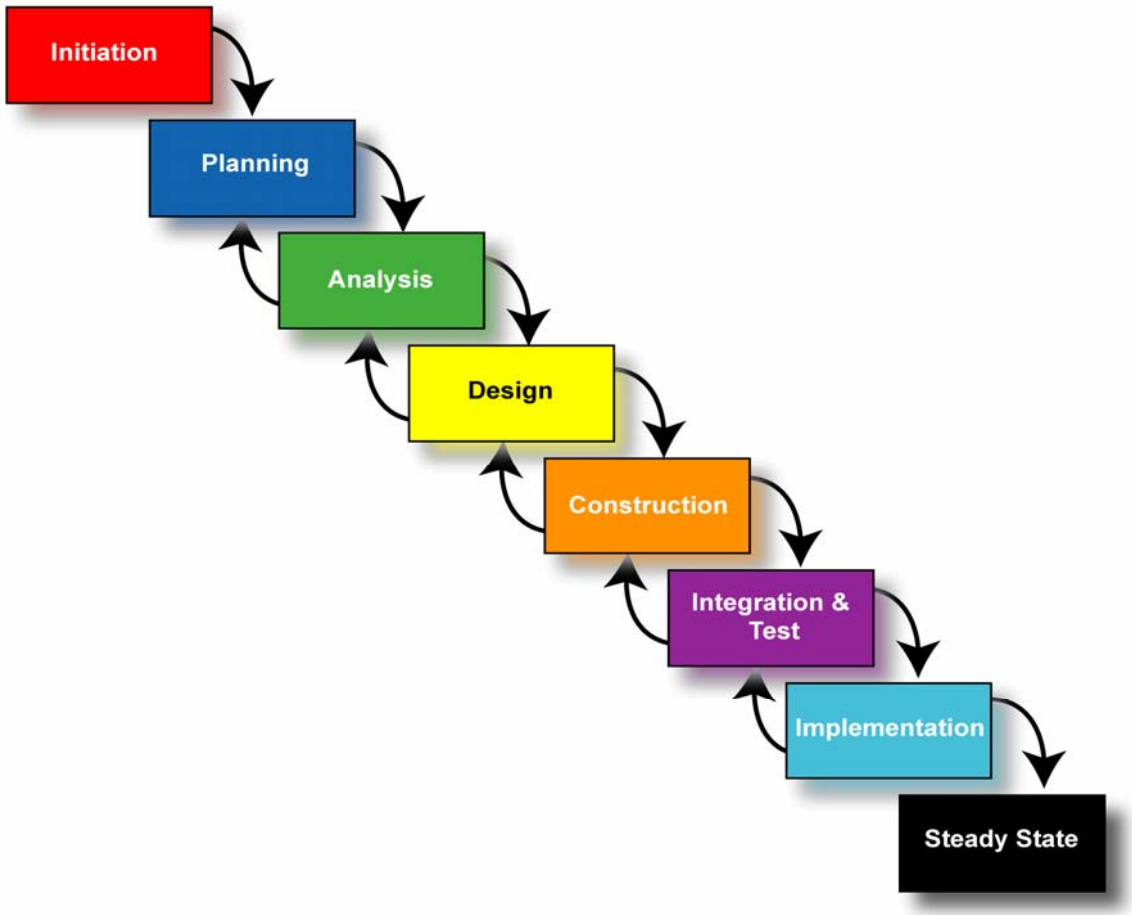
UNITED STATES DEPARTMENT OF THE

Interior

Information Technology Solution Development Lifecycle Guide



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Updates to this document: The Department of the Interior (DOI) recognizes that the SDLC process and this Guide are going through continuous change and process improvement. Changes and improvements to the SDLC process and this Guide come from their interdependence on other processes and best practices, including Interior's change control management (CCM) process, project management process (and best practices) and an integrated life cycle process. As Interior matures, the SDLC process and the other interdependent processes will become better defined and aligned.

If you would like to make a suggestion for enhancement, please send an email or written memo to the OCIO PMD. Please be very specific with your recommendation and include the section, paragraph and page number in your note.

For further information on IT investment management or DOI's CPIC process, please contact the Chief of the Portfolio Management Division (PMD), in the OCIO at either (202) 208-4109 or email OCIO CPIC Working Team at OS_PIO_CPIC@ios.doi.gov.

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Executive Summary

Information Technology Solution Development Lifecycle (SDLC) Guide

The Key Components

A successful IT architecture consists of three key components: repeatable, reliable processes compliant with all Government standards, mandates and directives; staff thoroughly trained in the execution of these processes; and tools to support these processes. The first of these three major components, the SDLC, forms the basis upon which the other two are built. In recognition of this fact, the DOI Office of the Chief Information Officer (OCIO) is deeply engaged in ongoing effort to establish, maintain and support a DOI-wide SDLC.

This Guide

The *DOI Information Technology Solution Development Lifecycle Guide* identifies the processes and activities necessary to ensure that IT investments established in the DOI CPIC become IT projects that are properly planned and managed, controllable, cost-effective, and support the missions and business goals of the organization. The SDLC is based on guidance from the DOI Chief Information Officer's Council, the Office of Management and Budget (OMB) and the Government Accountability Office (GAO).

SDLC Process Overview

The SDLC is a structured, integrated approach to developing and fielding IT solutions. The SDLC ensures that IT solutions align with the Department's mission and support its business needs while minimizing risks and maximizing returns throughout the solution life cycle. The SDLC relies on systematic solution planning, definition, development, and implementation subject to on-going internal and external evaluation processes, to ensure that the solution satisfies its objectives efficiently and effectively. These processes are depicted in **Figure ES-1: SDLC Information and Process Flow**. Each IT solution is consolidated into the Department's portfolio, so that the OCIO can ensure that all systems support the DOI mission and goals, and work in concert when appropriate, including systems under development, systems currently in use, and systems scheduled for retirement and or replacement.

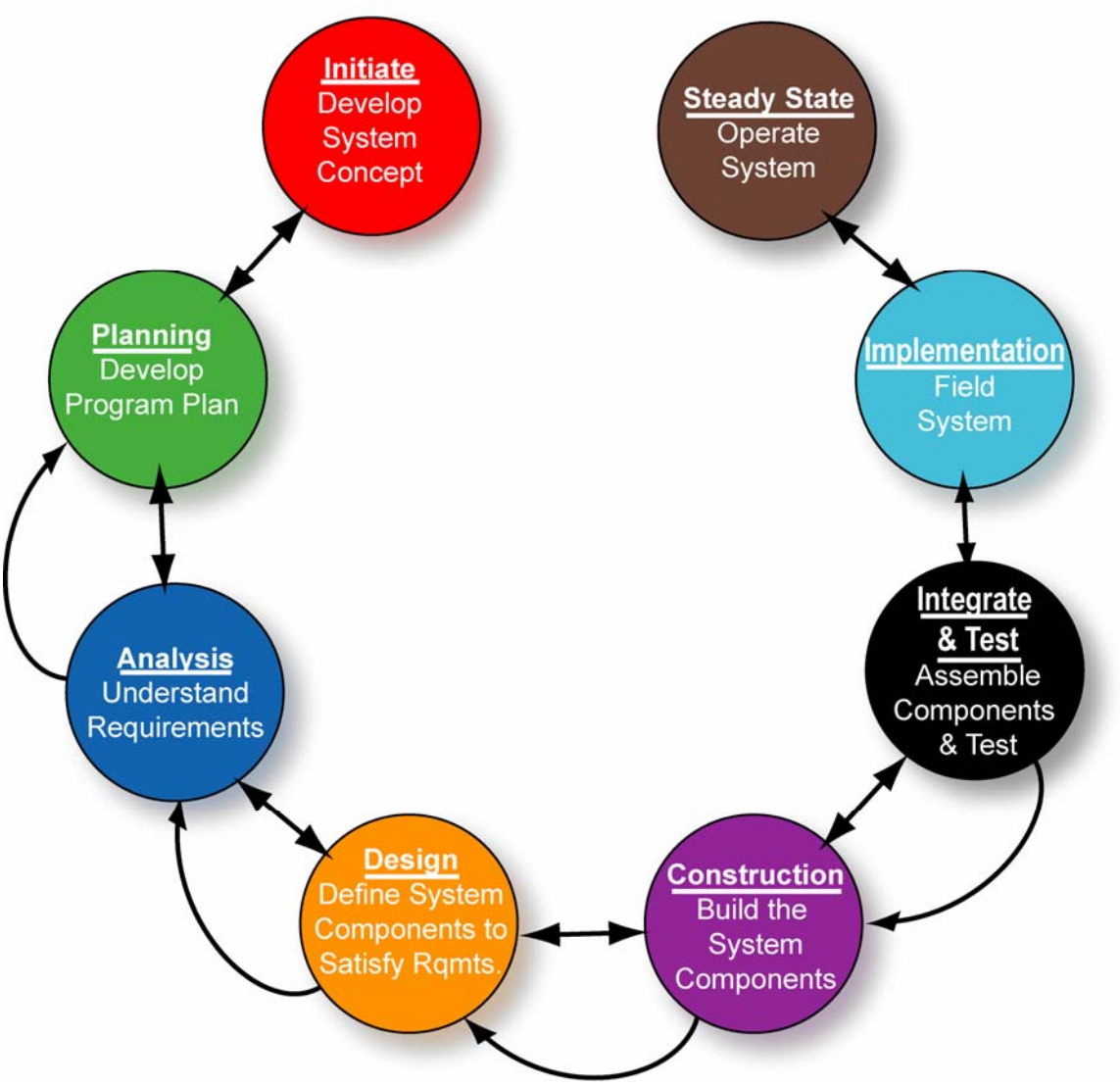

Figure ES-1: *Information and Process Flow in the SDLC*

At the highest level, the SDLC process is a flow of DOI solution development activities through eight phases:

Initiation Phase: The Initiation Phase builds on the solution concept developed as part of a CPIC Pre-Select phase. It identifies, through research, feasibility studies and system and project modeling, the best approach to the given IT investment strategy based on maximizing benefit while minimizing risk.

Planning Phase: During the Planning Phase, the solution concept is further developed and the necessary budget, resources, activities, schedules, tools, and reviews are determined. A document management strategy is

introduced to ensure that all documents/plans/artifacts are maintained and controlled in an orderly, consistent manner.

Analysis Phase: During the Analysis Phase, both the exact requirements necessary to design and implement the solution as well as the tests necessary to establish this compliance are specified.

