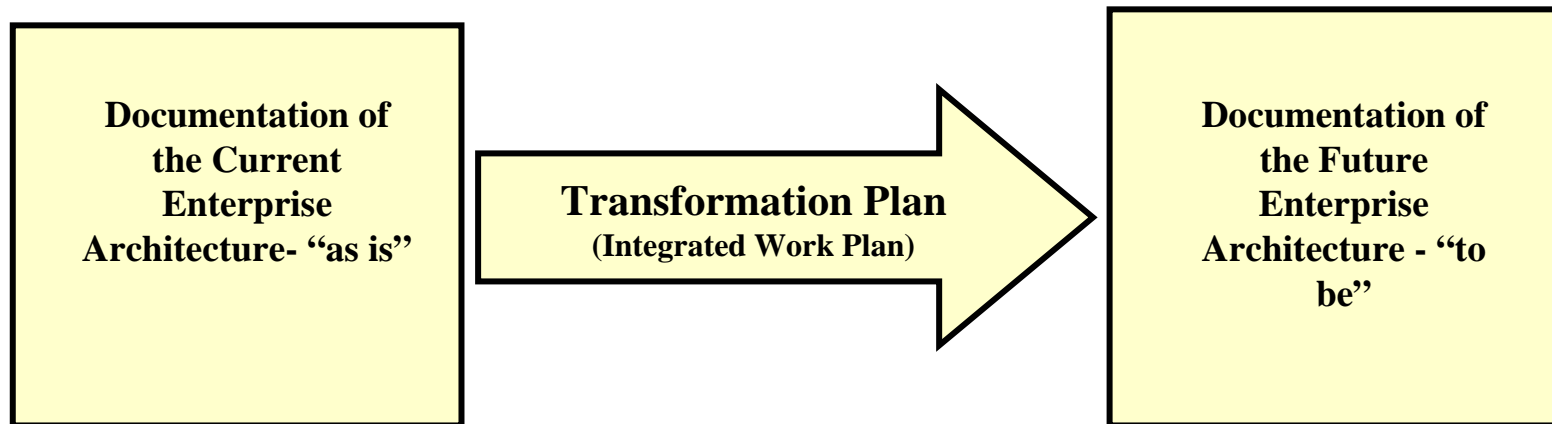 - **Engagement of** multiple entities **both public and private**

> **Enterprise Architecture provides the holistic structure to manage the transformation of the National Air Transportation System**

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How will we use Enterprise Architecture?

- **Enterprise Architecture as a** documentation method **provides a modeling** framework **for the enterprise**

Documentation of the Current Enterprise Architecture- "as is"	**Transformation Plan** (Integrated Work Plan) →	Documentation of the Future Enterprise Architecture - "to be"

- **Enterprise Architecture enables** effective management **of NGATS planning and development by:**
  - **Supporting** change management **at the various levels**
  - **Identifying** integrated decisions **leading to requirements, agency commitments, and ultimately to** synchronized investments **to deliver the NGATS**
  - **Tracing** key dependencies **between capabilities, policies, operations, organizations, systems, and technologies**

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Use of OMB FEA Reference Models in Support of NextGen EA