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**COMPLIANCE IS MANDATORY**

**NPR 2830.1**  
Effective Date: February 09,  
2006  
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2011

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## NASA Enterprise Architecture Procedures

**Responsible Office: Office of the Chief Information Officer**

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# Preface

## P.1 Purpose

The purpose of Enterprise Architecture (EA) is to inform and optimize the information technology (IT) investment decision process and, therefore, maximize the contribution of IT to Agency success. Effective EA management shall ensure that IT expenditures are aligned with Center, Mission Directorate, and Agency goals while reducing unnecessary duplication of both material expenditures and efforts. EA shall also provide a vision of the future state of new capabilities that will allow detailed planning to occur in conjunction with Agency and Federal Government-level initiatives and mandates.

EA leverages existing, required project management work products and harnesses them so they can be leveraged by the entire Agency. EA is both a source and a consumer of project management artifacts and, therefore, forms an information bridge and repository between the enterprise current state and future state. This document defines the management body of work required to construct and populate the EA and define the role the EA will fulfill in decision support. Finally, EA is a Federal-level mandate with associated reporting requirements. Data collection efforts will support and leverage these reporting requirements as well.

## P.2 Applicability

This NPR is applicable to NASA Headquarters and NASA Centers, including Component Facilities.

## P.3 Authority

- a. 40 U.S.C. §§ 11101 et seq., Clinger-Cohen Act of 1996, also known as the Information Technology Management Reform Act, as amended.
- b. 5 U.S.C. § 552a, Privacy Act of 1974, as amended.
- c. 29 U.S.C. § 794(d), Rehabilitation Act of 1973, as amended.
- d. 31 U.S.C. §§ 501 et seq., Chief Financial Officers Act of 1990, as amended.
- e. 40 U.S.C. § 11331, Computer Security Act of 1987: Responsibilities for Federal Information Systems Standards, as amended.
- f. 31 U.S.C. §§ 1101 et seq., Government Performance and Results Act of 1993, as amended.
- g. 41 U.S.C. § 251, Federal Acquisition Streamlining Act of 1994, as amended.
- h. 44 U.S.C. §§ 101 et seq. and 44 U.S.C. §§ 3501 et seq., Paperwork Reduction Act of 1995, as amended.

- i. 44 U.S.C. §§ 3601 et seq., E-Government Act of 2002: Management and Promotion of Electronic Government Services, as amended.
- j. 44 U.S.C. § 3504, Government Paperwork Elimination Act of 1998, as amended.
- k. 40 U.S.C § 11311, Federal Information Security Management Act (FISMA) of 2002: Responsibilities for Acquisitions of Information Technology, as amended.

## **P.4 References**

- a. NPD 1000.0, Strategic Management and Governance Handbook (2005).
- b. NPD 2810.1, Security of Information Technology.
- c. NPD 2820.1, NASA Software Policies.
- d. NPD 2830.1, NASA Enterprise Architecture.
- e. NPD 4200.1, Equipment Management.
- f. NPD 7120.4, Program/Project Management (Revalidated for one year 12/6/04), (cited as a resource).
- g. NPD 8831.1, Maintenance of Institutional and Program Facilities and Related Equipment.
- h. NPR 2810.1, Security of Information Technology.
- i. NPR 4200.1, NASA Equipment Management Manual.
- j. NPR 4200.2, Equipment Management Manual for Property Custodians.
- k. NPR 7120.5, NASA Program and Project Management Processes and Requirements.
- l. NPR 7150.2, NASA Software Engineering Requirements.
- m. NPR 8831.2, Facilities Maintenance Management.
- n. NASA-STD-8739.8, Software Assurance Standard.
- o. NASA-STD-2202-93, Software Formal Inspection Process Standard.
- p. NASA-STD-2804, Minimum Interoperability Software Suite.
- q. NASA-STD-2805, Minimum Hardware Configurations.
- r. NASA-STD-2814, Technical Architecture ? Volume 1 (June 27, 2000).
- s. NASA-STD-2814, Considerations for Agency-Wide and Inter-Center Deployment of IT Services and Applications - Volume 2 (June 27, 2000).
- t. National Institute of Standards and Technology (NIST) Specific Publications 800 Series (cited as a resource).
- u. NASA Enterprise Architecture Version 4.0 Documentation.
  - (1) EA Volume 1: Strategy and Overview (September 2005).
  - (2) EA Volume 2: Agency Business Overview (September 2005).

(3) EA Volume 3: Office Automation, IT Infrastructure, and Telecommunications Investment (September 2005).

(4) EA Volume 4: Program Unique IT and Multi-Program/Project IT Investment Category (September 2005).

v. NASA Information Technology Capital Planning and Investment Control Process (CPIC) (September 2004).

w. OMB No. A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs.

x. OMB Circular No. A-123, Management Accountability and Control (June 21, 1995).

y. OMB Circular No. A-130, Appendix III Management of Federal Information Resources (November 28, 2000).

z. OMB Circular No. A-11, Preparation, Submission and Execution of the Budget (Revised November 2, 2005).

aa. OMB 97-02, Funding Information Systems Investments.

ab. President's Management Agenda of 2002.

ac. SP 610S NASA Systems Engineering Handbook (1995) (cited as a resource).

ad. IEM Integration Project Risk Management Plan (cited as a resource).

## **P.5 Cancellation**

None.

/s/

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Chief Information Officer

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# CHAPTER 1: Scope

## 1.1 Scope

1.1.1 The NASA Policy Requirements (NPR) 2830.1 outlines and defines the specific tasks and activities that must be performed under the NPD 2830.1 authority. This NPR provides instruction for EA reviews to examine and quantify the Cost/Benefit Analysis (CBA) and benefits to the Agency for IT investments.

1.1.2 This document focuses on required Enterprise Architecture (EA) processes, products, roles, and responsibilities. While this NPR broadly addresses the entire enterprise life cycle, it describes how EA processes relate to enterprise engineering, program management, and the capital planning and investment control processes. The extent of the EA collection effort is proportional to the cost and impact of a new project and subject to the EA inclusion criteria as described in Chapter 7. This NPR addresses systems at all levels of maturity, including significant technical or budget cycle changes. The NASA Chief Information Officer (CIO), via an appointed Chief Enterprise Architect (CEA), shall disseminate and/or make available the contents of the NASA EA. Personnel responsible for IT planning, development, and implementation shall periodically review the NASA EA to ensure that their IT projects are in compliance with the EA and that it supports the strategic goals of the Agency.

a. All IT initiatives and services shall comply with the approved NASA EA. The CEA has instituted criteria and processes to review adherence of NASA IT initiatives and services to the NASA EA. The NASA CIO maintains oversight responsibility for all IT investments in the Agency, which are classified in three distinct categories:

(1) Office Automation and Infrastructure Technology (OAIT) - Core IT services provided across the NASA community (e.g., desktop computing, telecommunications).

(2) Multi-Program/Project - IT services used to support multiple projects within a given Mission Directorate (e.g., The NASA Columbia Supercomputing Facility, systems typically containing primarily Class F software as defined in NPR 7150.2).

(3) Program/Project-Unique - IT services to provide IT and data management services for a particular mission. These are generally funded at the mission project level and are managed as a project work element.

b. The NASA CIO has delegated NASA EA reporting and review responsibilities as follows:

(1) Office Automation and Infrastructure Technology (OAIT) - The Office of the CIO assigned program managers are responsible for providing semiannual updates to the NASA EA and for conducting EA project reviews and service reviews.

(2) Multi-Program/Project - The Mission Directorate program managers and Mission Directorate CIOs are responsible for providing semiannual updates to the NASA EA and for determining if EA project reviews or annual service reviews are required in accordance with NASA Policy.

(3) Program/Project Unique - The Mission Directorate program managers and Mission Directorate CIOs are responsible for providing semiannual updates to the NASA EA and for determining if EA project reviews are required in accordance with NASA Policy.



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# CHAPTER 2: Background

## 2.1 Background

2.1.1 Executive Order 13011, Federal Information Technology, implements the Information Technology Management Reform Act (ITMRA) of 1996, also known as the Clinger-Cohen Act. The Clinger-Cohen Act assigns the responsibility for "developing, maintaining, and facilitating the implementation of sound and integrated IT architectures for agencies" to Chief Information Officers. EA is one strategy that NASA uses to ensure compliance with the eight major information systems criteria defined under the Clinger-Cohen Act, which are to:

- a. Support core/priority enterprise mission functions.
- b. Manage investments.
- c. Simplify or redesign work processes to reduce costs and improve effectiveness.
- d. Demonstrate a positive return on investment.
- e. Ensure that proposed systems are consistent with the Agency's EA.
- f. Reduce risks.
- g. Implement projects in successive phases.
- h. Employ an IT acquisition strategy.

2.1.2 The President's Management Agenda (PMA), issued in 2001, is an explicit effort to address five key aspects of Federal Agency management. EA helps ensure that NASA's investments remain citizen-centered, not bureaucracy-centered, results-driven, and market based, actively promoting rather than stifling innovation through competition. The five areas are:

- a. Budget and Performance Integration - Link budget resources to program results; then use program performance information to make better budget and management decisions.
- b. Strategic Management of Human Capital - Maximize the value of each Agency's most important resource, its workforce.
- c. Competitive Sourcing - Regularly examine commercial activities the Government performs to determine if it is more efficient to have Federal employees or an outside contractor perform them.
- d. Improved Financial Performance - Provide managers with timely, meaningful, consistent, and useful financial data.
- e. Expanded Electronic Government - Manage information technology resources better and use Electronic Government (e-Government) to improve service delivery.

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# CHAPTER 3: Program Purpose and Benefits

## 3.1 EA Program Goals

3.1.1 EA is a strategic information asset that identifies the Lines of Business (LoB) for the Agency; the services in support of the LoB; the information, technologies, and systems necessary to create and perform the services; and the transitional processes for implementing new services, technologies, or systems in response to the changing needs of the Agency mission (LoB). The goal is to maintain the EA as the primary authoritative resource for IT planning and execution. This goal will be met through the value and utility of the information provided by EA products developed and maintained under the procedures defined in this NPR.

## 3.2 EA Offers Tangible Benefits

3.2.1 Listed below are the major benefits from an effective EA Program. A more comprehensive description of benefits for CIOs, business offices, and program and project managers is available in NASA Enterprise Architecture Volume 1: Strategy and Overview.

### a. Financial

- (1) Promote effective budgetary planning.
- (2) Guide the investment process (OMB 300 Reporting, CPIC).
- (3) Manage Service Level Agreements. (4) Reduce time of delivery.
- (5) Reduce support costs.
- (6) Lower acquisition costs.

### b. Technology

- (1) Promote strategic use of emerging technologies.
- (2) Improve interoperability.
- (3) Leverage existing systems more effectively.
- (4) Assist in the planning of decommissioning outdated technologies.

### c. Processes

- (1) Improve software and hardware development time.
- (2) Focus on unique requirements and share common requirements.
- (3) Guide the investment process (OMB 300 Reporting, CPIC).

(4) Enhance mission success.

d. Knowledge Capture

(1) Provides a list of current Agency-wide Projects.

(2) Provides a common view of the Enterprise Architecture.

(3) Provides a communication forum to vet requirements.

### 3.3 Guiding Principles

3.3.1 The EA Program will confirm that a proposed or ongoing IT project or service follows a set of guiding principles. Guiding principles document the fundamental concepts and guiding themes for the entire EA initiative and provide guidance to assure that common goals exist and a unified message is communicated. Ideally, every action taken in EA should be compared to the following guiding principles:

a. Customer Driven Solutions that Enable Business Achievement. Customer outreach is performed through capital planning and investment control to assure current and future investments are aligned with NASA's Enterprise Architecture and help achieve NASA's business goals.

(1) **Customer Focused.** EA is an enabling strategic tool to facilitate mission accomplishment and create an environment that strives to be competitive in providing services to our customers. Operational processing is balanced with decision support needs, resulting in an optimized system supporting the business process.

(2) **Ownership.** Systems should have a clear, recognized business owner and a clear, recognized IT owner. The business owner has functional responsibility for assuring the system meets the program or project goals. The IT owner has responsibility for the operational, technical day-to-day service.