Design Phase: During the Design Phase a complete set of software and hardware designs and test plans is written based on the detailed specifications created in the analysis phase.

Construction Phase: The detailed specifications produced during the Design Phase are translated into hardware, communications, and executable software. Software is tested, integrated, and retested in a systematic manner. Hardware is assembled and tested.

Integration and Test Phase: The system specified is assembled from the parts developed during the previous phases and systematically tested. The user tests the system to ensure that both the requirements, as defined in the requirements documentation, as well as all privacy, security and other mandated requirements are satisfied by the developed or modified system.

Implementation Phase: The system is installed and made operational in the production environment. This phase continues until the system is operating in production in accordance with the defined user requirements.

Steady State Phase: The system operation is ongoing. All system documentation is finalized and archived for future reference. The system is monitored for continued performance in accordance with user requirements, and needed system modifications are incorporated

Each of these eight phases is structured in a similar manner using a set of common elements. These common elements provide a consistent and predictable flow and coordination of activities within each phase.

The SDLC and Development Methodologies

Although the SDLC presented in this document forms a complete development methodology—the so-called *Waterfall Development Methodology*—in itself, it can also be used in several other well known methodologies: in particular, the *Spiral Development Methodology* and the *Incremental Development Methodology*. All three of these methodologies are acceptable for use in DOI solution developments. The choice of methodology should depend on the nature of the development at hand.

Waterfall Model: The waterfall is an approach to development that emphasizes completing a phase of the development before proceeding to the next phase. In conjunction with certain phase completions, a baseline

is established that "freezes" the products of the development at that point. If a need is identified to change these products, a formal change process is followed to make the change. The SDLC, as presented above in **Figure ES-2**, corresponds to the waterfall methodology.

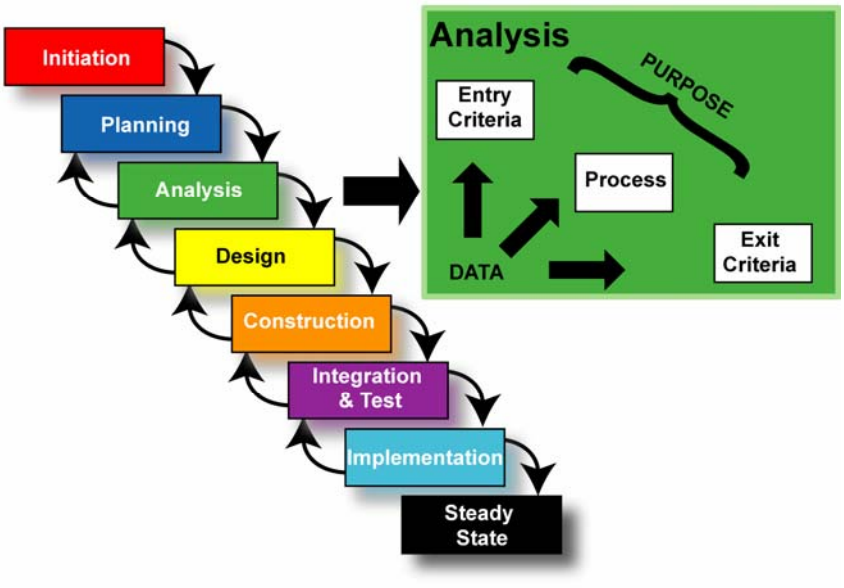

Figure ES-2: *Waterfall View of the SDLC*

Incremental Model: The incremental model performs the waterfall in overlapping sections, attempting to compensate for the length of waterfall model projects by producing usable functionality earlier. This may involve a complete upfront set of requirements that are implemented in a series of small projects. As an alternative, a project using the incremental model may start with general objectives. Then some portion of these objectives is defined as requirements and is implemented, followed by the next portion of the objectives until all objectives are implemented. As can be seen in **Figure ES-3,** the incremental approach is essentially several parallel implementations of the SDLC, one for each increment, with a single initiation and planning phase at the beginning and a single steady state phase at the end.

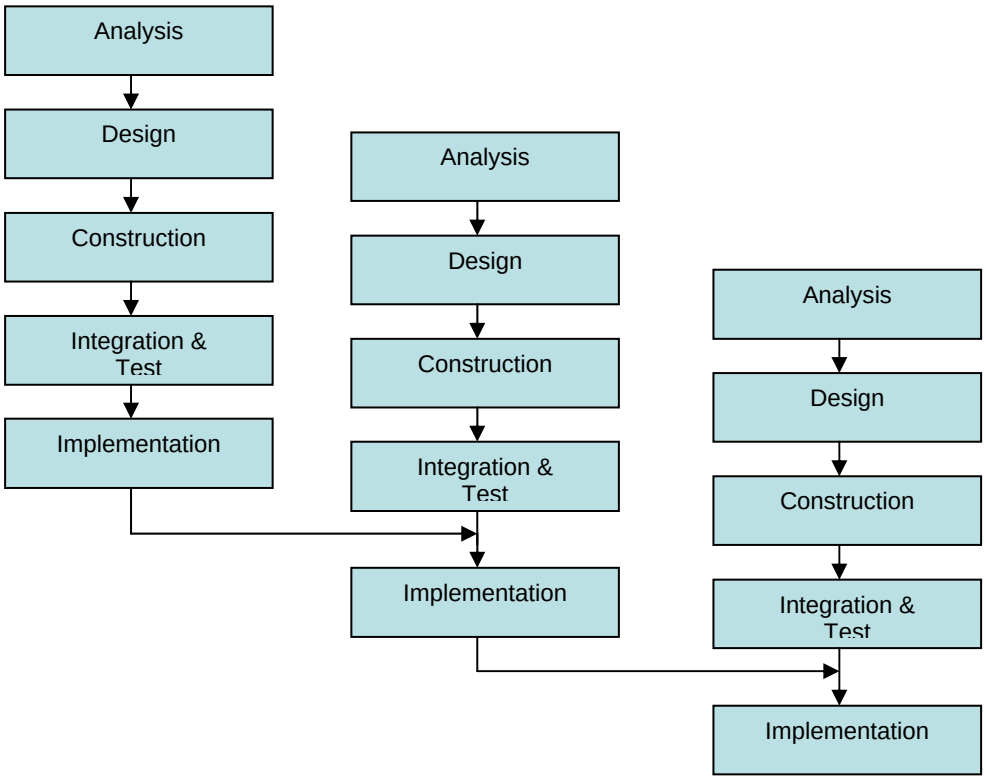

Figure ES-3: *The Incremental Development Methodology*

Spiral Model: The spiral model breaks the single development cycle of the waterfall model into a series of developments, each building on the previous one, to produce the final product. It is sometimes referred to as a "build a little, test a little" approach, where major risk elements are tackled in individual development segments. The spiral method is particularly well-suited for programs with unclear initial requirements, as the approach allows for moderate changes in the overall development direction throughout. The spiral methodology is shown in **Figure ES-4**. Each cycle represents a transition through the entire SDLC.

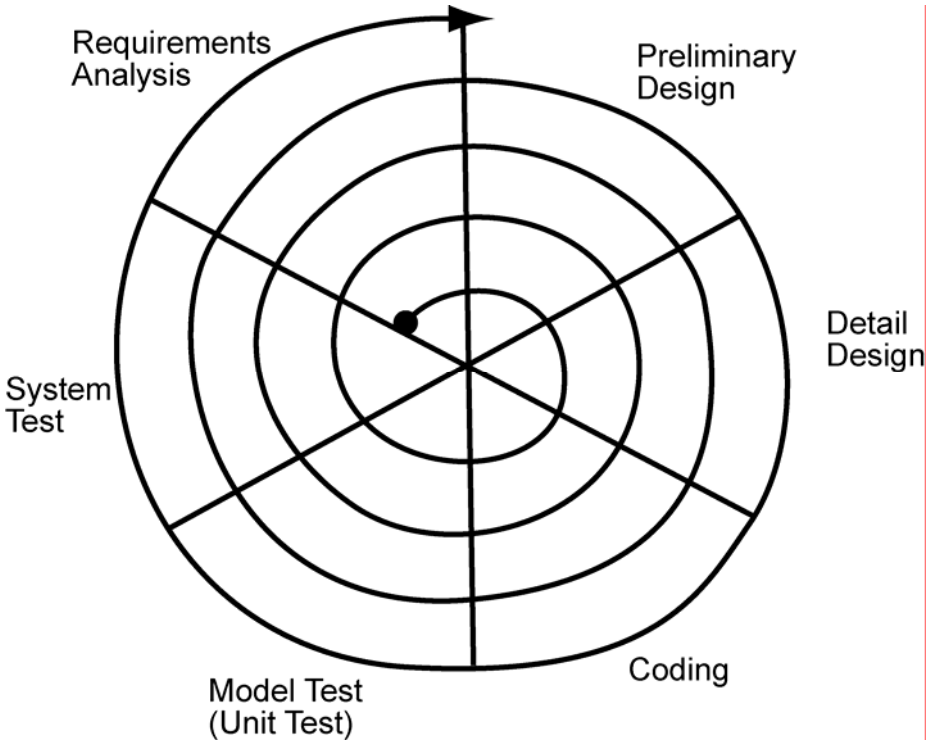

***Figure ES-4**: The Spiral Development Methodology*

Enterprise Architecture (EA)

The Department of the Interior Enterprise Architecture (IEA) guides the transformation of the Department's systems to a single, tightly-integrated whole, more responsive to the needs of both its internal users and external customers. The IEA is expressed as a set of plans, procedures and reference models tied to the Federal Enterprise Architecture (FEA) and the FEA architecture reference models

The DOI EA helps investment managers and solution developers to:

- Understand business processes to take advantage of standardization based on common functions to customers.
- Ensure that automated systems optimally support the business processes and minimize the data collection burden.
- Acquire new systems and coordinate technology investments in a fashion consistent with DOI strategic goals and policies.
- Streamline organizational structure and distribution of responsibilities across the DOI using Federal and DOI interoperability standards.

- Promote reusability of systems, data and processes across the Federal Government and DOI.
- Train employees in how the enterprise operates and how they fit into the enterprise.

The DOI EA methods and repository provide the means to describe analyze and improve IT Capital planning. All architected solutions developed must demonstrate traceability to the Business Reference Model (BRM), Technical Reference Model (TRM), Service Reference Model (SRM), Data Reference Model (DRM), and Performance Reference Model (PRM):

The **Business Reference Model** is a function-driven framework that describes the Lines of Business and Internal Functions performed by the Federal Government independent of the agencies that perform them. All IT investments (including non-major) are mapped to the BRM to identify collaboration opportunities.

The Technical Reference Model provides a framework to describe the standards, specifications, and technologies supporting the delivery, exchange, and construction of business (or service) components and e-Gov solutions. The Federal TRM unifies existing Department TRMs and electronic Government guidance by providing a foundation to advance the re-use of technology and component services from a government-wide perspective.

The Service Component Reference Model provides a common framework and vocabulary for characterizing the IT and business components that collectively comprise an IT investment. The SRM will help agencies rapidly assemble IT solutions through the sharing and re-use of business and IT components. A component is a self-contained process, service, or IT capability with pre-determined functionality that may be exposed through a business or technology interface.

The Data Reference Model describes, at an aggregate level, the data and information that supports government program and business line operations. This model enables agencies to describe the types of interaction and exchanges that occur between the Federal Government and citizens.

The Performance Reference Model is a standardized framework to measure the performance of major IT investments and their contributions to program performance. This model helps produce enhanced performance information to improve strategic and daily decision-making; improves the alignment and better articulates the contribution of inputs to outputs and outcomes; and identifies performance improvement opportunities that span traditional organizational structures and boundaries.

The SDLC and the Enterprise Architecture – The Alignment Process

All solutions developed under the DOI SDLC must conform to the principles, practices, and policies established by the EA and must contribute to the attainment of the Department's strategic goals at every stage of the development process. The degree of this conformance is normally referred to as the *alignment* of a solution to the EA. The determination of the degree of conformance is normally referred to as an *assessment*.

Assessment Process Overview

The assessment process compares a solutions policies, practices, procedures and development models against the EA and EA reference models to determine the extent to which a solution:

- Contributes to the attainment of the Department's EA strategic goals (PRM)
- Meets the Department's policy and technical standards (TRM)
- Corresponds to the federations best practices for data management (DRM)
- Corresponds to the federation's best practices for business processes (BRM)
- Interoperates with other solutions (TRM)

Although it is possible to identify failures in alignment such as violations of specific pass/fail criteria, it is not possible to assess the exact degree to which a solution aligns in a single number. Instead, assessment represents an overall judgment as to how well the solution advances the goals of the enterprise while observing its rules. Alignment is an evolutionary process. As each solution evolves, its degree of alignment increases.

The SDLC and the Governance Process

The SDLC guides the realization of investments selected during the CPIC process. In order to ensure that the solution developed under the SDLC corresponds in form, function, budget, and schedule to both the investment visualized during CPIC as well as the Enterprise Architecture, it is necessary to tightly couple the CPIC to the SDLC. **Figure ES-5** illustrates how the CPIC process governs the evolution of a solution across the SDLC.

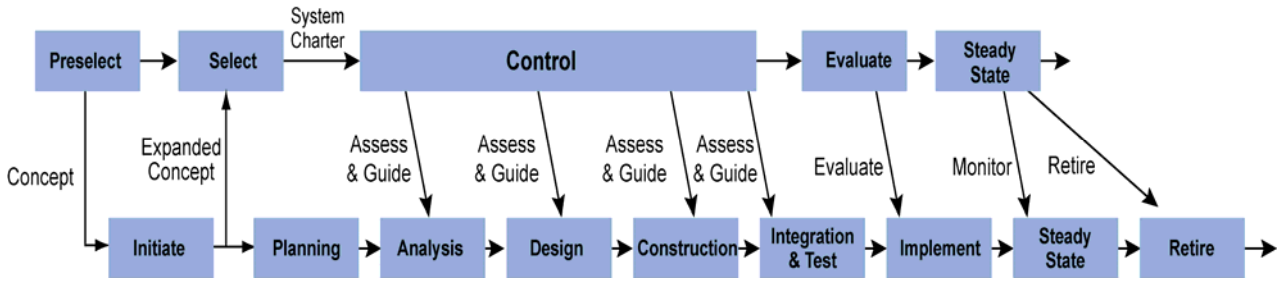

***Figure ES-5**: The SDLC and the CPIC—the Governance Process*

The Assessment and Guidance Process

As a solution progresses from requirements definition to implementation, regular governance reviews are held. These reviews provide an opportunity for Project Managers to raise issues concerning the IT developmental process, including security, telecommunications, enterprise architecture alignment, E-Government, GPEA compliance, Section 508 concerns, etc.

The project manager uses a performance based management system to evaluate project performance and report variance.

The project manager assess alignment with the EA in order to ensure that the program continues to contribute to the EA strategic goals while maintaining compliance with all plans, policies and procedures.

The DOI IRB review project performance, and take corrective action if the project performance variance exceeds 5 percent from the project's established baseline.

The DOI IRB reviews are based on factors including the strategic alignment, criticality, scope, cost, and risk associated with all initiatives. The Project Sponsor establishes milestones as part of the investment baseline against which performance will be measured throughout the SDLC. Agencies are expected to uphold these milestones; OMB will hold agencies responsible for meeting milestones as originally indicated in the baseline. After establishing the milestones, the Project Sponsor revises the project plan as required to meet the approved milestones.

IT Security

IT security is an explicit part of the SDLC process. All DOI systems must demonstrate that IT security controls are explicitly incorporated consistent with FISMA and OMB guidance. Cost effective security of DOI information systems must be an integral component of business operations.

Each system development should include costs associated with all aspects of security program including: ongoing cyclical Certification and Accreditation (C&A), risk identification & mitigation activities, and day-to-day investment level security operations activities.

Scope of SDLC

The DOI SDLC covers the development of both IT solutions originating at the supporting offices of the component bureaus as well as Department-wide/cross-cutting and multi-agency systems originating in DOI level offices and OMB. All DOI IT solutions are identified in the DOI IT Portfolio. All IT projects meeting the criteria for a major investment must employ either this SDLC or an SDLC in compliance with the requirements of this SDLC.

Major Investment Criteria

Major IT systems meet at least one of the following criteria:

- Any investment that was reported to OMB the previous year as a major investment.
- $5M annual cost or > $35M lifecycle cost
- Importance to the mission or its significant role in administration of programs, finances, property, or other resources
- Is an integral part of the Department's modernization blueprint (EA)
- Mandated by legislation or executive order, or identified by the Secretary as critical
- All financial systems with an annual cost greater than $500,000.
- High risk as determined by OMB, GAO, Congress and or the CIO.
- Directly Supports the President's Management Agenda Items of "high executive visibility"
- E-Government, Departmental, cross-cutting (across more than one office or Bureau)
- Links to the first two layers of the FEA. (This is meant to imply the first two layers of the BRM: Services to Citizens and Mode of Delivery)
- These investments are considered to be strategic for the Department and have a greater documentation burden. Each is individually reported to OMB as an Exhibit 300 business case. These investments form part of the DOI IRB IT portfolio together with smaller investments from DOI Bureaus.

Key Decision Making Bodies — General Guidance

The following decision-making bodies are responsible for ensuring that proposed investments meet the Department's strategic, business, and technical objectives:

DOI Investment Review Board (IRB)

The Departmental-level IT governing body is the IRB. It is responsible for the following activities;

- Selecting, controlling, and evaluating all investments included in the DOI portfolio.
- Defining the decision criteria that will be employed to select among IT investments for the DOI IT Investment Portfolio.
- Making technical decisions regarding the effective use of DOI IT investments and resources, including systems development, infrastructure, maintenance, and IT consulting.
- Approving, disapproving, or deferring judgment on the entire portfolio while also reserving the right to review each IT investment under consideration for, or already within, the DOI IT Investment Portfolio.

Integrated Project Team

Integrated Project Teams (IPTs) are tasked with the day-to-day oversight of solutions under development. These teams are required as part of the Fiscal Year 2005 President's Budget Pre-Select and Select Phases. The primary members of a project review board are: the Project Sponsor, who has been selected during the CPIC Pre-Select Phase and is responsible for articulating this need within the organization; and the Project Manager, who is responsible for the actual development of the solution. The Project Sponsor and Project Manager select the remainder of the IPT. IPTs are structured to oversee the development activities of solutions across the entire life cycle. Specifically, IPTs are structured to the following activities:

- Review on-going solution development activities to ensure that their status, progress, and outlook are satisfactory and consistent with project plans.
- Identify deficiencies in project development, develop corrective actions and monitor their execution.
- Provide recommendations to the ITMC to support their decision to continue reduce or terminate solution development activities.
- Conduct periodic reviews of project status, control, performance, risk and outlook.

- Establish and execute the necessary project controls to manage requirements; risk; cost, schedule, and technical baselines; and performance outcomes.

1 Introduction

1.1 Purpose

This document describes the Department of the Interior (DOI) Solution Development Lifecycle (SDLC) process. It presents a process that can be used by DOI to transform elements of its IT investment portfolio into actual systems and software. This process allows DOI to optimize the use of its IT resources, address its strategic needs, and comply with applicable laws and guidance.

The SDLC is a structured, integrated approach to system development. It ensures that all system developments align with the DOI mission and support business needs while minimizing risks and maximizing returns throughout the system's lifecycle. The SDLC relies on a systematic planning, analysis, development, test and on-going evaluation process to ensure each investment's objectives support the business and mission needs of the Department (see **Figure 1-1**).

By providing a standard methodology for these developments, the SDLC enables institutionalization of DOI's strategic IT direction and ensures that DOI develops IT systems with the objective of maximizing return to the Department and achieving business goals.