(3) **Collaboration.** EA must enable and promote collaboration among NASA organizational elements, partners, vendors, contractors, and external elements. EA supports the sharing of resources and costs while creating economies of scale.

b. Maintain an Adaptable Infrastructure. NASA's infrastructure must be dynamic yet secure, evolving from the current 'As-Is' state to a future 'To-Be' state that uses reference architectures to incorporate emerging technologies when appropriate and plan for end of life cycle systems. An adaptable infrastructure also promotes the reuse of viable existing systems, which reduces overall complexity and redundancy.

(1) **Interoperable, Extensible, and Open Systems.** EA must interoperate within, between, and across all NASA organizational elements, business partners, vendors, contractors, partners, and external elements.

(2) **IT Security.** NASA must comply with all applicable IT security requirements as delineated in NPD 2810.1.

(3) **Smallest Set of Systems that Fully Cover Agency Requirements.** EA constantly strives to reduce complexity and minimize redundancy.

(4) **Bind Technology at the Last Possible Moment.** Solutions are based on business requirements, not technology. Selecting the technology at the last possible moment assures use of the latest technology.

(5) **Commonality.** Systems should be common across organizational units and geographies where such commonality enhances the NASA mission. Global solutions should apply where business processes related to the solution are common across all organizational units and geographies in NASA.

c. Information is a Strategic Agency Asset. Quality information is necessary for informed investment decisions and planning. Models and metrics define the architecture to facilitate information sharing across the Agency to enhance and accelerate decisionmaking. EA promotes Agency-wide data standardization, reuse, interoperability, and information management within NASA, across the Federal Government, and with industry partners.

(1) **Information Management.** EA is proactive in sharing knowledge and information as a strategic asset. The requirement for data integrity, high-availability, reliability, and confidentiality is mandatory. EA supports anytime, anywhere information access in a secure environment and captures data once at the atomic (root or end) site.

(2) **Develop Conceptual Models to Facilitate Discussions.** NASA EA and the Federal Enterprise Architecture (FEA) encompass information, concepts, and models ranging from the top-level strategic vision to the detailed implementation of specific technologies.

(3) **Include Appropriate Performance Metrics.** As an integral part of the NASA Program/Project Management Process in all architectural and investment decisions, NASA will always address the key metric considerations.

d. Best Investment Value for the Agency. EA enables NASA to help meet its priorities while achieving spending restraint and accountability for investment decisions. Investments must be economically and technically achievable, reusable where practical to support the Agency's strategic goals, and provide the greatest benefit to the largest possible user community.

(1) **Economically and Technically Achievable.** The operational EA functions must be constructed recognizing that constrained resources and prudent management call for the utilization of technically proven and cost-effective solutions.

(2) **Leverage Existing Investments.** If a commercial or Government created product already exists and would fulfill the majority of requirements (i.e., 70-80%) imposed on a design, it must be considered before moving ahead on a custom development. All efforts should use existing investments wherever possible.

(3) **Focus on the "Big Picture."** NASA EA will focus on the Agency's strategic direction or the "Big Picture." This will support top-level investment and program-level decisionmaking. Management will prioritize investments through business case analysis.

(4) **Greatest Cost/Benefit.** NASA must use the solution that fully solves the business requirements, demonstrates the best value, and provides the lowest life-cycle cost.

## 3.4 Best Practices

3.4.1 For the EA Program to be successful, project managers must follow the NPR 7120.5 requirements and follow project management Best Practices found in Appendix D.

# CHAPTER 4: Definitions

## 4.1 Definitions

4.1.1 EA terminology carries many variations within each organization and in the vast array of literature. NASA has identified one consistent set of definitions for key terms used in its EA in Figure 1.

Term	Definition
Application Architecture	Describes how NASA information systems should be designed, how they cooperate with each other, and factors to consider in their deployment. It also serves as the focal point for an application systems inventory for NASA.
Architecture	The structure of components, their interrelationships, and the principles and guidelines governing their design and evolution over time.
Baseline Architecture (or Current Architecture)	The set of products that portray the existing enterprise, the current business practices, and technical infrastructure. Commonly referred to as the "As-Is" architecture.
Business Architecture	Defines what, where, and by whom the work of the Agency is performed. As the knowledge base for the EA, the Business Architecture provides a business-driven approach for determining the proper information, applications, and IT required by the enterprise.
Business Reference Model (BRM)	Provides a hierarchical structure for the business operations of the Federal Government. The BRM identifies four business areas that provide a high-level view of the operations the Government performs. The four areas are: (1)

	Services for Citizens, (2) Mode of Delivery, (3) Support Delivery of Services, and (4) Management of Government Resources.
Data Architecture	Provides an understanding of what information is needed to effectively execute the enterprise's business processes and provides a framework for effectively managing the enterprise's information environment. Data Architecture links information behavior (i.e., accessing, using, and sharing data), information management processes, and information support staff to other aspects of the enterprise.
Data Reference Model (DRM)	Describes the data and information that support programs and lines of business operations. Aids in describing the types of interaction and exchanges that occur between the Agency and its various customers, constituencies, and business partners. The DRM categorizes information into content areas, establishes a commonly understood classification for Federal data, and streamlines processes associated with information exchange both within the Agency and between the Government and its external stakeholders. The DRM will help to identify duplicative data resources.
EA Products	The graphics, models, and/or narrative that depicts the enterprise environment and design.
Enterprise	An organization or cross-organizational entity supporting a defined business scope and mission. An enterprise includes interdependent resources (i.e., people, organizations, and IT) that must coordinate their functions and share information in support of a common mission or set of related missions.
Enterprise Architecture (EA)	From NPR 7120.5: Enterprise Architecture - An explicit description and documentation of the current and desired relationships among business and management processes and information technology. An Enterprise Architecture includes principles, an architecture framework, a technical standards profile, current and target architectures, and a transition strategy to move from the current to target architecture.



Information Technology (IT)	FAR 2.101 Definition: Information Technology (IT) means any equipment or interconnected system(s) or subsystem(s) of equipment that is used in the automatic acquisition, storage, analysis, evaluation, manipulation, management, movement, control, display, switching, interchange, transmission, or reception of data or information by the Agency.?
Reference Architecture	A reference architecture is a graphically represented, high-level system overview that is intentionally free of implementation details. It generally includes high-level descriptions of the system components, a definition of relationships between components, definitions of relationships between system components and elements external to the system, and identification of performance drivers and capacity requirements. Where applicable, a reference architecture also provides high-level definitions of key data sources, data stores produced, and interfaces between the system components.
Sequencing Plan	A document that defines the strategy for changing the enterprise from the current baseline to the target architecture. It schedules multiple, concurrent, interdependent activities, and incremental builds that will evolve the enterprise.
Service Reference Model (SRM)	A business and performance-driven, functional framework that classifies service components with respect to how they support business and/or performance objectives. The SRM is intended to support the discovery of Agency-wide business and application service components in IT investments and assets. The SRM is structured across horizontal and vertical service domains that, independent of the business functions, can provide a foundation to support the reuse of applications, application capabilities, components, and business services.
Technology Architecture	The bottom layer in the architectural hierarchy and is considered the foundation upon which all the other IT architectures are built. The architecture or design of the technology is driven by business needs communicated by the design of the three higher architectural layers (Business Architecture, Data Architecture, and Application

	Architecture).
Technical Reference Model (TRM)	Identifies and describes the technical services used throughout the Agency. The TRM is a high-level view of the NASA service areas and how they are related to the general technology layers. It describes the inter-relationship between the services and the user environment, applications, integration, data, and common infrastructure. The TRM is also used for communicating technology component elements such as policies, standards, and product recommendations.
System Development Life Cycle (SDLC)	The scope of activities associated with a system, encompassing the system's initiation, development and acquisition, implementation, operation and maintenance, and ultimately its disposal that instigates another system initiation.

Figure 1



# CHAPTER 5: Enterprise Architecture (EA) Requirements

## 5.1 EA Goals and Objectives

5.1.1 EA is a strategic information asset that identifies the Lines of Business (LoB) for the Agency; the services in support of the LoB; the information, technologies, and systems necessary to create and perform the services; and the transitional processes for implementing new services, technologies, or systems in response to the changing needs of the Agency's mission LoB. The goal is to maintain the EA as the primary authoritative resource for IT planning and execution. This goal will be met through the value and utility of the information provided by EA products developed and maintained under the procedures defined in this NPR. The Chief Enterprise Architect (CEA) or designee will make information contained within the EA Repository available to NASA staff for use in evaluating and planning for IT investments. Personnel responsible for IT planning, development, and implementation shall periodically review the EA to ensure that their IT projects are in compliance with the Enterprise Architecture and support the strategic goals of the Agency.

5.1.2 EA largely leverages existing, required project management work products and harnesses them so they can be leveraged by the entire Agency. EA is both a source and a consumer of project management artifacts and, therefore, forms an information bridge and repository between the Enterprise current state and future state. EA-required data elements are the normal products of data generated during the phases of IT system life cycle development. The typical project life cycle incorporating EA activities is shown in Figure 2. In principal, EA products are typically developed in the formulation or initiation stage of a project. Services are subject to EA Review at any time in their life cycle. Projects may also undergo directed reviews at any point in their life cycle. This is presented in greater detail in Chapter 7.

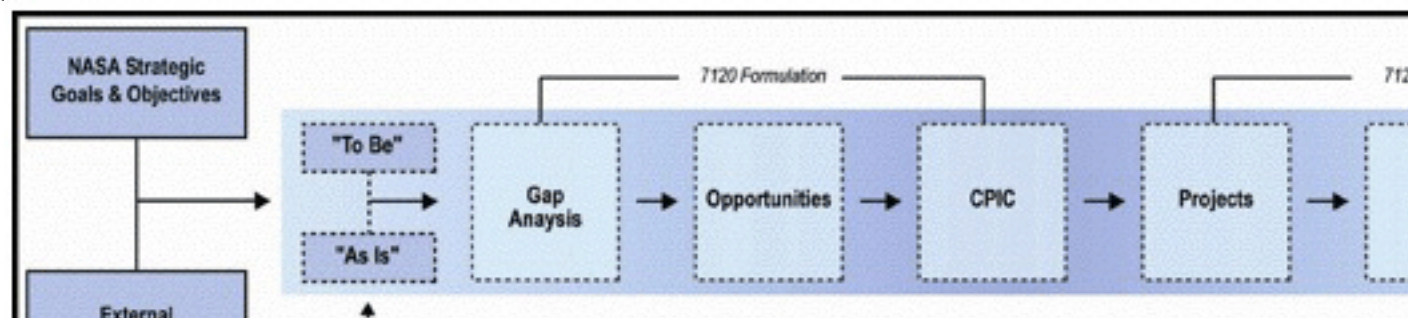


Figure 2

5.1.3 The inclusion of EA information in the above process cycle indicates the importance of 'As-Is' and 'To-Be' data for NPR 7120.5 formulation activities. Project Managers shall consult the EA Repository in the initiation phase to determine the minimum amount of work and expenditure necessary to accomplish the IT mission or goal. This is accomplished through a gap analysis between the current state and the desired state. The opportunities identified by the gap analysis activity are documented in a business case analysis. This analysis is then submitted to the Capital

Planning and Investment Control (PIC) process for review and approval. The approved project follows its detailed technical planning, execution, and completion phases. As these phases are completed, various management by-products must be generated, and information in the EA Repository must be updated to assure the repository maintains the most current information about NASA's IT investments (see section 5.2 below). The new project updates the EA "As-Is" state or the "To-Be" state, if the project significantly changes NASA's technology direction.

5.1.4 To achieve the benefits of having a well-documented EA, a number of information requirements must be met to support both internal NASA planning activities and delivery of the Office of Management and Budget (OMB) and Government Accountability Office (GAO) mandated reporting requirements. Both OMB and GAO require the submission of annual reporting assessments that determine the growth in NASA's EA Program maturity against their respective measurement models. The information requirements levied on the system will be commensurate with the system's maturity, size, cost, and contemplated change impacts.

## 5.2 Project Management Artifacts List and Submission Requirements

5.2.1 Project artifacts (i.e., objects or processes resulting from project activity) are required to support a well documented EA for a specific project or for a service portfolio. These artifacts should not be new to any project or service currently following existing NPRs. Project artifacts:

- a. Are already required by other existing NPRs. This NPR is not intended to, nor does it call for, change to those existing requirements.
- b. Are specifically related to what shall be reported to the EA Repository.
- c. Include program and project management documentation typically required and created throughout the project management life cycle.
- d. Include information required by OMB reporting processes.