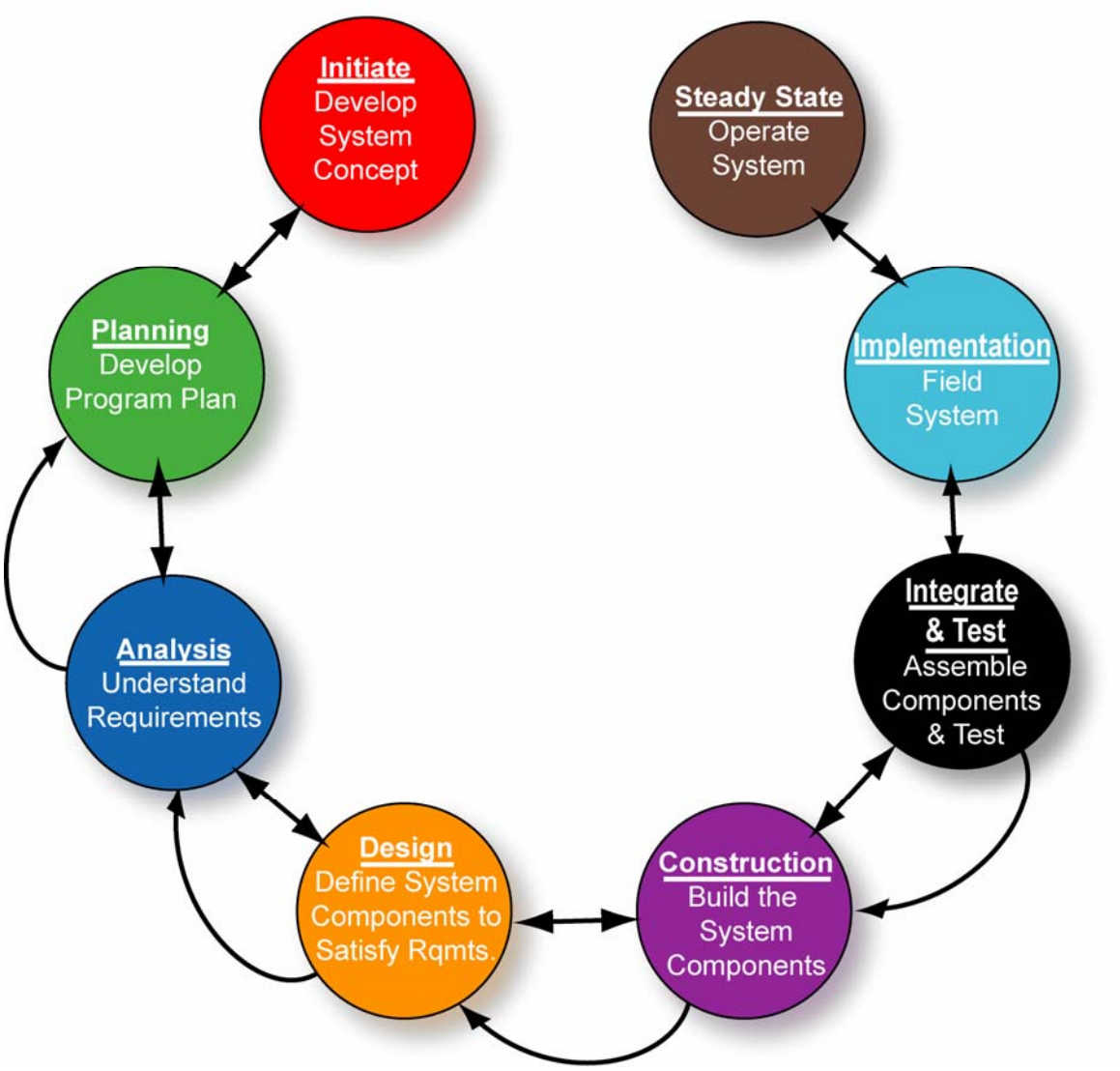

Figure 1-1 *SDLC Information and Process Flow*

1.2 Point of Contact

The SDLC process is primarily supported and maintained by the DOI Office of the Chief Information Officer (OCIO). For further information about this Guide or the SDLC process, please contact the Chief, Portfolio Management Division (PMD) in the OCIO at either (202) 208-4109 or OCIO CPIC Working Team at OS_PIO_CPIC@ios.doi.gov.

1.3 Scope of SDLC

All Departmental IT system developments, maintenance efforts, at all levels of sensitivity, whether developed by DOI, or developed on behalf of DOI bureaus and offices must conform to this guidance.

1.4 Roles and Responsibilities

The following decision-making bodies and personnel have been established.

Investment Review Board (IRB): The governing and approval bodies responsible for ensuring that proposed investments meet DOI strategic, business, and technical objectives and manages the overall IT portfolio. The IRB reviews, makes decisions and issues guidance on the implementation of recommendations contained in Modernization Blueprints for information technology (IT) lines of business.

Budget Analyst: Official responsible for serving as the primary interface between the investment and the Budget Office.

Bureau or Office Chief Information Officer: Responsible for implementing Departmental policy, reviewing Bureau specific investments, and making recommendations to the bureau or office IRB.

Capital Planning Coordinator: Official responsible for serving as the primary interface for capital planning between the investment and CIO is also a member of the Capital Planning Working Team (CPWT) that helps to shape and refine DOI's CPIC process.

Capital Planning Working Team: The mission of the CPWT is to enable and assist Bureaus and offices in IT capital planning and investment management. The mission is cooperative, inclusive of architecture, budget, security, financial and other high priority DOI efforts.

Contracting Officer: Official responsible for serving as the primary acquisition support for the investment and interface between the investment and the Office of Acquisition and Property Management.

CPIC Sponsor: Responsible official for providing executive sponsorship of the investment; should be a senior level executive within the applicable mission area or office or Bureau.

DOI Chief Information Officer (CIO): Responsible for setting Departmental IT policy, reviewing all IT investments, and making recommendations to the DOI IRB.

DOI Office or Bureau Head: Responsible official for approving CPIC documentation before submission to OCIO.

Executive Working Group(s) (EWG): Responsible for assessing how well potential major investments meet a predetermined set of capital planning decision criteria and providing recommendations to the IRB. The IRB appoints Executive Working Groups as needed. (Examples; Architecture Review Board (ARB) or e-Gov team)

Project Manager: Trained or experienced official responsible for management and completion of one or more IT investment projects. (Reference DOI OCIO Directive 2004-019)

Project Sponsor or Functional Manager: Business official responsible for the strategic business processes under development or enhancement and for ensuring their integrity; also serves as the primary user interface to the CIO, EWG, and IRB.

Proponent: Individual or organization that proposes an IT investment to meet a mission or business need.

System Owner: Responsible for ensuring that an investment is evaluated on an annual basis and receives an appropriate level of funding for the operations and maintenance of the system. The System Owner and the Project Sponsor can be identical.

1.5 Process Overview

The SDLC is a structured process in which DOI systems are conceived, defined, developed, tested and continually monitored throughout their lifecycle. Both successful developments and those that are terminated or delayed are evaluated to assess the impact on future developments and to benefit from any lessons learned. The SDLC contains eight phases (Initiation, Planning, Analysis, Design, Construction, Integration and Test, Implementation and Steady State). In the following paragraphs, each SDLC phase is described in the following format:

Purpose: Describes the objective of the phase;

Entry Criteria: Describes the phase requirements, and thresholds for entering the phase;

Process: Describes the type of justification, planning, and review that will occur in the phase;

Enterprise Architecture Considerations: describes the how the IPT should use the EA in the phase and the governance activities that will take place during the phase; and

Exit Criteria: Describes the action necessary for proceeding to the next phase.

Completing one phase is necessary before beginning a subsequent phase. Each phase is overseen by the IRB, which ultimately approves or rejects an investment's advancement to the next phase. This ensures that each

investment receives the appropriate level of managerial review and that coordination and accountability exist.

1.6 Process Coordination

Approved investments must move through the CPIC and budget processes to obtain investment funding. They must conform to any guidance issued by the IRB. The sponsoring program office is responsible for preparation and submission to the Department of all budget and/or Working Capital Fund requests for its investments.

1.7 Document Structure

This document is divided into nine chapters and two appendices as described below:

Chapter 1: Introduction. Describes the SDLC purpose, scope, thresholds, roles and processes.

Chapter 2: Initiation Phase. Validates a solution concept and explores potential solutions based on the concept.

Chapter 3: Planning Phase. Further extends the solution concept, describing how the business will operate once the approved system is implemented and assessing the system's impact on business processes, employee and customers.

Chapter 4: Analysis Phase. Transforms the needs specified in the previous phases into explicit statements of requirements in terms of system inputs, processes, outputs, and interfaces.

Chapter 5: Design Phase. Converts the detailed, defined requirements developed in the Analysis Phase into the complete, detailed specifications for the solution necessary to guide its actual construction. Addresses, in detail, how the solution will meet the defined functional, physical, interface, and data requirements.

Chapter 6: Construction Phase. Creates the hardware, communications, and executable software according to the detailed specifications produced during the design phase and verifies that the created elements meet their original design specifications.

Chapter 7: Integration and Test Phase. Integrates and systematically tests the various components of the system; verifies the satisfaction of all functional, physical and requirements.

Chapter 8: Implementation Phase. Transfers the integrated and tested solution from the development environment to the actual operating environment. Re-tests all major functions to ascertain that the system operates as

expected when used by all actual internal users, external customers, and other systems.

Chapter 9: Steady State. Assesses the mature system to ascertain its continued effectiveness in supporting mission requirements and evaluates the costs of continued support, potential retirement and replacement.

Appendices:

A: Glossary of Terms and Acronyms. Provides definitions for terms and acronyms used throughout this document.

B: References. Provides a list of references used to develop this document.

2 Initiation Phase

2.1 Purpose

The Initiation Phase supports and extends the CPIC Select Process by:

- Validating a system concept developed in the CPIC Pre-Select Phase for improving business accomplishments or removing a deficiency related to a business need,
- Identifying significant assumptions and constraints on solutions to that need, and
- Exploring alternative methods and technologies that implement the system concept.

2.2 Entry Criteria

The CPIC Pre-Select Phase is complete and the following information is available:

- Draft Business Case - Exhibit 300
- Mission Needs Statement
- Architecture Blueprint or Enterprise Context for Investment
- System Concept

In addition, The Integrated Project Team (IPT) comprising the project sponsor, project manager and other members identified during the Pre-Select Phase of the CPIC process are in place.

2.3 Process

Initiation Phase is the first step in the process of transforming an IT investment decision into an actual system. This process may be initiated as a result of business process improvement activities, changes in business functions, advances in information technology, or may arise from external sources, such as public law, the general public or state/local agencies. The Project Sponsor, who has been selected during the CPIC Pre-Select Phase, articulates this need within the organization to initiate the project life cycle. During this phase, a qualified project manager, i.e., a DOI Certified Project Manager is appointed who prepares a concept proposal based on the business and technical goals articulated in the Mission Needs Statement, System Concept and Business Case developed in the CPIC Pre-Select Phase. During this phase, the project team begins the process of defining business

requirements and associated system performance metrics, performance measures, benefits, and costs, as well as initial project planning efforts in preparation for inclusion in the Department's IT portfolio.