5.2.2 Each of the following requirements will identify primary documents, which are required to supply EA information for either a specific project or a services portfolio. Some of the requirements will also identify supporting documents, which can provide additional instruction and/or rationale for certain requested artifacts. The requirements are:

### 5.2.2.1 Requirement 1: Project Management Artifact Submission Requirements

a. Primary Documents for projects and services portfolios:

(1) NPR 7120.5 compliant project plan or its equivalent, including the documentation from the system readiness review (SRR), preliminary design review (PDR), critical design review (CDR), and operational readiness review (ORR) presentations.

(2) NPR 7150.2 compliant software plans or their equivalent.

(3) NPR 2810.1 compliant Agency Master Security Plan as defined by the OCIO standard operating procedure (SOP), System Security Plan Template, or its equivalent.

b. Supporting Documents:

(1) NASA NPR-7150.2, Compliant Software Documentation or its equivalent.

c. Project management artifact documents shall be submitted to the CEA or designee by the Program

or Project Manager. The CEA or designee shall enter the documents into the EA Repository.

#### 5.2.2.2 Requirement 2: OMB Reporting Submission Requirements

a. Submission of the OMB 300 for incorporation into the EA, with emphasis on current state and future state descriptions, will ensure consistency between the OMB 300 submission and the EA submission to OMB in both breadth and depth. OMB 300 currently asks for both a description of the program/project and a series of performance measures and milestones. This data usually can be arranged by current state and future state along with a gap analysis and transition plan. This information will help map and define the overall future state of the EA and provide other NASA developers with the ability to leverage any designs or engineering performed under the program/project.

b. Primary Documents:

- (1) OMB 300's Capital Asset Plan.
- (2) OMB 300's Business Case or equivalent.

c. Supporting Documents:

- (1) OMB Circular A-11. (Defines OMB 300's reporting guidelines).
- (2) OMB Circular A-130. (Reference for using the CPIC Process).
- (3) Capital Planning Investment Control (CPIC). (Reference for Business Case Development and Capital Asset Plan.)

d. The OMB documents shall be submitted to the CEA or designee by the Program or Project Manager. The CEA or designee shall enter the documents into the EA Repository.

#### 5.2.2.3 Requirement 3: FEA Reference Model Classification Submission

- a. a. Complete a mapping to the Federal Enterprise Architecture (FEA). The FEA consists of a set of interrelated reference models designed to facilitate cross-Agency analysis and the identification of duplicative investments, gaps, and opportunities for collaboration within and across Federal agencies.

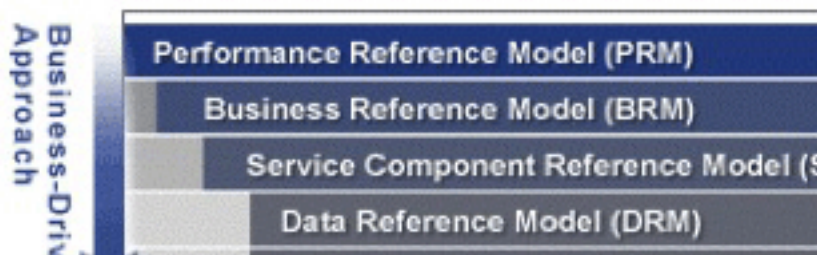


Figure 3

OMB also requires this data during the annual EA audit.

b. Primary Document:

- (1) Federal Enterprise Architecture (FEA) Reference Model Classifications: Mappings to the FEA, BRM, SRM, TRM, DRM.

c. These documents shall be submitted to the CEA or designee by the Program or Project Manager. The CEA or designee shall enter the documents into the EA Repository.

#### 5.2.2.4 Requirement 4: NPR 7120.5, Program and Project Management Document Submission Requirements

- a. The program and project plans detail the approach and plans for formulating, approving, planning, implementing, and evaluating programs and projects. This ensures that the Agency and all supporting organizations understand the programmatic, technical, and management system requirements and commit to providing the necessary resources. NPR 7120.5 also requires the capture of knowledge and the commercialization of technology, where applicable. The knowledge capture component directly supports the EA initiative as it applies to IT.
- b. The CEA will designate specific programs and/or projects for which documentation shall be submitted.
- c. The combined collection of NPR 7120.5 plans, which will:
  - (1) Allow assessment of initial designs against the baseline architecture.
  - (2) Allow assessment of EA inventories for reusable assets.
  - (3) Allow assessment of EA inventories for reusable designs.
  - (4) Permit leveraging of existing talent and prior knowledge work across the Agency to reduce duplicative development work.
  - (5) Provide data to generate initial designs in a cognizant, contextual manner.
  - (6) Allow the development of initial designs that align with the ?As-Is? or ?To-Be? architecture.
  - (7) Promote standardization.
- d. These documents shall be submitted to the CEA or designee by the Program or Project Manager. The CEA or designee shall enter the documents into the EA Repository.

#### 5.2.2.5 Requirement 5: NPR 7150.2, Software Engineering Documentation Submission Requirements

- a. NASA makes significant investments in software engineering to support the Agency's product lines. NASA must ensure that programs, projects, systems, and subordinate systems that utilize software follow a basic set of requirements. Software engineering is the application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software. With much of the cost of developing systems tied to software development, it is important that any significant work performed be leveraged to the maximum extent possible through incorporation into the EA.
- b. Primary Documents:
  - (1) Documentation that is required for compliance with NPR 7150.2.
  - (2) The Agency CIO/CEA will designate specific software projects for which this documentation shall be submitted.
- c. The documents shall be submitted to the CEA or designee by the Program or Project Manager. The CEA or designee shall enter the documents into the EA Repository.

#### 5.2.2.6 Requirement 6: NPR 7150.2, Software Documentation Standard Documentation Submission

- a. NPR 7150.2, Chapter 5, is designed to support the documentation of all software developed for NASA. IT provides a framework and model for recording the essential information needed

throughout the life cycle development and maintenance of a software system.

b. The project manager must ensure compliance with NASA NPR 7150.2 by tailoring project software to a minimum set and by ensuring that the resulting documentation meets the following criteria:

- (1) The documentation goals of the project are adequately satisfied.
- (2) Clear descriptions of the software management, engineering, and assurance processes and products are provided.
- (3) Consistency of format across the project documentation is achieved.
- (4) Traceability to the untailed standard is maintained.
- (5) Traceability between products of each phase of the development life cycle is maintained.
- (6) Specified information is captured and retained during the development effort and, therefore, is crucial to determining the updated "As-Is" state of the EA.

c. The documents shall be submitted to the CEA or designee by the Program or Project Manager. The CEA or designee shall enter the documents into the EA Repository.

d. Projects started after September 27, 2004, shall use the software documentation requirements of NPR 7150.2, Chapter 5.

#### 5.2.2.7 Requirement 7: CPIC -- Mission Directorate/Mission Support Office/Center IT CPIC Result Submission

a. The NASA Integrated IT CPIC process is an integrated approach to managing IT through continuous identification, selection, control, life cycle management, and evaluation of NASA's entire IT investment portfolio. The CPIC process ensures that all IT capital investments are aligned with the Agency's mission, EA, and business needs, while balancing risk and return throughout each investment's life cycle.

b. Primary Document:

(1) The Investment Portfolio. Follow the instructions in Appendix C, Investment Portfolio Requirements.

c. The documents shall be submitted to the CEA or designee by the Program or Project Manager. The CEA or designee shall enter the documents into the EA Repository.

#### 5.2.2.8 Requirement 8: Compliant IT Security Plan Submission Requirements

a. All IT master systems and their subordinate systems must have complete security plans in place following the Agency CIO SOP, Information Technology System Security Plan. The master and subordinate systems must be fully certified, accredited, and have an authorization to operate. This can be accomplished by compliance with the requirements set forth in NPR 2810.1, Security for Information Technology and NIST SP 800-37, Guide for the Security Certification and Accreditation of Federal Information Systems.

b. The Agency Deputy CIO for IT Security shall collect and make available IT security system plans and information for inclusion in the NASA EA Repository. The accumulation in the EA Repository of security plans will provide a valuable resource that can be leveraged for the new system developments or modifications.



c. Security plans with sensitive information, which must be protected appropriately, shall be stored in the single authoritative source for security plans. The EA Repository shall have a reference that indicates where the security information can be obtained.

d. Primary Document:

(1) The completed Executive Summary for Master System Security Plans, as defined in the Agency CIO SOP, Information Technology System Security Plan.

e. For EA reviews, the documents shall be submitted to the CEA or designee by the Program or Project Manager. The CEA or designee shall enter the documents into the EA Repository.

5.2.2.9 Requirement 9: Certification of compliance with NASA's EA "To-Be" state

a. IT investments will be classified according to whether they are a new capability to be developed, which will undergo a project review, or are a continuing investment for an ongoing service, which will undergo a service review. The specific reviews and products vary slightly and are described separately in Chapter 6.

b. All IT investments shall be certified for compliance with the NASA EA, in particular, compliance with the EA "To-Be" state. This certification will take one of three paths depending upon the owning investment portfolio and whether the investment is a new or existing service.

(1) All investments in the OAIT investment portfolio, projects, and services will undergo an EA review according to the specifications described in Chapter 6. The CEA or designee will conduct the review. The project or service manager will provide review materials. Upon completion of the review, the CEA will certify compliance, issue a waiver for compliance, or recommend termination of the investment.

(2) Multi-Program/Project - The Mission Directorate program managers and Mission Directorate CIOs are responsible for providing semiannual updates to the NASA EA and for determining if EA project reviews or annual service reviews are required in accordance with the specifications described in Chapter 6. The project or service manager will provide review materials. Upon completion of the review, the CEA will certify compliance, issue a waiver for compliance, or recommend termination of the investment.

(3) Program/Project Unique - The Mission Directorate program managers and Mission Directorate CIOs are responsible for providing semiannual updates to the NASA EA and for determining if EA project reviews are required in accordance with the specifications described in Chapter 6. The project or service manager will provide review materials. Upon completion of the review, the CEA will certify compliance, issue a waiver for compliance, or recommend termination of the investment.

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# CHAPTER 6: Enterprise Architecture Project and Service Reviews

## 6.1 EA Review Overview

6.1.1 The CEA has provided two processes to guide project and service managers through the preparation of an EA review. Information to be included in any EA review briefing is derived largely from project documentation that should already exist in the artifacts described in section 5.2. The EA review is designed to be a concise, stand-alone, executive-level briefing that presents evaluators with the information necessary to make an informed investment decision.

6.1.2 EA reviews are recommended for any Develop/Modernize/Enhance (DME) Project, Steady State (SS) Service or Mixed Life Cycle (MLC) Project/Service. The reviews are primarily used to ensure the financial and business viability of any proposed or ongoing investment. All CIOs, executive sponsors, and project/service managers can use EA reviews as a methodology to confirm or establish the investment priority within their respective IT Investment Portfolios.

6.1.3 All projects or services that go through an EA review will be deemed either compliant or noncompliant with the Agency EA by the CEA or designee.

## 6.2 High-Level EA Review Process

6.2.1 EA reviews may be requested by:

- a. An executive sponsor who desires more information or higher confidence in a specific project/service investment under their authority.
- b. A CIO who needs more information or higher confidence in a specific project/service investment listed in their respective IT investment portfolio.
- c. A project or service manager seeking greater clarity and depth for an investment under their management.

6.2.2 Initiation of an EA review:

- a. The requestor contacts the CEA or designee.
- b. The Agency EA team interacts with the designated investment contact and associated team to ensure expert help appropriate to the investment size of the proposed EA review.
- c. The assigned EA review leader:

(1) Is an EA-qualified civil servant with appropriate team resources. An EA-qualified civil servant is: (a) FEAC certified, (b) trained to prepare EA review briefings, and (c) has participated in at least five successful EA reviews.

(2) Sets the EA review schedule and requests that the review presentation be reasonably brief to force focus on the big picture.

(3) Sets expectations of the team preparing the EA review.

(4) Defines the Agency EA Team's expectations.

(1) Quantify everything. Clearly show the qualitative and quantitative benefits.

(2) Provide timely feedback and tracking of changes.

(3) Ensure that all estimates are substantiated by math and/or logic.

(4) Provide more pictures than words - people linger over charts/pictures and skip over words.

e. The final EA review product should:

(1) Meet the appropriate requirements as outlined in either Appendix A or Appendix B.

(i) Appendix A is the process for an Enterprise Architecture Project Review (EAPR) which is appropriate for DME and MLC projects investments.

(ii) Appendix B is the process for an Enterprise Architecture Service Review (EASR) which is appropriate for SS and MLC ongoing investments.

(2) Provide a complete executive-level, PowerPoint stand-alone presentation.

(3) Provide review results represented in auditable materials.

(4) Reflect the clarity and depth appropriate to the investment size.

f. The EA team is responsible for scheduling draft and final reviews:

(1) The EA team works with the project/service EA review team to create the working drafts. Typically, the EA review goes through three draft iterations. More or fewer drafts may be necessary depending on the size of the investment and the quality of the initial data.

(2) When the assigned EA review leader determines the EA review package is ready for final review work will be coordinated through the Agency EA team to schedule a final review with the CEA or designee. The final review may be held in person or via teleconference.

(3) Upon successful completion of a final EA review, the following actions will occur:

A NASA EA compliance statement from the NASA CEA will be generated to document the project/service as compliant with the Agency EA.

The materials from the completed EA review will be posted to the NASA EA Repository to document this portion of current NASA projects/services and the future direction based on investments.

The information from the EA review will be used in the next iteration of the NASA ?As-Is,? ?To-Be,? and Gap analysis.

The EA review briefing becomes an official document auditable by the IG, OMB, GAO, and Congress.

(i) All new project/service investment proposals are measured against the certified reference architectures and documented operations and services in the EA Repository.



## 6.3 Enterprise Architecture Project Review Contents

6.3.1 An EAPR is required prior to any investment consideration for a project that meets the funding thresholds established listed in Chapter 7. The review is presented to the CEA for approval to move forward for funding consideration. The goal of any EAPR is to ensure that projects have a fundamentally sound business foundation for successful funding and implementation. Additional EAPRs may be conducted during other phases of project life cycle.

6.3.2 The EA project review:

- a. Ensures that a DME or MLC project investment proposal has a solid business basis and is consistent with the Center, mission, and Agency goals and objectives.
- b. Considers the project investment and whether it meets the funding thresholds established in Chapter 7.
- c. Is ideally conducted during the project formulation or initiation stage but may be conducted at any stage of the project life cycle. An EAPR helps ensure that key sponsors, executives, and stakeholders have the appropriate detailed information to make informed investment and funding prioritization decisions.

6.3.3 The EAPR format is fully described in Appendix A, Enterprise Architecture Project Review (EAPR) Process.

## 6.4 Enterprise Architecture Services Review Contents

6.4.1 An EASR is required to consider sustained investment or modification/enhancement proposals for any service (i.e., steady state (SS) or MLC) that meets the funding thresholds established in Chapter 7. The review, prepared primarily from information already available in the service operating plans and documents, is presented to the CEA for approval in order to move forward for funding consideration. The goal of any EASR is to ensure investments in sustained operations, modifications, upgrades, or enhancements have a fundamentally sound business foundation and are aligned with Agency requirements. Additional EASRs may be conducted throughout the life-cycle of any service.

6.4.2 The EASR:

- a. Ensures that a sustained operation, SS, or MLC services investment portfolio proposal has a solid business basis and is consistent with the Center, mission, and Agency goals and objectives.
- b. Fully describes the ?As-Is? state, near-term ?To-Be? state, actions needed to transition state, and the transition action plan.
- c. Can be conducted at any time during a service portfolio life cycle. Subsequent EA reviews will occur at least annually.
- d. The EASR format can be found in Appendix B, Enterprise Architecture Service Review (EASR) Process.

# CHAPTER 7: Enterprise Architecture (EA) Inclusion Criteria

## 7.1 EA Inclusion Criteria

7.1.1 NASA seeks to perform an EA review on all significant IT investments, whether planned or existing. A set of criteria is defined to determine those investments that are candidates for an EA review. The applicable criteria are based on the significance of the investment to the Agency. While the investment amount may be small, the affect to the Agency may be large, therefore initiating an EA review. Any investment impacting many NASA employees or more than one NASA Center is designated a candidate for an EA review. The authority and responsibility for conducting an EA review is determined by the Investment Category (OAIT/ Multi-Program/Project/Program Unique) and the stage (DME/SS) of the investment. A review can be called by (a) either meeting the mandatory criteria below for project or services, or (b) the appropriate NASA manager detailed below can direct them:

<b>Quantitative Inclusion Criteria for EAPR (Projects)</b>
All OAIT and Multi-Program/Project investments must determine if an EA review is required.
? An EA project review will be required for any new (DME) investment if it:
o Is over \$500,000 in value.
o Affects more than one Center.
o Affects more than 100 people.
o Is a major investment requiring an OMB 300 (also called an exhibit 300).
If any of these criteria are met, the Chief Enterprise Architect or designee shall be notified and an EA review will be scheduled.

<b>Quantitative Inclusion Criteria for EASR (Services)</b>
? An EA Services Review will be required for any Steady State Investment if it:
o Is over \$1 Million in value.

o Affects more than one Mission Directorate.
o Affects more than one Center.
o Affects more than 100 Customers.
o Is a major investment requiring an OMB 300 (also called an exhibit 300).
If any of these criteria are met, the Chief Enterprise Architect or designee shall be notified and an EA review will be scheduled.

<b>Directed Inclusion Criteria (Project or Service)</b>
? If an investment is classified as OAIT, it can be directed to undergo an EA review by the NASA CIO, Center CIO, or Program/Project/Service Manager (PPSM). If the NASA CIO or designee is informed, an EA review will be scheduled.
? If an investment is classified as Multi-Program/Project, it can be directed to undergo an EA review by the Mission Directorate CIO, NASA CIO, Center CIO, or Program/Project/Service Manager. If the NASA CIO or designee is informed, an EA review will be scheduled.
? If an investment is classified as Program Unique, it can be directed to undergo an EA review by the Mission Directorate or Program/Project/Service Manager. If the NASA CIO or designee is informed, an EA review will be scheduled.
If any of these authorized directions occur, the CEA or designee is notified, and an EA review will be scheduled.

Figure 4 ?EA Review Inclusion Criteria?

7.1.2 The full process flow diagram of the EA review inclusion criteria is shown in Figure 5 below.

7.2 Enterprise Architecture Waiver Process

7.2.1 All IT investments are subject to compliance with the NASA EA. All investments for projects/services must be in agreement or alignment with the future architecture or be granted a waiver. This applies to IT initiatives of any size and scope, and is independent of the EA reporting requirements. If an investment is determined not to be compliant with the NASA EA but can be certified, in writing, by the appropriate Mission Directorate CIO as necessary for mission goals, then a waiver can be requested through the NASA CEA.

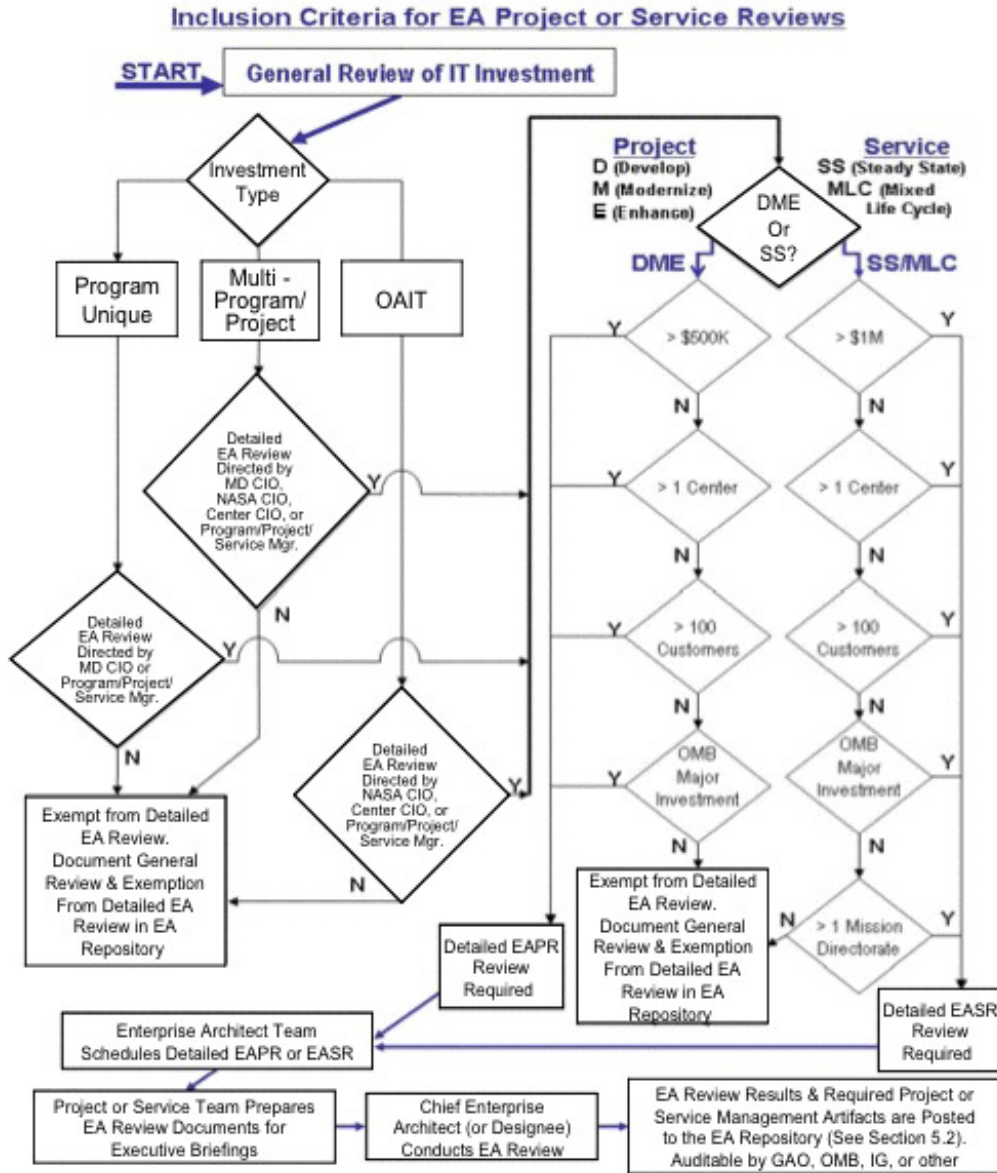


Figure 5: Inclusion Criteria Flowchart

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# APPENDIX A: Enterprise Architecture Project Review (EAPR) Process

## A.1 Introduction

- a. Appendix A outlines the process to prepare a NASA project (DME or MLC) for an EAPR. The purpose of an EAPR is to ensure that project proposals do not create capabilities that already exist, have a solid business mapping to the program goals they support, and will create new capabilities for the Agency. Typically, the EA review is conducted in the formulation stage of a project. A review during this stage helps ensure that key sponsors, executives, and stakeholders have the appropriate information detail to make informed investment and funding prioritization decisions.
- b. An EAPR is necessary prior to any investment consideration for a project that meets the funding thresholds established as listed in the NPR 2830.1. The review, prepared primarily from information already available in the project's documentation, is presented to the CEA for approval in order to move forward for funding consideration. The goal of any EAPR is to ensure projects have a fundamentally sound business foundation for successful funding and implementation. Additional EAPRs may be conducted during other phases of the project's life cycle.

## A.2 Need and Benefits

- a. Executive management and stakeholders have a business requirement to use EA principles for analysis of investments in projects that develop, modify, or enhance (DME) Agency capabilities. The EAPR provides the deep-level analysis that is used to determine the following:
- (1) How the project investment provides benefits for the Agency, Centers, Directorates, or programs; essentially the qualitative and quantitative benefits of the investment.
  - (2) Thorough analysis of the "As-Is" state to show how the project enhances current capabilities.
  - (3) Analysis of customer densities and clear benefits to the customer community.
  - (4) Project plan that shows clear development to the enhanced "To-Be" state.
- b. The following are anticipated benefits to the executive sponsor, supervisors, and project managers in completing the EAPR:
- (1) A thorough understanding of the current state in order to transition toward the future state.
  - (2) Better data for product development life cycle (PDLC) management analysis in order for investment prioritization:
    - (i) Initiate new services.
    - (ii) Sunset Legacy services.