The IPT uses the information provided in the initial Project Charter and the draft Business Case - Exhibit 300 to develop a high-level scope statement, a description of the project and an initial system concept. Next, an expanded IPT is identified; that is, the team that will be responsible for the actual realization of the solution. The Project Charter is expanded to identify each IPT member, their anticipated length of time on the project and their individual roles and responsibilities. Finally, as guidance to the IPT, the Project Charter is also expanded to convey the purpose and requirements of the Project to the IPT – the "who, what, and why" of the Project. The Project Charter details the sponsors, customers and organizational expectations on how the project will be managed and what the high level deliverables will be.

Figure 2-1 provides a summary of the Initiation Phase process steps.

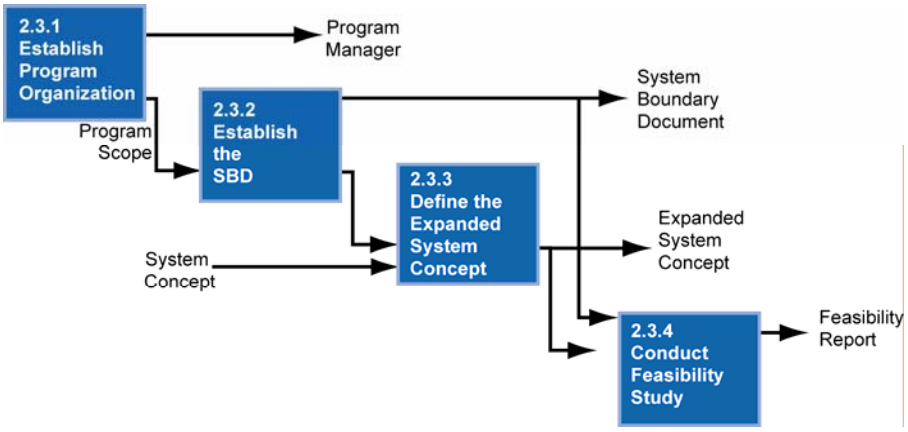

Figure 2-1: *Initiation Phase Process Steps*

2.3.1 Establish Project Organization

This activity involves the appointment of a project manager who carries both the responsibility and accountability for project execution. For small efforts, this may only involve assigning a project to a manager within an existing organization that already has an inherent support structure. For new, major projects, a completely new organizational element may be formed - requiring the hiring and reassignment of many technical and business specialists.

Each project will have an individual designated to lead the effort. The individual selected will have appropriate skills, experience, credibility, and availability to lead the project. Clearly defined authority and responsibility must be provided to the project manager.

The project manager will work with Stakeholders to identify the scope of the proposed program, the participation of the key organizations, and individuals who can participate in the formal reviews of the project. This decision addresses both programmatic and information management-oriented participation as well as those technically interested in the project.

2.3.2 Establish the System Boundary Document

The system boundary document identifies the scope of a system (or capability). It should contain the high level requirements, benefits, business assumptions, and program costs and schedules. It records management decisions on the envisioned system early in its development and provides guidance on its achievement.

2.3.3 Define the Expanded System Concept

A set of potential system solutions based on the system concept developed in the CPIC Pre-Select Phase are identified and evaluated for potential risks and benefits. Initial estimates of cost, schedule and resource requirements are prepared. A selection is made based on the feasibility of the potential solutions. This selection becomes the basis for the System Charter developed in the CPIC Select Phase.

The following activities are conducted during concept expansion:

- Analyze mission needs statement.
- Identify business objectives based on mission analysis and mission needs statement.
- Identify high-level performance measures. (Additional detailed performance measures will be developed as part of the Definition Phase.)
- Identify risk criteria.

- Determine key selection criteria to evaluate concept alternatives that support high-level performance measures and business objectives.
- Identify a set of acceptable solutions for further analysis. (Note that solutions may have both IT and non-IT components; that is, a solution may involve both the installation of new or modernized systems and software *and* the modernization or reorganization of business practices.)
- Ensure that each solution aligns with Department standards for security and privacy, enterprise architecture and e-Government planning.
- Determine whether each solution may incorporate components applicable to other mission needs and, if so, whether it may be appropriate to identify it as a key system for the development of a modernization blueprint. If not, special care should be taken to determine and justify how the solution is truly unique and entails components that cannot be shared and reused for other purposes.
- Conduct a detailed alternatives analysis, based on return on investment and net present value, of each proposed solution, together with the three best alternatives. Pay particular attention to:
    - Expected benefits measured against the value of current technology
    - Potential organizational changes regarding facilities and/or users
    - Budget, schedule and personnel constraints
    - Internal control and information security requirements
    - Project risks, both technical, organizational and schedule related
    - Project costs, both recurring and non-recurring
    - Expected useful life of the project
    - Tangible and intangible benefits of the solution, for example, interoperability with other systems and overall architectural alignment
- Based on the analysis, select a solution for detailed analysis during the Definition Phase and for use in the CPIC Select Phase.

2.3.4 Prepare an Alternatives Analysis

An alternatives analysis is compiled and submitted for senior management or board study. The analysis provides an overview of the proposed project and identifies expected costs and benefits in terms of economic, technical, and operational feasibility. The analysis should also describe alternative solutions and include a recommendation for approval or rejection. The analysis should be reviewed and signed off on by all affected parties. If approved, management should use the Alternatives Analysis and support documentation to begin the planning phase.

2.3.5 Review and Approve Proposed Solution

The Bureau Head reviews the Alternatives Analysis and requests the project sponsor or functional manager, and/or bureau sponsor to update the package or make changes as needed. The Bureau Head then approves the submission and sends it to the bureau CIO.

2.3.6 Review Proposed Solution and Recommend Appropriate Action

The CIO reviews the Alternatives Analysis and provides any comments and/or questions to the bureau. The bureau addresses the issues and sends an updated project charter to the CIO. The CIO forwards the updated Alternatives Analysis with its assessment to the bureau IRB for review. The bureau IRB assesses the investment with an emphasis on architecture alignment, conformance to any applicable IT Modernization Blueprints, and the proposed concept management plan. This information is then linked to future portfolio selection decisions.

2.3.7 Make Final Development Decisions

The DOI IRB reviews the bureau's IRB recommendation and makes the final investment decisions. If the DOI IRB approves the bureau's IRB recommendation, the investment moves forward into the Select Phase.

2.4 Enterprise Architecture Considerations

The key considerations for developers are avoiding duplication with existing systems and making sure that the system concept being developed satisfies the business requirements. In order to minimize the risk of duplication, EA repositories such as the DOI EA Repository (DEAR), the bureau EA repository (if present), and any applicable Federal EA repositories should be carefully researched to ascertain what currently exists. In order to ensure that the business focus is being properly maintained, the solution should be

folded into the DOI Performance Reference Model (PRM) to ensure that the "line of sight" from business needs to the conceptual technical solution is unbroken.

From the EA governance perspective, the proposed solution must be carefully investigated to ensure that it is contributing, to the maximum extent possible, to the attainment of DOI strategic goals and will adhere to all major policies, mandates, and procedures.

2.5 Exit Criteria

Table 2-1 provides a summary of the documents and models generated during the Initiation Phase process, as well as the whether the document requires approval or whether the document is required only for the file for recordkeeping purposes.

Document	Required For File	Required For Approval
Expanded System Concept	X	X
Alternatives Analysis	X	X
System Boundary Document	X	
Performance Reference Model (updated)	X	
Preliminary Budget and Staffing Plan	X	X

Table 2-1 *Summary of documents generated during the Initiation Phase.*

3 Planning Phase

3.1 Purpose

The Planning Phase further extends the solution concept, describing how the business will operate once the approved solution is implemented and assessing the solution's impact on business processes, employee and customers. To ensure that the solution can deliver the products and/or services required on-time and within budget, the project resources, activities, schedules, tools, and reviews are defined and detailed and documented in plans. Additionally, security certification and accreditation as well as record management activities begin with identification of system security requirements and the completion of a high-level vulnerability assessment. These plans and certifications are essential to the success of the entire project; they are carefully reviewed and updated throughout the remaining SDLC phases.

The SDLC Planning Phase is very tightly associated with the CPIC Select Phase through the plans, many of which are used in the CPIC Select Phase to construct the System Charter. Additionally, both the CPIC and SDLC processes work closely together during this phase in the areas of risk management, lifecycle costing and overall project planning.

3.2 Entry Criteria

Prior to entering the Planning Phase, the expanded solution concept must be complete and the resulting Alternatives Analysis must have obtained IRB approval.

3.3 Process

The Planning Phase is the most critical step in completing development, acquisition, and maintenance projects. Careful planning, particularly in the early stages of a project, is necessary to coordinate activities and manage project risks effectively. The depth and formality of project plans should be commensurate with the characteristics and risks of a given project.

The project plans refine the information gathered during the Initiation Phase by further identifying the specific activities and resources required to complete a project. A critical part of a project manager's job is to coordinate discussions between user, audit, security, design, development, and network

personnel to identify and document as many functional, security, and network requirements as possible.

Figure 3-1 provides a summary of the Planning Phase process, as well as the individual(s) and/or group(s) responsible for completing each process step. Each step is detailed in the following diagram:

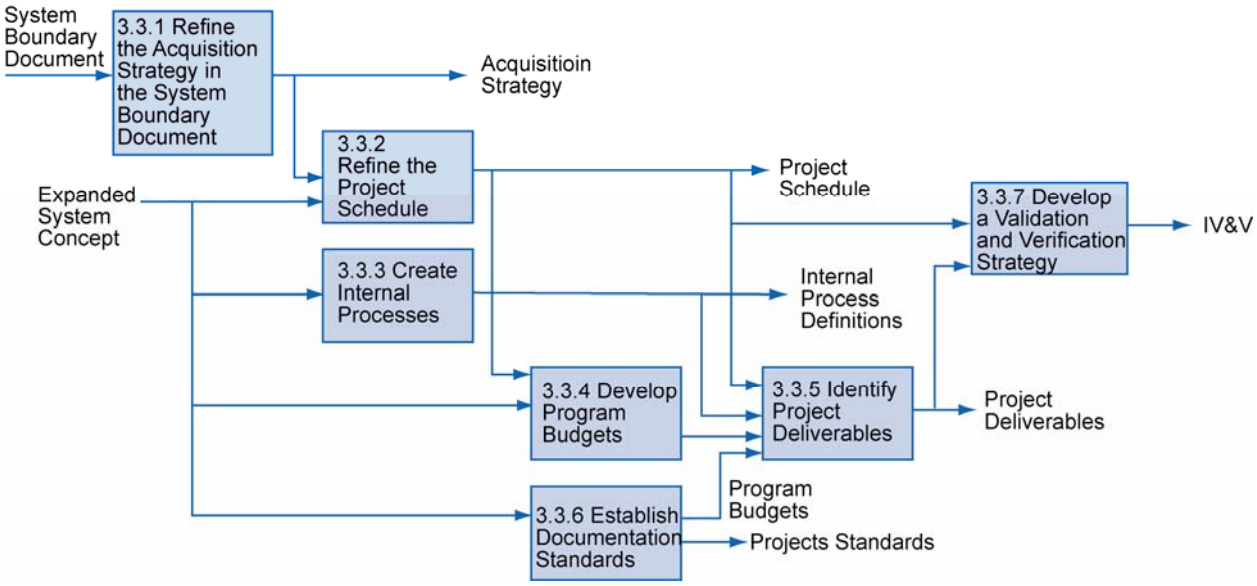

Figure 3-1: *Planning Phase Process Steps*

3.3.1 Refine the Acquisition Strategy in the System Boundary Document

The IPT refines the role of system development contractors during the subsequent phases and plans accordingly. For example, if the system concept envisions active participation of system contractors in the Analysis Phase. Then, the Planning Phase must include complete planning, solicitation preparation, and source selection of the participating contractors (awarding the actual contract may be the first activity of the next phase). If contractors will be used to complete the required documents, up-front acquisition planning is essential.