- (iii) Evaluate services in the life cycle.
- (3) Thoroughly understand the current state in order to respond quickly to external influences.
  - (i) Funding reductions.
  - (ii) Policy directives.
  - (iii) Unfunded mandates.
  - (iv) Executive resource redirection.
- (4) A recommended list of potential projects for executive decision that create the next near-term ?To-Be? state from analysis of the data.
- (5) Finished, approved reviews constitute our ?To-Be? Projects while documenting our transition plan. These are auditable EA artifacts.
- (6) Creates good materials for funding requests and provides details for explanation to customers, executives, and other organizations such as NASA HQ, Office of Inspector General (OIG), GAO, OMB, and Congress.
- (7) Clarity of information allows executive sponsors to better understand the high-level view, manage interfaces for the project, and to assess the extent and effectiveness against program goals.
- (8) Results are helping people refocus. The focus EA reviews provide helps projects and sponsors gain insight that can be used for future state modeling and decisionmaking.
- (9) Ensures investments are mapped to the organizational business goals, the 18 NASA Strategic Objectives, and the FEA BRM ?Services for Citizens? Line of Business (as described in section A.6).
- (10) Allows the Agency to depend on standard tools and processes, thereby reducing complexity and redundancy.

## **A.3 Instructions**

- a. Prepare a concise PowerPoint briefing that answers the following categories of questions and include as much detail as possible. All required documents shall also be submitted. The content used to prepare the briefing should be derived from information already contained in existing documentation such as program plans, project plans, and formulation authorization documents (FAD?s). There is no need for redundancy in the submitted response. If a question or element is answered in any other part of the submitted response, it need not be repeated, but should be referenced for ease of evaluation. Samples of completed EAPR briefings are available from the CEA or designee.
- b. Successful reviews include the following actions:
  - (1) Identify your team members early on.
  - (2) Identify a single point of contact to represent the service portfolio.
  - (3) Prepare a schedule.
  - (4) Plan a minimum of two meetings per week.



(5) Have a PowerPoint specialist available.

## A.4 EAPR Questions

### A.4.1 Project Overview (NPR 7120.5 Compliant)

#### a. Project Description

- (1) What problems does this project solve?
- (2) What benefits, qualitative and quantitative, can NASA expect?
- (3) How was it determined that this project is necessary?
- (4) What is the overall context of the project?
- (5) What are the guiding principles, vision, and values for this project?

#### b. Requirements Document and Validation Strategy

- (1) How will you manage changing requirements?
- (2) How are the requirements gathered, and does the process allow for the voice of stakeholders?
- (3) How will you prevent ?scope creep??
- (4) What is the process or mechanism to add/delete/modify requirements?
- (5) What is the process for periodic validation of the requirements if the project is longer than six months?

### A.4.2 Results of the Mission Directorate, Mission Support Office, or Center Capital Planning and Investment Control Process

#### a. Who are the investors and executive sponsors?

- (1) What are their roles and expectations of the project?
- (2) How will the funding be procured or delivered?
- (3) How will they interact with the periodic reviews and project management?
- (4) How do they prioritize this project in their respective project investment portfolio?

#### b. What organization is the ?anchor? sponsor for the project (i.e., the sponsor with the most interest in completion)?

#### c. What program/Center/project will perform project management and periodic reviews?

#### d. What is the anticipated contract vehicle, and who will oversee the contract?

#### e. CPIC responses to selection criteria. (This must be answered verbatim.)

- (1) Does the initiative support core or priority mission and business functions that have to be performed by the Federal Government?
- (2) Is the initiative critical to the performance of these functions?
- (3) Does the initiative support work processes that have been simplified or otherwise redesigned?

- (4) Does the initiative support critical infrastructure?
- (5) Is the initiative being undertaken because no alternative is available in the private sector?
- (6) What are the expected benefits of the proposed initiative?
- (7) What are the expected costs of the proposed initiative?
- (8) Do the benefits justify the cost for the proposed initiative?
- (9) Is the initiative required by law?
- (10) Are there major risks involved that reduce the chances that the initiative will perform as expected?
- (11) Do performance measures exist, and do they adequately reflect the linkage to the appropriate mission and business functions and objectives?
- (12) Does the initiative comply with NASA EA, or has a waiver been granted and by whom?
- (13) Does the initiative provide OAIT or Multi-Program/Project Support?

## **A.5 Project Plan (NPR 7120.5 Compliant)**

a. Earned value (EV) management or operational analysis. The scope and level of detail depend on the size of the project. Follow NASA policy in Section 7 below.

- (1) EV is most appropriate for projects with clearly-defined schedules, milestones, and budget.
- (2) If EV is difficult to prepare, focus on cost/benefit or an overall operational analysis of full value.
- (3) It is appropriate to use estimates based on the best data available in trying to quantify impacts.
- (4) Qualitative impacts should be specifically described, even if they are not readily quantifiable.
- (5) Cost/Benefit Analysis and EV charts should be prepared to illustrate an estimated return.
- (6) Quantify and try to assign a reasonable value to everything. Lloyds of London is the world leader in assigning value to qualitative assets and future benefits based on available data and future projections. Try to assign quantifiable value to things like "One day of Flight Operations."

(7) Resources:

(i) NASA SP 610S (1995) ? NASA Systems Engineering Handbook  
[http://ldcm.gsfc.nasa.gov/library/Systems\\_Engineering\\_Handbook.pdf](http://ldcm.gsfc.nasa.gov/library/Systems_Engineering_Handbook.pdf)

(ii) NPD 1000.0 (2005) ? NASA Strategic Management and Governance Handbook  
[http://nodis3.gsfc.nasa.gov/displayDir.cfm?Internal\\_ID=N\\_PD\\_1000\\_0000\\_&page\\_name=main](http://nodis3.gsfc.nasa.gov/displayDir.cfm?Internal_ID=N_PD_1000_0000_&page_name=main)

(iii) NPR 7120.5 (2005, in Draft) NASA Program and Project Management Processes and Requirements

b. Alternatives Analysis. (See Appendix E.) Options should include the following, as a minimum:

- (1) Do nothing. This is always an option.
- (2) COTS: Is there a commercial product to build this project?
- (3) MOTS: Is it possible to modify/customize (e.g., no more than 20% as a rule of thumb) a



commercial product?

(4) GOTS: Has another Government agency already solved this problem and can we use their solution?

(5) Build the system. Why is this project so unique as to demand a one-off build? Check for previously developed modules available in NASA or other agencies for reuse.

c. Risk Assessment and Mitigation

(1) Use the NASA-approved 5x5 Probability versus Impact/Expectations Risk matrix.

(2) Articulate how the project will manage risk at a high level.

(3) Identify the significant risks with associated mitigation strategies.

(4) Resources:

(i) The primary instruction for an EA review risk assessment is the IEM Integration Project Risk Management Plan. This document outlines the 5x5 risk assessment process (see pages A-16 through A-22) and explains a problem versus a risk (page A-5).

(ii) For instruction on risk management for IT resources, see NPR 2810.1, Security of Information Technology, and NIST SP 800-30, Recommended Security Controls for Federal Information Systems.

d. Full Cost Budget

(1) Articulate all associated project costs, direct or indirect, in the context of a full-cost analysis.

(2) NASA will likely never get to a full "For Profit" cost business model, but we should strive toward that granularity.

(3) Understand how involved missions/offices/executives/sponsors will view the project in their full-cost models.

(4) Cost assumptions, projections, and estimates may be used as long as the rationale and supporting math are also provided. If the assumptions are disputed, it would only be a matter of changing the base assumption value and recalculating.

(5) Quantify and try to assign a reasonable value to everything, if possible. For example, Lloyds of London is the world leader in assigning value to qualitative assets and future benefits based on available data and future projections. Try to assign quantifiable value to things like "One day of Flight Operations."

e. Cost Recovery Model (if a fee for service)

(1) Build charts that snapshot the estimated rate and time for investment recovery.

(2) Examine the project to see if there is a "per fee" or "per use" schedule potential.

(3) Build charts that are easily understood.

(4) Define the process for cost/benefit even if that is something as difficult as ?improved quality of life,? for example.

## A.6 Mapping to the NASA and FEA Models

- a. How does this project map to the goals and objectives of the Mission Directorate(s)?
- b. How does the project map to the NASA goals and objectives? (EA team will provide template for mapping to NASA goals.)
- c. How does the project map to the defined NASA EA reference models? (EA team will provide templates for mapping to FEA goals.)
- d. How does the project map to the FEA business reference model? Examples are available from previous projects. (EA team will provide templates for mapping to FEA goals.)
- e. If the project cannot map back to NASA and FEA business goals, then it may need a check for validity.
- e. Map to the NASA Centers for usage. Construct a matrix to illustrate the project usage and impact as it pertains to each of the NASA installations.
- f. Resources:
  - (1) e-Gov, FEA site <http://www.whitehouse.gov/omb/egov/a-1-fea.html>
  - (2) Federal Enterprise Architecture Management System (FEAMS) <https://www.feams.gov/>

## **A.7 Compliance with EA ?To-Be? State**

- a. Define the ?As-Is? state that exists prior to project formulation. Diagrams and pictures can quickly demonstrate the ?As-Is? in the EA review. A thorough description should be maintained in the project documentation.
- b. Define the ?To-Be? state that will exist when the project is completed. Diagrams and pictures are best used to easily describe the ?To-Be? in the EA review. A thorough description should be maintained in the project documentation.
- c. How does the project design line up with the known mission, program, office, Center, or NASA ?To-Be? architecture and vision? The documentation must demonstrate that this project will be valid through its implementation and as far into the life cycle as the EA is defined.
- d. How does the project line up with the overall EA vision, objectives, goals, and principles?

## **A.8 IT Security Plan (draft or approved)**

- a. Ensure interaction with Program/Center/Mission IT Security Manager and appropriate IT Security support staff to ensure that:
  - (1) The IT System Security Plan Executive Summary represents a system that is based on realistic expectations. Requirements for a complete IT System Security Plan can be found in the Agency CIO SOP, System Security Plan Template.
  - (2) The IT Security Team is fully engaged through all phases of the project.
  - (3) The project plan is updated as IT Security regulations and direction change.

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# Appendix B: Enterprise Architecture Service Review (EASR) Process

## B.1 Introduction

a. Appendix B outlines the process to prepare a NASA service (SS or MLC) for an EASR. The purpose of an EASR is to fully describe the ?As-Is? or current state, the envisioned near-term ?To-Be? state, and the recommendations for actions to transform to the future state. The review is created with a clear articulation of customer requirements in every phase. This review allows key sponsors, executives, and stakeholders to assess the extent and effectiveness of that service against the program goals it supports.

b. An EASR is necessary in order to consider sustained investment or modification or enhancement proposals for any service (SS or MLC) that meets the funding thresholds established in NPR 2830.1, Chapter 7. The review, prepared primarily from information already available in the service operating plans and documents, is presented to the CEA for approval in order to move forward for funding consideration. The goal of any EASR is to ensure investments in sustained operations, or which are undergoing modifications, upgrades or enhancements, have a fundamentally sound business foundation, and are aligned with Agency requirements. Additional EASR?s may be conducted throughout the life cycle of any service.

## B.2 Need and Benefits

a. Executive management and stakeholders have a business requirement to use EA principles for analysis of investments in sustaining, or ongoing, operational service portfolios. The EASR provides the deep-level analysis that is used to determine the following:

- (1) How selective IT services might scale to effectively support a broader user community with minimal additional investment.
- (2) Thorough analysis of the ?As-Is? state to reveal the extent of today?s capabilities.
- (3) Analysis of customer densities and input as indicators for what customers may want as a part of our future ?To-Be? state.
- (4) Gap analysis in order to build action plans to steer toward the near-term ?To-Be? state.

b. Anticipated benefits that the executive sponsor, supervisors, and service managers can expect following the completion of the EAPR are:

- (1) A thorough understanding of the current state in order to transition toward the future state.
- (2) Better data for Product Development Life Cycle (PDLC) management analysis for investment prioritization, which takes into consideration:

- (i) Initiation of new services.
  - (ii) Sunset Legacy services.
  - (iii) Evaluation of services in various stages of the life cycle.
- (3) Thorough understanding of current state in order to respond quickly to external influences by considering:
- (i) Funding reductions.
  - (ii) Policy directives.
  - (iii) Unfunded mandates.
  - (iv) Executive resource redirection.
- (4) A recommended list of potential projects for executive decision that create the next near-term ?To-Be? state from analysis of the data.
- (5) Documentation of completed and approved service reviews which constitute the manager?s ?As-Is? state. These are auditable EA artifacts.
- (6) Good materials for funding requests and provides details for explanation to customers, executives, and other organizations such as NASA HQ, OIG, GAO, OMB, and Congress.
- (7) Clear understanding of the high-level view and managed interfaces for the services portfolio. This will also provide information for the manager to assess the extent and effectiveness of systems and services against program goals.
- (8) Discovery of how top-level customers may be representing services to atomic (root or end) customers. (If we do not understand who the atomic customer is, we do not know who is representing our services or how our services are being represented.)
- (9) Use the results to refocus a service portfolio. The focus EA reviews help projects and sponsors to gain insight that can be used for future state modeling and decision-making.
- (10) Assurance that investments are mapped to the organizational business goals, the 18 NASA Strategic Objectives, and the FEA BRM ?Services for Citizens? Lines of Business.
- (11) Ability depends on standard tools and processes, thereby reducing complexity and redundancy.

## **B.3 Instructions**

a. Prepare a concise PowerPoint briefing that answers the following categories of questions and include as much detail as possible. All required documents shall also be submitted. The content used to prepare the submitted briefing should be derived from information already contained in existing documentation such as program plans, project plans, and FAD?s. There is no need for redundancy in the submitted response. If a question or element is answered in any other part of the submitted response it need not be repeated, but should be referenced for ease of evaluation. Samples of completed EA project review briefings are available from the CEA or designee.

b. Successful reviews include the following actions:

- (1) Identify your team members early on.
- (2) Identify a single point of contact to represent the service portfolio.

- (3) Prepare a schedule.
- (4) Plan a minimum of two meetings per week.
- (5) Have a PowerPoint specialist available.

## **B.4 EASR Services Decomposition and Reference Architectures**

a. The appropriate starting point for an EASR is to conduct a services decomposition and prepare a reference architecture for each service area. The services decomposition activity fully delineates each discrete service for a given services portfolio and defines each discrete service. For example:

- (1) Mainframe Hosting: The NASA Data Center (NDC) provides industry standard mainframe hosting for applications.
- (2) Disaster Recovery: The NDC provides industry standard business continuity and recoverability for both mainframe and midrange platforms.

b. A fully decomposed services portfolio assures the services portfolio manager that all services are identified and understood, and it provides all EASR development participants with a common starting model.

c. A reference architecture is a graphically represented, high-level system overview that is intentionally free of implementation details. It generally includes high-level descriptions of the system components, a definition of relationships between components, definitions of relationships between system components and elements external to the system, and identification of performance drivers and capacity requirements. Where applicable, a reference architecture also provides high-level definitions of key data sources, data stores produced, and interfaces between the system components.

d. This notional system view allows EASR development participants to quickly review and understand the composition and functionality of a discrete service area, thereby improving their understanding of the overall services portfolio.

## **B.5 EASR Structure**

### **B.5.1 Services Portfolio Introduction and Overview**

a. This section provides the direction to create the charts to describe and discuss the entire services portfolio overview. The services portfolio shall:

- (1) Provide a brief description/introduction of the services portfolio.
- (2) Describe the guiding principles, vision, and values for the service.
- (3) Identify executive sponsors and managers.
- (4) Identify the services within the services portfolio.
- (5) Identify the services from a customer's viewpoint. Also, identify the full set of services offered under the services portfolio from the customer's perspective.
  - (i) List the services each customer uses today.
  - (ii) Show how the customer uses each service (i.e., strategic communications).

- (iii) Identify the criticality of each service to the customer.
- (6) Provide a matrix showing customer densities across the services including:
  - (i) Full portfolio demand charts.
  - (ii) Risk of demand outstripping capacity.
  - (iii) Customer density per service.
- (7) Describe any facilities common across the entire services portfolio.
- (8) Provide an organizational chart for operations, maintenance, and support.

### B.5.2 Individual Services Decomposition

- a. This section details the specific ?As-Is? state, desired ?To-Be? state, and identified transitional actions for each individual service under the services portfolio. Each individual service identified under the services portfolio will need the charts that provide the information below.
- b. Thoroughly document each Service ?As-Is? in the portfolio for executive review. Fully describe each service to include:
  - (1) Provide a brief executive description of the service.
  - (2) Provide an overview of the customer densities at each of the 11 Centers and 4 Mission Directorates. Also, list users outside the Agency or within programs/projects that do not fall under the 11 Centers or 4 Mission Directorates.
  - (3) Describe the systems, applications, equipment, and other technologies used to create and maintain the delivery of the service.
  - (4) Describe the capacity of the service. Show the relationship between capacity and demand (customer density). Show past, current, and future demand trends.
  - (5) Provide greater detail about the customers of each service in the portfolio.
    - (i) Identify the atomic (root or end) customers.
    - (ii) Identify the customers and how they are affected by service interruptions or technology migrations.
    - (iii) Determine the cost to the customer and ripple effect of a service interruption.
    - (iv) Decompose the funding sources, if more than one exists.
    - (v) Discuss how customers of this service use it in their business.
  - (6) Identify the full set of services offered under this individual service from the customer?s perspective.
    - (i) Show how the customer uses the service (i.e., strategic communications).
    - (ii) Identify the criticality of each service to the customer.
  - (7) What the current supply capacity is for this service based on the current configuration (i.e., today?s ?As-Is?).
    - (i) Describe the supply or capacity for each service (i.e., service ability to deliver).



(ii) Identify infrastructure capacity to support each service (e.g., building, power, HVAC).

(iii) Determine the maximum number of customers each service can support.

(8) Define the demand for each current service within the portfolio, including:

(i) Demand by specific customer (atomic, root or end customer).

(ii) Demand by Center.

(iii) Demand by mission directorate/program/project/activity/task.

(9) Define the full set of customers and stakeholders for each service:

(i) Identify the owners of the data supported by each service.

(ii) Determine which communities (served) are dependent on each service.

(iii) Determine which businesses are supported by each service.

(iv) Identify the industry partners and developers for each service, if any.

c. Clearly define the near-term ?To-Be? state through customer driven requirements. Each individual service identified under the services portfolio will need the charts to provide the following information:

(1) Define the portfolio service delivery model to drive down cost, including:

(i) Capacity demand for capacity and timeline.

(ii) Service models for each service, if different.

(iii) Peak versus sustained performance.

(2) Forecast services to create the service portfolio ?To-Be? model, including:

PDLC Management - evaluate all services concerning life cycle.

(i) Initiate new services.

(ii) Sunset Legacy services.

(iii) Define services with low customer density.

(iv) Service cost pools.

(v) Service recovery pools.

(vi) Service pricing model.

d. Individual Service Analysis and Recommended Actions. This section provides the direction to create the charts that describe and discuss the analysis and transition plans to take the individual service from the ?As-Is? state to the ?To-Be? state. This section generates analysis and recommendations specific to each individual service under the services portfolio. The data gathered in these charts for each individual service will ultimately roll up to help create the service portfolio summary section. Each individual service identified under the services portfolio will need the charts to provide the information below.

(1) ?To-Be? versus ?As-Is? supply/demand delta analysis (charts), including:

- (i) Capability to deliver new work.
  - (ii) Identify any impediments in service delivery model.
  - (iii) Recommended list of actions for executive decision for each service.
- (2) Define the risks associated with each service in the portfolio, including:
- (i) Aging infrastructure (e.g., building age, fire suppression, HVAC, and power).
  - (ii) Depth of critical resources (i.e., knowledge management).
  - (iii) Funding.
  - (iv) Competition.
  - (v) Internal rates.

### B.5.3 Services Portfolio Summary and Action Plan

a. This section provides the direction to create the charts that describe and discuss the analysis and transition plans to take the entire services portfolio from the ?As-Is? state to the ?To-Be? state. This section generates analysis and recommendations for executive approval to identify potential projects, sunset activities, activities or tasks to transform the services portfolio. The resultant list of identified actions shall be prioritized for discussion.

b. Provide analysis of the ?To-Be? versus ?As-Is? supply/demand delta analysis for the entire services portfolio, including:

- (1) Capability to deliver new work.
- (2) Impediments in service delivery model.
- (3) Definition of the risks associated with the services portfolio, including:
  - (i) Aging infrastructure (e.g., building age, fire suppression, HVAC, and power).
  - (ii) Depth of critical resources (e.g., knowledge management).
  - (iii) Funding.
  - (iv) Competition.
  - (v) Internal rate.
  - (vi) Other agencies (i.e., federalization).
  - (vii) External commercial capabilities.

c. Compile a recommended list of actions for executive decision, including:

- (1) Development of alternatives analysis.
- (2) Identification of actions that affect the One NASA Vision.
- (3) Prioritization of actions for CPIC consideration.
  - (i) Validation that the costs for recommended actions are accurate.
  - (ii) Prioritization of the actions/costs as required by the CPIC process. Examples are available from the EA team.



d. Take all of the potential actions described throughout the EASR package and create an action plan. The action plan shall:

- (1) Show a full timeline to cover all intended actions.
- (2) Have scheduled dates and milestones.
- (3) Include success criteria.
- (4) Indicate review cycle (i.e., monthly, quarterly, etc.).
- (5) Identify the owners for each action, as well as the owner for the overall plan.

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# APPENDIX C: Investment Portfolio Requirements

## C.1 Introduction

CPIC is the methodology to create a prioritized list of intended, cyclical investments. The resultant artifact for the CIO is the actual IT Investment Portfolio. This document outlines the general instruction for the creation of a CIO IT Investment Portfolio. This instruction was prepared specifically for use by the Office of the NASA CIO but can be easily adapted for use by any CIO, executive, or senior manager.

## C.2 Goals and Benefits

a. IT Investment Portfolio Requirement Goals:

- (1) Balanced OCIO IT portfolio aligned with NASA's strategic needs.
- (2) Clear priorities.
- (3) Improved program and project metrics collection.

b. The Investment Portfolio process results in the following benefits:

- (1) A clear list of prioritized investments that align with the Agency's goals.
- (2) Key priority discussions and decisions are made in a clear and consistent manner.
- (3) Improved metrics.

## C.3 Portfolios

a. The IT Investment Portfolio is a tool to manage and monitor a list of IT investments. The list of investments in the IT Investment Portfolio is periodically analyzed against the evolving Enterprise Architecture and strategic goals of NASA. The IT Investment Portfolio clearly shows all IT investments grouped by three portfolios: (1) Office Automation, IT Infrastructure and Telecommunications, (2) Multi-Program/Project IT, and (3) Program Unique IT and their nine subsequent portfolio elements: Voice, WAN, LAN, Video, Desktop Hardware/Software, Data Centers, Application Services, Messaging and Collaboration, and Public Web. The ongoing identification and evaluation of IT investments will ensure that the IT Investment Portfolios and NASA strategic goals are aligned.

b. The resultant document from the IT Investment Portfolio process is a stack-ranked, prioritized list of the IT investments for any given organization. The document clearly shows all IT investments in order of priority and clearly indicates the line where the current budget ends. The resultant view of

budget line placement clearly indicates those IT investments above the line, which are funded, and those IT investments below the line, which are necessary but unfunded.

## C.4 Instructions

a. Use the instruction contained below to create an IT Investment Portfolio for your organization. The IT Investment Portfolio should contain all of the relevant projects, programs, activities, and tasks. Organize all relevant actions into a prioritized list. Once the list of prioritized actions is completed with the appropriate information, then a line should be drawn where budget cycle funding runs out. All actions above the line are fully funded for the next budget cycle, and all actions below the line are unfunded unless there is a change in budget. A clear, well documented priority list simplifies decisions if the budget and associated funding changes.

b. Definition of ?IT Investment?

(1) NASA uses the OMB definition of an ?IT Investment? which is defined as, ?All funding spent on IT systems, including funding for development, modernization and enhancement, and funding for steady state operations.?