3.3.2 Refine the Project Schedule

The preliminary project schedule contained in the system concept is refined and expanded. The IPT should identify and schedule major project phases and the tasks to be completed within each phase. Due to the uncertainties involved with estimating project requirements, the team should build flexibility into project schedules. However, the amount of flexibility built into schedules should decline as projects progress and requirements become more defined.

3.3.3 Create Internal Processes

Project management creates, gathers, adapts, and/or adopts the internal management, engineering, business management, and contract management internal processes that will be used by the project office for all subsequent life-cycle phases. This could result in the establishment of teams or working groups for specific tasks.

Most projects include working groups in the following areas:

Risk Management – Managing risks is an important part of the project planning process. Organizations should establish procedures to ensure managers appropriately assess, monitor, and manage internal and external risks throughout a project's life cycle. The procedures should include risk acceptance, mitigation, and/or transfer strategies.

External risks include issues such as vendor failures, regulatory changes, and natural disasters. Internal risks include items that affect budgets, such as inaccurate cost forecasting or changing functional requirements; scheduling difficulties, such as unexpected personnel changes or inaccurate development assumptions; and work flow challenges, such as weak communication or inexperienced project managers.

Change Management – Personnel often request the addition or modification of functional requirements during software development projects. Although the addition or modification of requirements may be appropriate, standards should be in place to control changes in order to minimize disruptions to the development process. Project managers should establish cut-off dates after which they defer requested changes to subsequent versions. Additionally, representatives from the same departments involved in establishing requirements should be involved in evaluating and approving proposed changes. Large, complex, or mission-critical projects should include formal change management procedures.

Standards – Project plans should reference applicable standards relating to project oversight activities, system controls, and quality assurance. Oversight standards should address project methodology selections, approval authorities, and risk management procedures. System controls standards should address functional, security, and automated-control requirements. Quality assurance standards should address the validity of project assumptions, adherence to project standards, and testing of a product's overall performance. Management should review, approve, and document deviations from established standards.

3.3.4 Develop Program Budgets

IPT managers should develop initial budget estimations of overall project costs so they can determine if projects are feasible. Managers should monitor the budgets throughout a project and adjust them if needed; however, they should retain a baseline budget for post-project analysis. In addition to budgeting personnel expenses and outsourced activities, it is important to include the costs associated with project overhead such as office space, hardware, and software used during the project.

3.3.5 Identify Project Deliverables

Clearly defined expectations are a prerequisite for successfully completing projects. Representatives from all departments involved in, or affected by, a project should assist in defining realistic project objectives, accurate informational, functional, and interface requirements, and objective acceptance criteria.

Major project deliverables include:

- Acquisition Plan
- Configuration Management Plan
- Validation and Verification Plan
- Quality Assurance Plan
- Project Management Plan
- System Security Plan
- Systems Engineering Management Plan

3.3.6 Establish Documentation Standards

Project plans should identify the type and level of documentation personnel must produce during each project phase. For instance, personnel should document project objectives, system requirements, and development strategies during the initiation phase. The documentation should be revised as needed throughout the project. For example, preliminary user, operator, and maintenance manuals created during the design phase should be revised during the development and testing phases, and finalized during the implementation phase.

3.3.7 Develop a Validation and Verification Strategy

Describe the testing strategies that will be used throughout the lifecycle phases. Include descriptions of contractor, government, and appropriate independent assessments required by the project.

3.3.8 Establish a Governance Schedule

A major element in the CPIC Control Phase is a regular review of development activities from the SDLC Analysis through the SDLC Implementation and Test Phases. Both a regular review cycle and reviews tied to major project events should be established at this time with particular emphasis on:

- architecture alignment,
- strategy,
- cost/schedule and
- policy and procedures

3.3.9 Review Project Plans

The Bureau Head reviews the project plans and requests the project manager to make changes any necessary changes. The Bureau Head then approves the submission and sends it to the Bureau CIO.

3.3.10 Review Planning Phase and Recommend Appropriate Action

The bureau CIO reviews the results of the Planning Phase based on the established CPIC criteria and develops findings and recommendations. The bureau CIO forwards the package to the bureau IRB for review. The bureau IRB reviews the results for compliance with Departmental strategic, legislative, and budgetary goals. The bureau IRB forwards its findings and recommendations to the DOI IRB for the final decision.

3.3.11 Make Final Investment Decisions

The DOI IRB reviews the bureau's IRB recommendation and makes the final decision. If the DOI IRB approves the bureau IRB's recommendation, the transition to the Analysis Phase is approved and a review schedule for the Analysis Phase is established in concert with the CIO and bureau IRB. Simultaneously, the CPIC initiative corresponding to this project moves to the Control Phase.

3.4 Enterprise Architecture Considerations

The restrictions placed on a solution by the Technical Reference Model should be carefully considered during the solution planning, since these restrictions could have a significant effect on project cost and schedule. Existing repositories should also be re-visited at this stage to identify potentially reusable elements from other projects.

3.5 Exit Criteria

Prior to exiting the Planning Phase, the following areas must have been planned and documented in detail:

- Established performance goals and quantifiable performance measures.
- Developed a project plan which details quantifiable objectives including an acquisition schedule, project deliverables, and projected and actual costs.
- Identified costs, schedule, benefits, and risks.
- Established security, Section 508 (IT accessibility), Privacy Act assessment, data, and architecture goals and measures.
- Established an EA governance review schedule.
- Obtained management approval to enter the Analysis Phase.

Table 3-2 provides a summary of the documents generated during the Planning Phase, as well as whether the document requires approval or whether the document is required only for the file for recordkeeping purposes.

Document	Required For File	Required For Approval
Concept of Operations Plan	X	
Risk Management Plan	X	
Configuration Management Plan	X	
Updated lifecycle cost projections	X	
Project Schedule	X	
Security Plan	X	
Enterprise Architecture Plan	X	
Prototype or Pilot Plans	X	
Project Plan (includes budget and project schedule)	X	X
Acquisition Plan and Strategy	X	
System Engineering Management Plan	X	
System Test Plan	X	

Table 3-2 *Summary of documents generated during the Planning Phase.*

4 Analysis Phase

4.1 Purpose

The purpose of the Analysis Phase is to transform the needs specified in the previous phases into explicit statements of requirements in terms of system inputs, processes, outputs, and interfaces. This process takes place at the functional level: That is, the system is described in terms of the functions to be performed (*what* it will do), not in terms of software and hardware operations (*how* it will do it).

The Analysis Phase begins when the DOI IRB approves the transition from the Planning Phase or by management direction. Documentation related to user requirements from the Planning Phase forms the basis for further user needs analysis and the development of detailed user requirements. Because this analysis may reveal new insights into the overall information systems requirements, the team should be prepared to revise deliverables from the Planning Phase, if necessary.

4.2 Entry Criteria

Prior to entering the Analysis Phase, the following areas must have been planned and documented in detail:

- Established performance goals and quantifiable performance measures
- Developed a project plan which details quantifiable objectives, including an acquisition schedule, project deliverables, and projected and actual costs
- Identified costs, schedule, benefits, and risks
- Established security, Section 508 (IT accessibility), Privacy Act assessment, data, and architecture goals and measures
- Established an EA governance review schedule
- Obtained management approval to enter the Analysis Phase

4.3 Process

The Analysis Phase proceeds in four sub-phases: Requirements Analysis, Functional Analysis, Function Allocation, Validation and Verification and the System Requirements Review. These sub-phases are roughly sequential; however, discoveries in one sub-phase could necessitate changes to outputs from previous phases.

During the Requirements Analysis Phase, the system's functional architecture is defined in terms of the operations and events that must be performed in order to meet the mission goals of the system. This proceeds in a top-down fashion and is independent of allocation to hardware, software, or humans. The goal of the function analysis is to assist in defining and allocating functions to the human that are best suited to their capabilities and limitations. Requirements are divided into functional and nonfunctional types: *functional requirements* describe how the system will respond to external stimuli such as a user or external system input, a clock tick or other type of signal; *non-functional requirements* include performance requirements, physical and environmental requirements, legal mandates (e.g., Section 508) and service level agreements.

During the Functional Analysis Phase, the business processes are broken into functional flows. The functional requirements are then allocated to the various functions, creating new functions or breaking apart existing ones as necessary. This process continues until every functional requirement is associated with a function and every function has at least one associated requirement.

During the Function Allocation Phase, the functions defined are allocated to the available resources (humans, hardware, software or combinations). The allocation of some functions will be mandatory and predetermined by constraints established in the Planning Phase or the Requirements Analysis sub-phase. Allocation is determined by comparison of performance between humans, hardware, and software; cost factors; and support for the operators. Allocation decisions are made so as to maximize total system performance and effectiveness. Allocation of a function may require its redefinition into one or more components. Function allocation is also be guided by what pieces of information and decisions are required to initiate, sustain, and otherwise support the functions. The designer must determine how decisions affect or alter the system performance of the system itself. Allocation may be done in static terms or it may be dynamic, with functions changing their allocation at different stages of the system. The system must be defined in terms of component functions, tasks, and subtasks, including the flow of information and the allocation of the functions, tasks, and subtasks to individual system components.