(2) The investment definition must be applied consistently. Every funding decision represents a decision to invest limited resources and includes all allocated dollars, committed workforce, and any assigned assets.

## C.5 What shall be included in the IT Investment Portfolio?

a. It is critical that all investments are included. The decisions affect the complete OCIO program and project portfolio. Investments to be included in the IT Investment Portfolio include:

(1) All programs and projects funded by the Office of the CIO.

(2) All investments that are in the current OCIO FY budget.

(3) All years in current budget plan to get complete picture.

## C.6 Who shall participate in the Process?

Although many people will be ultimately involved in creating the validated, prioritized IT Investment Portfolio, the primary participants are the OCIO program executives, the OCIO Business Office, and the NASA CIO. Program executives perform the first pass by reviewing and rating all programs and projects for which they are responsible. The OCIO Business Office provides support for all budget information and all program or project metrics. The NASA CIO oversees integration of the program executive?s inputs, reviews merged priority lists, and validates the final result. The program executives are the program or project advocates in the OCIO CPIC process.

## C.7 How to Apply Ratings

a. In order for the IT Investment Portfolio to start with valid parallelism, each program executive must use the same criteria for their respective scoring distributions. The following explains the rating methodology:

(1) First, all listed programs and projects are mapped for alignment with the Information Resources

Management (IRM) Strategic Plan and the NASA Strategic Plan.

(2) Then, all programs and projects are assigned a ?1,? ?2,? or ?3? using the following distribution. See table below:

Assignment	Priority Level	Description
1	High	No more than 15% of all investments may have a ?1.?
2	Medium	A minimum of 70% of investments are assigned a ?2.?
3	Low	No more than 15% of all investments may have a ?3.?

(i) The diagram below further illustrates this distribution.

Figure C1

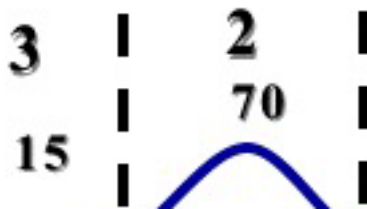


Figure C2

b. A forced distribution is necessary in order to kick off the overall process and bring hard decisions to the forefront early. The forced distribution means program executives must prioritize their work, since not everything can be a high priority. A forced distribution also creates balance across program executives and the programs and projects that they represent. The rating process causes many of the difficult discussions to be made early in the budget process.

### C.8 Using the Results

a. The OCIO program executives, OCIO Business Office, and the NASA CIO use the results of the CPIC process to make all decisions related to changes in the OCIO budget.

b. Each program executive?s list is merged into an overall OCIO list.

c. The overall list is reviewed by the NASA CIO.

(1) Each program executive advocates for each program or project they manage.

(2) Each classification is checked for consistency.

(3) Boundary conditions are checked for consistency.

(4) The final list is validated by the NASA CIO.

d. The prioritized CPIC list is reviewed on a regular basis to make sure it is still aligned with

NASA's evolving strategic needs.

e. The prioritized CPIC list is used to make all budget-related decisions.

(1) In all budget exercises, the funding line is adjusted and the lowest rated programs and projects are dropped.

(2) All cuts are clear and the impacts are easy to identify. It is not appropriate to "spread" the reductions.

f. The CPIC results are used both internally and externally to make all budget-related decisions based on a clear and validated list of priorities.

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# **APPENDIX D: Project Management Best Practices**

## **D.1 Project Management Best Practices**

a. Project managers should read NPD 7120.C and the Office of the Chief Engineer's Lessons Learned Web site to get the most current list of best practices.



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# **APPENDIX E: Approaches for Conducting Alternatives Analysis**

## **E.1 Approaches for Conducting Alternatives Analysis**

This appendix provides instruction for conducting a quantitative alternatives analysis. OMB recommends this detailed approach when selecting an alternative to meet the needs and requirements of the organization. The seven steps that are necessary for conducting this level of analysis are highlighted below.

### **E.2 Step 1: Analyze the Current Environment and Requirements**

The first step in conducting an alternatives analysis is to understand the current operating or status quo environment. This will provide a baseline for making comparisons between the existing and the proposed environment for each of the identified alternatives. Almost every investment, whether in facilities, personnel, technology, or knowledge affects numerous parts of the organization. Understanding how a potential investment impacts the current environment is critical in evaluating the return on investment and the expected short- and long-term values of the project.

### **E.3 Step 2: Identify Future Environment Requirements**

After evaluating the current environment, the results of the current process should be compared to the stated objectives of the future environment. The outcome of this comparison enables the organization to determine its remaining requirements of the current environment and identify change opportunities. Once the opportunities for change have been identified, potential solutions must be developed. These solutions will become the investment alternatives that you should evaluate. By this point, the organization has analyzed its current environment, determined what needs to be improved, and can identify investment alternatives that will meet its future requirements.

### **E.4 Step 3: Identify Viable Alternatives**

Once potential alternatives have been identified and the decision has been made to explore investing in a project, the alternatives are narrowed to a few viable options. The list of alternatives will include the status quo, as well as two other potential investments for comparing and selecting the appropriate alternative. To develop a short list of alternatives, each alternative is evaluated using nonfinancial, qualitative factors. Asking whether the organization can absorb the change and gauging the probable long-term success of the investment are critical before starting to calculate costs and benefits.

### **E.5 Step 4: Conduct Cost Analysis for the Status Quo and Each**

## Alternative

The first step in conducting a cost estimate is to develop a cost element structure that categorizes the major cost components for the status quo and each alternative. This includes all costs that will be incurred in the development, production, and operations and maintenance phases of the projects. By first developing a cost estimate for the status quo, you can determine the resources required to operate and maintain the existing environment and determine the additional resources that will be required to develop, deploy, and maintain the proposed alternatives.

### E.6 Step 5: Conduct Benefit Analysis for Each Alternative

- a. A business case analysis typically identifies both the quantitative and qualitative benefits of an alternative when evaluating total benefits. Quantitative benefits include the dollar saving investments to both the Federal Government and key stakeholders that may be obtained by implementing the proposed initiative. However, many benefits for certain public Government investments are qualitative in nature and do not lead directly to dollar savings. Improvements in customer service and employee morale are certainly recognized as benefits, but rarely can be included in the dollar-valued benefits stream or return on investment measures. Because many public goods are difficult to reliably quantify in dollar units, nonmonetary benefits are also vital to understand the total implementation outcome of the investment.
- b. The following benefits should be addressed when evaluating total annual benefits for each alternative:
  - (1) Qualitative benefits.
  - (2) Cost savings.
  - (3) Cost avoidance.
  - (4) Stakeholder benefits.
  - (5) Nonmonetary quantitative benefits.
- c. Each of these benefit categories is described in further detail in the following sections. Examples for calculating each of these benefits are also provided.
- d. Qualitative Benefits ? This includes intangible benefits that are not dollar-quantifiable (e.g., employee morale, customer satisfaction).
- e. Cost Savings ? This includes the savings that will result in a direct budget reduction for operations and maintenance costs between the status quo and proposed alternative environments (e.g., reduction in software/hardware maintenance costs). For example, if under the status quo system, NASA currently pays \$1 million for annual hardware maintenance costs and will only pay \$850,000 under the proposed alternative, then NASA will save \$150,000 annually. This should be noted as a cost savings in your analysis. Similarly, if the proposed alternative will reduce the need for annual outsourcing by a certain amount, then this should be noted as well. The total operations and maintenance savings between the alternatives should be identified.
- f. Cost Avoidance ? This includes the costs that will not be incurred under the proposed alternative that would otherwise have been incurred if the investment had not been made (e.g., avoid having to hire additional staff that would have been required under the status quo). For example, if under the alternative, NASA will not have to hire the additional five employees that would have been required

to support increased workload under the status quo, the cost associated with the five employees should be calculated and included in the benefits analysis. The following section provides an example for conducting this cost avoidance analysis.

(1) Calculation: To determine the cost avoidance associated with these employees, you must first take the annual salary of a GS-13 employee, as required by the Office of Personnel Management, and multiply this salary by a burden/overhead rate to determine the fully-burdened cost of labor. This rate includes the cost of the following items: personnel benefits (i.e., Social Security, Federal Employees Group Life Insurance, Federal Employees Health Benefit, Federal Employees Retirement System, Civil Service Retirement System, and Thrift Savings Plan), overtime, cash awards, pay differentials, travel, ADP equipment, nonADP equipment, repairs and alterations to office space, etc. Typically, this burden/overhead rate is approximately 1.6 depending on the unique requirements of the Agency.

(2) The following equation can be used to determine the cost avoidance:

$$\text{FTE's Avoided} \times \text{Employee's Salary} \times \text{Burden/Overhead Rate} = \text{Cost Avoidance}$$

<b>FTE's Avoided</b>	<b>Employee's Salary</b>	<b>Burden/Overhead Rate</b>	<b>Cost Avoidance =</b>
5	\$71,642	1.6	\$573,136

Figure E1

g. Stakeholder Benefits ? This includes the savings that would be incurred by key stakeholders outside the organization (e.g., benefits to public citizens or private industry).

h. Nonmonetary Quantitative Benefits - This includes the performance improvements that will be achieved as a result of implementing the initiative (e.g., decreased response time for customer service calls). For example, suppose one alternative will decrease the amount of time that will be required to address level one customer service calls at one of NASA's contact Centers. You can illustrate improved performance levels by filling in the following table:

<b>Performance Measure</b>	<b>Current Target</b>	<b>Future Target</b>	<b>Business Process Improvement</b>
Average Customer Service Call	8 minutes	5.5 minutes	Improve customer service by reducing the amount of time to process a service call.
Number of Service Locations Covered by Help Desk Support	5 locations	10 locations	Increase help desk coverage to NASA employees.

Figure E2

i. Similar to preparing a cost estimate, the benefit analysis should include potential benefits over the same time period.

## E.7 Evaluate Economic Measures Among the Alternatives

a. After calculating the costs and benefits for each alternative, comparisons can be made between the

status quo and viable alternatives. In order to compare costs and benefits between alternatives, it is necessary to discount future costs and benefits to reflect the time value of money. The time value of money reflects the fact that money in hand today is more valuable than an identical amount of money received in the future. The following section provides an overview of what is discounting and how it should be applied when conducting cost/benefit analysis of alternatives.

b. What is discounting?

(1) Question: Why is current money more valuable than future money? Answer: Because you can do something with it now, e.g., the ability to buy food today is clearly more valuable than the ability to buy food a year from now.

(2) Benefits and costs are worth more if they are experienced sooner. We discount cost streams when we need to compare incurring costs at different times. For example, if cost is the only deciding factor, which investment should the organization invest in if the total cost is \$500,000 over a five-year period?

<b>CONSTANT \$</b>	<b>Year 1</b>	<b>Year 2</b>	<b>Year 3</b>	<b>Year 4</b>	<b>Year 5</b>	<b>Total</b>
Project A						
Present Value (PV) Cost	\$100,000	\$100,000	\$100,000	\$100,000	\$100,000	\$500,000
Project B						
PV Cost					\$500,000	\$500,000
Project C						
PV Cost	\$500,000					\$500,000

Figure E3

(3) At first glance it may appear that the total investment is the same, since they each total \$500,000. However, since the costs are incurred over different years, there are different cost implications for the organization.

c. The organization should invest in the project with the lowest discounted cost stream, given that the benefits for the alternatives are the same. In the example below, Project B has the lowest cost in terms of present value. For example, you need \$500,000 today for Project C. Alternatively, you could put \$440,810 in a bank today and receive the \$500,000 you need in Year 5 for Project B. Economists contend that you are better off with Project B because you can do something else with the \$59,190 you did not put in the bank.

<b>DISCOUNTED \$</b>	<b>Year 1</b>	<b>Year 2</b>	<b>Year 3</b>	<b>Year 4</b>	<b>Year 5</b>	<b>Total</b>
Program Year	0	1	2	3	4	
Discount Factor	1.0000	0.9690	0.9389	0.9098	0.8816	
Project A						

PV Cost	\$100,000	\$96,899	\$93,895	\$90,983	\$88,162	\$469,939
Project B						
PV Cost					\$440,810	\$440,810
Project C						
PV Cost	\$500,000					\$500,000

Figure E4

d. OMB Circular A-94, Appendix C, provides the appropriate discount rates for conducting the alternatives analysis. Based on the ten-year real interest rates on Treasury notes and bonds, the real discount rate is 2.8%. Note: The real discount rate was recently updated in February 2004. While the following example is based on the assumption that the rate is 3.2%, please ensure that your analysis is based on the 2.8% rate.). The discount factor is equal to  $1/(1+i)^t$ , where  $i$  is the interest rate and  $t$  is the number of years from the date of initiation for the project.