The Validation and Verification Phase has two major goals: to ensure that requirements are complete and to prepare for the testing. The requirements are complete when every mission need can be traced to a set of requirements and no requirement exists that is not traceable to a business need. Preparations for testing at this point involve the examination of each requirement to ensure that it is testable and to develop a test plan outlining the requirements testing process.

The final phase is the Preliminary Design Review. At this review, all system requirements, functions, function allocations and testing strategies are presented to project stakeholders and upper management for review. The

results of this review form the basis for a management's decision as to whether the program should be allowed to proceed forward.

Figure 4-1 provides a summary of the Analysis Phase process, as well as the individual(s) and or group(s) responsible for completing each process step. Each step is detailed in the following diagram:

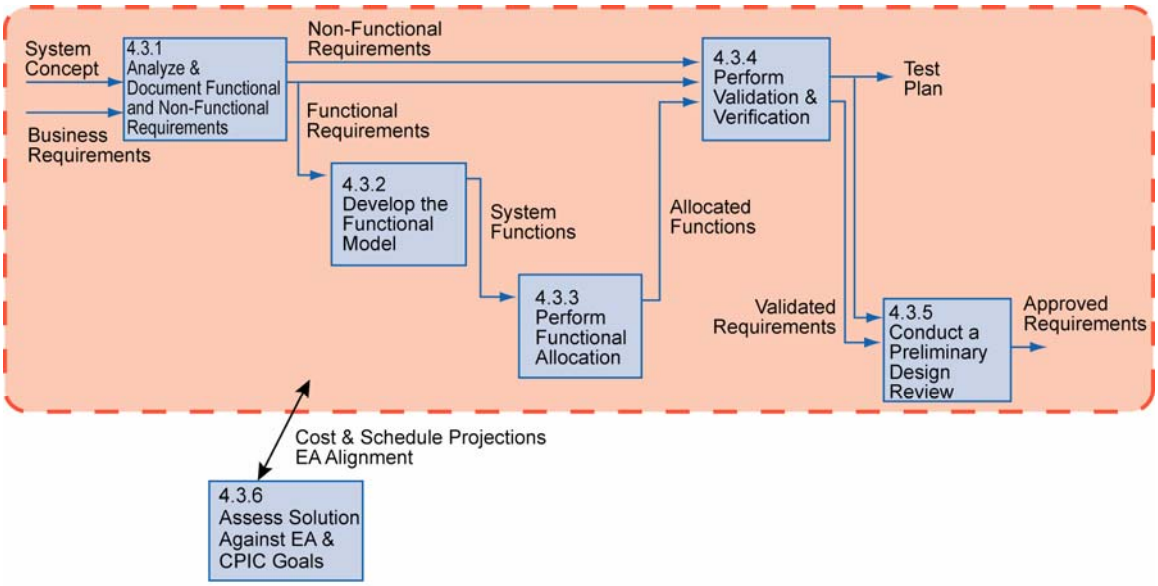

Figure 4-1: *Analysis Phase Process Steps*

4.3.1 Analyze and Document Functional and Non-Functional Requirements

The team first consolidates and affirms the business needs, reviewing them with project stakeholders to ensure both business and technical agreement on what the system is to do. Next, the team analyzes the intended use of the system and specifies the functional and data requirements, connecting the functional requirements to the data requirements. Requirements that cannot be expressed in data and process models such as service level agreements, legal mandates and physical specifications are captured separately in a set of non-functional requirements. The high level architecture and logical design is then refined to support the system and functional requirements.

Define all possible requirements including those for:

- functional and capability specifications, including performance, physical characteristics, and environmental conditions under which the software item is to perform;
- interfaces to external systems;
- qualification requirements;
- safety specifications, including those related to methods of operation and maintenance, environmental influences, and personnel injury;
- security specifications, including those related to compromise of sensitive information;
- human-factors engineering (ergonomics), including those requirements related to manual operations, human-equipment interactions, constraints on personnel, and areas requiring concentrated human attention that are sensitive to human errors and training.

These processes should take place in accordance with the program plan and the plans and standards described in section 3.3.5 and 3.3.6 of the Planning Phase.

4.3.2 Develop the Functional Model

The development team constructs a logical model that describes the fundamental processes and data needed to support the desired business functionality. This logical model will show how processes interact and how processes create and use data. These processes will be derived from the activity descriptions provided in the System Boundary document.

Functions and entity types contained in the logical model are next extended and refined. End-users and business area experts will evaluate all identified processes and data structures to ensure accuracy, logical consistency, and completeness. An analysis of business activities and data structures is next performed to produce entity-relationship diagrams, process hierarchy diagrams, process dependency diagrams, and associated documentation. An interaction analysis is performed to define the interaction between the business activities and business data. This analysis produces process logic and action diagrams, definitions of the business algorithms, entity lifecycle diagrams, and entity state change matrices. A detailed analysis of the current technical architecture, application software, and data is conducted to ensure that limitations or unique requirements have not been overlooked.

4.3.3 Perform Functional Allocation

During this phase, the functions previously defined are allocated to elements of the system (hardware, software and users) for execution. This is normally done using some form of "MABA-MABA[1]" list to characterize what types of function humans and machines are best at combined with some means of comparing trade-offs between possible allocations. The input to this process is the list of functions the system needs to achieve and the output is typically the same list categorized in terms of whether the human, machine, or some combination should implement each function. The decision-making process takes into account the specific strengths and weaknesses of both personnel and machines in achieving each function and the associated risks.

Upon completion of the allocation process, decisions can be made about the automation requirements, personnel requirements and training needed to support the concurrent development of the hardware, software and human aspects of the system.

4.3.4 Perform Validation and Verification

Two different activities take place here: validation of the requirements developed and the preparation for the initial testing and subsequent verification of the requirements.

As part of the validation process, the following checks are performed:

- Is every business activity completely fulfilled by one (or more) functions?
- Is every function associated with at least one business activity?
- Is the functional architecture is capable of operating within established constraints?
- Does the functional architecture satisfy the stated measures of effectiveness and performance?
- Is the functional architecture complete?
- Does the functional architecture satisfy current system requirements, including mission, human, and job or task requirements?
- Are the functions described at a sufficient level of detail for the design process?

As part of the test and verification process, the following tasks are carried out:

- Establish the test criteria and begin test planning. Include all areas where testing will take place and who is responsible for the testing. Identify the testing environment, what tests will be performed, test procedures; and traceability back to the requirements.
- Describe what will be tested in terms of the data or information. If individual functions are being tested separately, this needs to be

[1] "Men Are Best At-Machines Are Best At"

stated in the test plan. Smaller plans may be needed for specialized testing, but they should all be referenced in the test plan.

- Describe how non-functional requirements such as physical or environmental constraints, service levels of agreement and other mandates such as Section 508 requirements will be verified.

4.3.5 Conduct a Preliminary Design Review

The Preliminary Design Review is conducted upon completion of the Analysis Phase by the technical review board, key stakeholders from the business and CPIC personnel. Here the functional requirements identified are reviewed to ensure that they are sufficiently detailed, satisfy all business and technical requirements and constraints and are testable. It also provides the project manager with the opportunity to ensure a complete understanding of the requirements and that the documented requirements can support a detailed design of the proposed system.

4.3.6 Assess Project Progress against EA and CPIC Goals

The CPIC Control Phase for an investment (system) proceeds in parallel with the definition, design and development of the system itself. As part of this phase, the project sponsor holds periodic reviews of system development to determine whether to continue the project. As part of these reviews, the project sponsor determines if the project manager is managing investment cost and schedule variance, mitigating risks, and providing projections for future performance based upon work accomplished to date. From this information, the project sponsor determines whether current cost and schedule projections align with investment implementation (e.g., based upon an assumption of baseline actual costs 10 percent greater than actual, what are the expectations of future performance).

In addition to the budgetary reviews, the alignment of the proposed solution to the enterprise architecture is also conducted. This alignment will be confined to the policy and strategic aspects of the EA, since the functional and data characteristics of the new system are not yet sufficiently well identified. Any significant deviations from the policy requirements of the EA should trigger a major re-evaluation of the solution; likewise, a determination that the system contributes only minimally to the attainment of strategic goals should also be a cause for concern.

The bureau sponsor and project sponsor apply EA and CPIC control screening criteria to determine whether the project has met expectations and identify any deficiencies and corrective actions needed. Updated investment information is submitted to the OCIO and the investment undergoes a control review by the DOI IRB. The results of these reviews are used by the DOI IRB for management of the IT investment portfolio.

4.3.7
Maintain Current Project Cost, Schedule, Technical, and General Status Information

The project manager collects actual information on the resources allocated and expended throughout the Analysis Phase. The project manager compares the actual information collected to the estimated baselines developed during the Planning Phase and identifies root causes for any differences. The project manager reviews the security and infrastructure analyses for accuracy. The project manager maintains a record of changes to the initiative's technical components including hardware, software, security, and communications equipment. Technical component changes may trigger a new architecture review.

4.3.6
Review Documentation and Recommend Appropriate Action

The CIO prepares findings and recommendations based on project documentation and the results of the Preliminary Design Review and forwards the updated package to the bureau IRB for review. The bureau IRB reviews the investment and determines whether to provide continued support to the investment and forwards its recommendations to the DOI IRB for the final decision.

4.3.7
Make Final Control Review Decisions

The DOI IRB issues a decision, based upon the recommendations received from the bureau IRB. The decision is sent to the project sponsor and project manager.

4.3.8
Project Sponsor and Project Manager Implement Decisions

The Project Sponsor acknowledges and implements any corrective action recommended by the IRB.

Prior to the next scheduled review date, the Project Sponsor and Project Manager update the investment information and initiate another preliminary assessment. This formal monitoring of investment progress, and the determination of risks and returns, continues through the Integration and Test Phase of the SDLC.

4.4 Enterprise Architecture Considerations

During this phase, the following factors should be considered:

Examine the **Business Reference Model.** Are the functions being developed similar or identical to existing BRM functionalities? If so, consider the possibility of reusing existing functionality. In the case where the business functionality being developed is new, consider whether this functionality might be usable by other business elements. If so, consider adding the

functionality under development to the Department's BRM and making it available to outside agencies.

Examine the current solution development in the context of the **Technical Reference Model.** Does any element of the new development conflict with the standards, specifications, and technologies described therein? If so, what considerations justify overriding these requirements?