E.7.1. How do you discount costs?

a. To illustrate this concept, a five-year estimate for three projects is provided in the following tables. By following each of the three steps, you will be able to discount both the costs and benefits for your project.

(1) Step 1 ? Determine the cost of each alternative in constant dollars.

CONSTANT \$	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Project A (Status Quo)						
Investment Operations and Maintenance (O&M)	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$5,000,000
Total Cost	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$5,000,000
Project B						
(Alternative 1)						
Investment	\$500,000					\$500,000
O&M	\$1,000,000	\$850,000	\$850,000	\$850,000	\$850,000	\$4,400,000
Total Cost	\$1,500,000	\$850,000	\$850,000	\$850,000	\$850,000	\$4,900,000
Project C						
(Alternative 2)						
Investment	\$200,000		\$100,000		\$200,000	\$500,000
O&M	1,000,000	1,100,000	1,100,000	\$1,100,000	1,100,000	\$5,400,000
Total Cost	\$1,200,000	\$1,100,000	\$1,200,000	\$1,100,000	\$1,300,000	\$5,900,000

Figure E5

(2) Step 2 ? Determine the benefits of each alternative in constant dollars.

(i) The assumptions for calculating cost savings, cost avoidance, and stakeholder benefits for Alternatives 1 and 2 are provided in the previous section entitled

Step 5: Conduct Benefit Analysis for Each Alternative.

<b>CONSTANT \$</b>	<b>Year 1</b>	<b>Year 2</b>	<b>Year 3</b>	<b>Year 4</b>	<b>Year 5</b>	<b>Total</b>
Project B (Alternative 1) Cost Savings	(\$500,000)	\$150,000	\$150,000	\$150,000	\$150,000	\$100,000
Cost Avoidance		\$573,136	\$573,136	\$573,136	\$573,136	\$2,292,544
Stakeholder Benefits		\$68,000	\$68,000	\$68,000	\$68,000	\$272,000
Total Difference From A	(\$500,000)	\$791,136	\$791,136	\$791,136	\$791,136	\$2,664,554
Project C (Alternative 2) Cost Savings	(\$200,000)	\$(100,000)	\$(100,000)	\$(100,000)	\$(100,000)	\$(600,000)
Cost Avoidance		\$571,696	\$571,696	\$571,696	\$571,696	\$2,286,784
Stakeholder Benefits		\$68,000	\$68,000	\$68,000	\$68,000	\$272,000
Total Difference From A	(\$200,000)	\$539,696	\$539,696	\$539,696	\$539,696	\$1,958,784

Figure E6

(ii) The costs and benefits are then discounted by the appropriate discount factor to account for the time value of money. Each of the tables provides only a five-year estimate for illustrative purposes. The actual estimate should cover a ten-year period.

(3) Step 3 ? Discount the costs and benefits:

<b>DISCOUNTED \$</b>	<b>Year 1</b>	<b>Year 2</b>	<b>Year 3</b>	<b>Year 4</b>	<b>Year 5</b>	<b>Total</b>
Program Year	0	1	2	3	4	
Discount Factor	1.0000	0.9690	0.9389	0.9098	0.8816	



Project A (Status Quo)						
PV Investment						
PV O&M	\$1,000,000	\$968,992	\$938,946	\$909,831	\$881,620	\$4,699,389
PV Total Cost	\$1,000,000	\$968,992	\$938,946	\$909,831	\$881,620	\$4,699,389
PV Cost Savings						
PV Cost Avoidance						
PV Stakeholder Benefits						
PV Total Benefits						
Project B (Alternative 1)						
PV Investment	\$500,000					\$500,000
PV O&M	\$1,000,000	\$823,643	\$798,104	\$773,357	\$749,377	\$4,144,481
PV Total Cost	\$1,500,000	\$823,643	\$798,104	\$773,357	\$749,377	\$4,644,481
PV Cost Savings		\$145,349	\$140,842	\$136,475	\$132,243	\$554,908
PV Cost Avoidance		\$555,364	\$538,144	\$521,457	\$505,288	\$2,120,253
PV Stakeholder Benefits		\$65,891	\$63,848	\$61,869	\$59,950	\$251,558
PV Total Benefits		\$766,605	\$742,834	\$719,800	\$697,481	\$2,926,720
Project C (Alternative 2)						
PV Investment	\$200,000		\$93,895		\$176,324	\$ 470,219
PV O&M	\$1,000,000	\$1,065,891	1,032,841	\$1,000,815	\$969,782	\$5,069,328
PV Total Cost	\$1,200,000	\$1,065,891	\$1,126,735	\$1,000,815	\$1,146,105	\$5,539,547
PV Cost Savings		\$(96,899)	\$(93,895)	\$( 90,983)	\$( 88,162)	\$( 369,939)
PV Cost Avoidance		\$553,969	\$536,792	\$520,147	\$504,018	\$2,114,926
PV Stakeholder Benefits		\$65,891	\$63,848	\$61,869	\$59,950	\$251,558
PV Total Benefits		\$522,961	\$506,745	\$491,032	\$475,807	\$1,996,546

Figure E7

(i) After the costs and benefits are discounted, the following three economic measures should be used to compare the economic feasibility of each of the alternative investments:

(4) Net Present Value (NPV) - OMB Circular A-94 states that the standard criterion for deciding whether a Government program can be justified on economic principles is net present value, the discounted monetized value of expected net benefits (i.e., benefits minus costs). Net present value is computed by assigning monetary values to benefits and costs, discounting future benefits and costs using an appropriate discount rate, and subtracting the sum total of discounted costs from the sum total of discounted benefits. Discounting benefits and costs transforms gains and losses occurring in different time periods to a common unit of measurement. Programs with positive net present value increase social resources and are generally preferred. Programs with negative net present value should generally be avoided. Net present value can be calculated by the following equation:

(i)  $NPV = (PV \text{ O\&M Savings Between Status Quo and Alternative} + PV \text{ Cost Avoidance} + PV \text{ Stakeholder Benefits} - PV \text{ Investment Costs})$ .

PV (Annual Benefits)			PV (Annual Costs)	Net Present Value (NPV)
	Plus	Plus	Minus	Equals
PV O&M Savings Between Status Quo & Alternative	PV Cost Avoidance	PV Stakeholder Benefits	PV Investment Costs	
\$554,908	\$2,120,253	\$251,558	\$500,000	\$2,426,720

Figure E8

(5) Return on Investment (ROI) ? The ROI measures the amount of savings generated for each dollar of investment for an alternative. In a desirable economic situation, the ROI is greater than one. If the ROI is equal to one, then there is no advantage in implementing the proposed environment. The higher the ROI, the greater the economic advantage to the organization. ROI is calculated by the following equation:

(i)  $ROI = (PV \text{ Savings} / PV \text{ Investment}) = (PV \text{ O\&M Savings Between Status Quo and Alternative} + PV \text{ Cost Avoidance} + PV \text{ Stakeholder Benefits}) / PV \text{ Investment Costs}$ .

**PV Savings =** The PV of any systems operations savings that may arise from the replacement of the status quo by the proposed alternative plus the present value of potential cost avoidance and stakeholder benefits.

**PV Investment =** The PV of the initial investment for the proposed alternative (development cost plus implementation cost).

Figure E9

PV (Annual Benefits)	PV (Annual Costs)	ROI
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	Plus	Plus	Divided By	Equals
PV O&M Savings Between Status Quo & Alternative	PV Cost Avoidance	PV Stakeholder Benefits	PV Investment Costs	
\$554,908	\$2,120,253	\$251,558	\$500,000	5.85

Figure E10

(ii) To illustrate this measure, the ROI has been calculated for Alternative 1. The same process should be used to compute the other alternatives? ROIs.

Alternative 1 ROI =  $(\$554,908 + \$2,120,253 + \$251,558) / \$500,000 = 5.85$

(6) Discounted Payback Period (DPP) ? DPP is defined as the number of years it takes to recover the investment costs from the discounted net cash flows. The advantage of DPP is that it gives consideration to a project's cost of capital. DPP is measured in time, where NPV is measured in dollars. DPP occurs the first year in which cumulative NPV is positive.

(i) To illustrate this measure, the NPV for Alternative 1 has been calculated over a five-year period. In addition, the cumulative NPV has also been calculated.

<b>DISCOUNTED \$</b>	<b>Year 1</b>	<b>Year 2</b>	<b>Year 3</b>	<b>Year 4</b>	<b>Year 5</b>	<b>Total</b>
Alternative 1 Annual NPV	\$ (500,000)	\$766,605	\$742,834	\$719,800	\$697,481	\$2,426,720
Alternative 1 Cumulative NPV	\$ (500,000)	\$266,605	\$1,009,439	\$1,729,239	\$2,426,720	\$2,426,720

Figure E11

(i) From this analysis, you can see that the cumulative NPV for the project is positive for the first time in Year 2. Therefore, the discounted payback period is approximately two years.

(7) Compare and Recommend an Alternative

(i) Once all of the costs and benefits of the alternatives are understood, a comparison of alternatives may be conducted. Comparisons must be made in two areas: the financial impact and the strategic value impact per dollar invested. ROI and NPV metrics represent the return realized by an organization in financial terms. The Discounted Payback Period illustrates the number of years it takes to recover the investment costs from the discounted net cash flows. These metrics allow an organization to understand how they will save money or avoid certain costs through implementation of a particular initiative.

## E.8 Summary Analysis

	<b>Status Quo</b>	<b>Alternative 1 Enhancement to Status Quo</b>	<b>Alternative 2 New Systems</b>
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Feasibility/Performance Score	16	25	22
Discounted Cost	\$4.7 M	\$ 4.6 M	\$ 5.5M
NPV	-\$ 4.7 M	\$2.4 M	\$1.5 M
ROI	Do not need to calculate.	5.85	4.25
Payback Period	Do not need to calculate.	Approximately 2 years.	Approximately 2 years.

Figure E12

(1) Based on the key measures, Alternative 1 should be selected due to its higher NPV and ROI values and performance score. However, when comparing and recommending an alternative, it is imperative to also demonstrate that this alternative also best supports the mission of the organization.

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# APPENDIX F: Abbreviations and Acronyms

ACWP	Actual Cost of Work Performed
BCWP	Budgeted Cost for Work Performed
BCWS	Budgeted Cost of Work Scheduled
BRM	Business Reference Model
CDR	Critical Design Review
CPIC	Capital Planning and Investment Control
CV	Cost Variance
DME	Development/Modernization/Enhancement
DPP	Discounted Payback Period
DRM	Data Reference Model
EA	Enterprise Architecture
EAPR	Enterprise Architecture Project Review
EASR	Enterprise Architecture Service Review
EV	Earned Value
EVM	Earned Value Management
FAD	Formulation Authorization Document
FEA	Federal Enterprise Architecture
FEAMS	Federal Enterprise Architecture Management System
FISMA	Federal Information Security Management Act
FTE	Full-Time Equivalent

IRM	Information Resources Management
IT	Information Technology
ITMRA	Information Technology Management Reform Act
MLC	Mixed Life Cycle
NIST	National Institute of Standards and Technology
NPD	NASA Policy Directive
NPR	NASA Procedural Requirement
NPV	Net Present Value
O&M	Operations and Maintenance
OMB	Office of Management and Budget
OAIT	Office Automation, IT Infrastructure, and Telecommunications
OCIO	Office of the Chief Information Officer
PDLC	Product Development Life Cycle
PMB	Performance Measurement Baseline
PV	Present Value
RM	Risk Management
ROI	Return on Investment
SDLC	System Development Life Cycle
SOP	Standard Operating Procedure
SRM	Service Reference Model
SS	Steady State
STD	Standard
SV	Schedule Variance
TRM	Technical Reference Model
VAC	Variance at Completion
WBS	Work Breakdown Structure