Ensure that the vocabulary being used in solution development is consistent with the vocabulary specified by the **Service Component Reference Model.** If this is not the case, either modify the solution vocabulary or develop a cross-reference. Next, try to group functions together into components based on the notion of *coherence*; that is, select functions that can be grouped around a common theme, such as "calculating performance measures" or "adding a new employee". Record these functional groupings for use in later phases.

Review the **Performance Reference Model.** Consider whether the solution under consideration truly improves strategic and daily decision-making and contributes to the needs of the business.

4.5 Exit Criteria

Prior to exiting the Analysis Phase, investments must execute the following activities:

- Complete the description of all functional and non-functional system requirements.
- Map all system functional requirements to system functions.
- Allocate each system function to hardware, software or personnel.
- Validate all requirements and prepare for testing.
- Conduct a successful Preliminary Design Review.
- Demonstrate to the IRB conformance with any applicable guidance issued pursuant to an IT Modernization Blueprint.
- Demonstrate EA alignment.
- Obtain DOI approval to enter the Design Phase.

Table 4-1 provides a summary of the documents generated during the Design Phase process, as well as the whether the document requires approval or whether the document is required only for the file for recordkeeping purposes.

Document	Required For File	Required For Approval
System Requirements Specification	X	X
Functional Requirements Specification	X	
Requirements Allocation Document	X	
Project Status Reports	X	
Quarterly or Monthly Reports	X	X
System Test Plan	X	
System Requirements Review Materials	X	

Table 4-1 *Summary of documents generated during the Design Phase.*

5 Design Phase

5.1 Purpose

The purpose of the Design Phase is to transform the detailed, defined requirements developed in the Analysis Phase into complete, detailed specifications for the solution that will guide the Construction Phase. The decisions made in this phase address, in detail, how the solution will meet the defined functional, physical, interface, and data requirements. Design Phase activities may be conducted in an iterative fashion, producing first a general design that emphasizes the functional aspects of the solution, then a more detailed design that expands the general design by adding all the necessary technical detail.

Throughout this phase both the design process and the designs themselves are continuously monitored as part of the CPIC Control Phase. (The CPIC Control Phase extends to the Implementation Phase, continuously evaluating the products and process of the project development.).

5.2 Entry Criteria

Prior to entering the Design Phase, the following areas must have been developed and documented in detail:

- Functional and non-functional requirements
- System functions
- Initial Test Plans and Procedures
- Established a CPIC review schedule
- Management approval to enter the Design Phase

5.3 Process

During this phase, the functional architecture is translated into the information required to create the solution and to verify that it meets the requirements specified for it. Attention is focused on decision analysis and task design; information flow (human to computer, human to human); human workload (cognitive, physical, and temporal); human-machine interface; anthropometrics; etc. Trade-offs are considered to ensure that the system architecture optimizes all resources and yields maximum performance. Throughout this phase, the solution is continually monitored for performance, maintenance activities, costs, resource allocation, defects, problems, and requirements changes as part of the CPIC Control process.

Lessons learned for both the investment and the CPIC process are collected and fed back to prior CPIC phases.

The final element in this process is the Critical Design Review. This review is attended by the technical management team, project stakeholders and upper management. At this review, all hardware designs, software designs, and tasks assigned to systems operators and/or other personnel are examined in detail. Traceability between all functional system requirements and the designs is demonstrated. Testing strategies are presented and evaluated for complete testing of all functional and non-functional requirements. The results of this review form the basis for a management's decision as to whether the investment should be allowed to proceed forward.

Figure 5-1 provides a summary of the Design Phase process, as well as the individual(s) and or group(s) responsible for completing each process step. Each step is detailed in the following diagram.

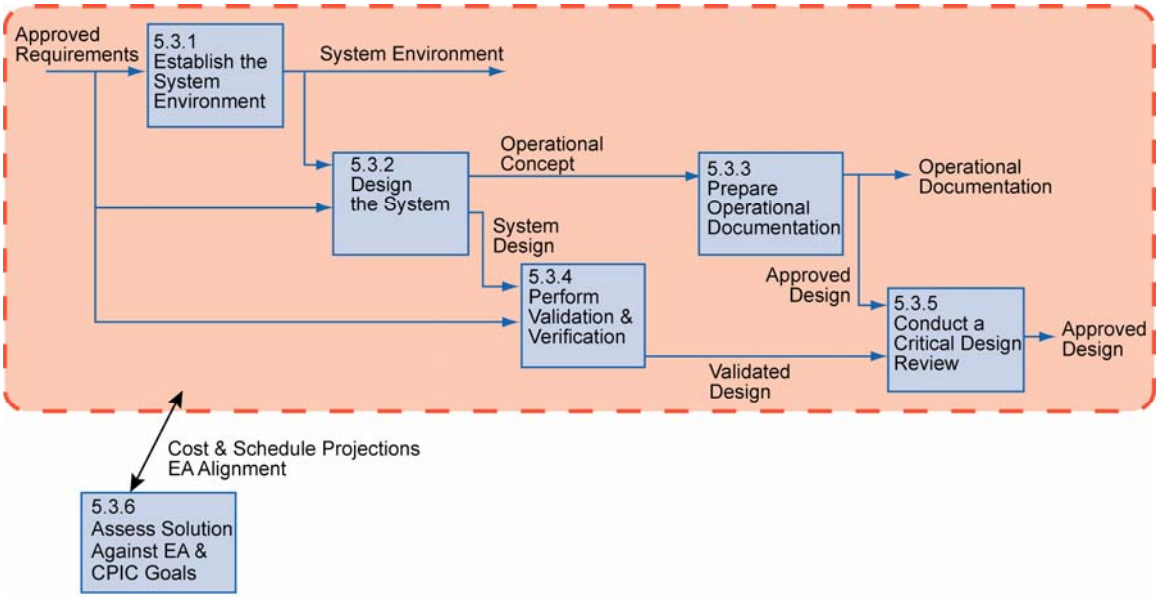

Figure 5-1: *Design Phase Process Steps*

5.3.1 Establish the System Environment

The hardware and software configuration of the target system, the development platform and the test environment. Allocated functions are examined and a decision is made to where inside the system each hardware and software element will reside. Managers and associated teams responsible for each activity are put in place.

5.3.2 Design the System

As the first step in the system design, the general system characteristics are defined:

- The data storage and access for the database layer
- The user interface at the desktop layer
- The business rules layer
- The application logic

Next, top-level solution architecture is established and documented. This architecture identifies the major hardware and software configuration items that comprise the solution. The solution requirements are then allocated among the hardware configuration items, software configuration items, and manual operations.

A top level software design is conducted next: here, each major software configuration item is decomposed into a set of software components. Solution requirements allocated to software configuration items are then assigned to each software component. A check is performed to ensure that all the requirements for each software configuration item are allocated to its software components and further refined to facilitate detailed design.

Top-level designs for interfaces with external hardware and software components are performed and the results documented.

Tasks to be performed by system personnel are identified and described in detail. These descriptions include user inputs, expected outputs, interface designs and procedure.

5.3.3 Prepare Operational Documentation.

Based on the results of the system design process, the following documents are developed:

A Maintenance Manual explaining what is necessary to ensure continued operation of the system once it is completed;

An Operations Manual for mainframe systems/applications (if necessary) and a System Administration Manual for client/server systems/applications;

A Training Manual identifying the users and how they will be trained on the new solution.

A Conversion Strategy document describing how the migration of existing information, systems and procedures that will interoperate with the new solution will be achieved.

5.3.4 Perform Validation and Verification

.As part of the validation and verification process, the following checks are performed:

- Can every functional requirement be traced to a design or operator procedure in the design?
- Can every design element trace back to a required functional requirement?
- Is the system, as designed, capable of operating within established constraints?
- Does the system, as designed, satisfy the stated measures of effectiveness and performance?
- Is the system design complete?
- Does the design satisfy the business needs of the system as originally planned?
- Are the designs described at a sufficient level of detail for the implementation process?

In addition to this work, the following testing processes are carried out:

- Have tests been defined to ensure that each hardware and software component meets its design requirements?
- Have integration tests been created to ensure that each component interacts correctly with other components and the outside world?
- Have tests been defined to ensure the stability and reliability of each hardware and software element?
- Have tests been defined to ensure that system-wide requirements such as security, privacy and internal control features are met?

5.3.5 Conduct a Critical Design Review

The Critical Design Review (CDR) is conducted upon completion of the Design Phase by the technical review board, key stakeholders from the business and CPIC personnel. The CDR is a multi-disciplined technical review to ensure that the system under review can proceed into system fabrication, demonstration, and test; and can meet the stated performance requirements within cost (program budget), schedule (program schedule), risk, and other system constraints.

Generally, this review assesses the system final design as captured in product specifications for each configuration item in the system (product baseline), and ensures that each product in the product baseline has been captured in the detailed design documentation. Product specifications for hardware enable the fabrication of configuration items, and may include production drawings. Product specifications for software enable coding of software configuration items.

Completion of the CDR should provide:

- An established system product baseline;
- An updated risk assessment;
- An integration test plan;
- An updated cost analysis based on the system design;
- An updated program development schedule including fabrication, test, and software coding critical path drivers; and
- An updated maintenance plan.

The CDR determines whether the hardware, human, and software final detail designs are complete, and whether the IPT is prepared to start system fabrication, demonstration, and test.

5.3.6 Assess Project Progress against EA and CPIC Goals

The CPIC Control Phase for an investment (system) proceeds in parallel with the definition, design and development of the system itself. As part of this phase, the project sponsor holds periodic reviews of system development to determine whether to continue the project. As part of these reviews, the project sponsor determines if the project manager is managing investment cost and schedule variance, mitigating risks, and providing projections for future performance based upon work accomplished to date. From this information, the project sponsor determines whether current cost and schedule projections align with investment implementation (e.g., based upon an assumption of baseline actual costs 10 percent greater than actual, what are the expectations of future performance).

In addition to the budgetary reviews, the alignment of the proposed solution to the enterprise architecture is also conducted. This alignment will should apply to all aspects of the system: i.e., the policy and strategic aspects of the EA as well as the data and process aspects. Any significant deviations from the policy requirements of the EA should trigger a major re-evaluation of the solution; likewise, a determination that the system contributes only minimally to the attainment of strategic goals should also be a cause for concern. Deviations from the data and process aspects should trigger redesign efforts, as they indicate that the solution is not integrating with enterprise processes and data structures as well as possible.

The bureau sponsor and project sponsor apply EA and CPIC control screening criteria to determine whether the project has met expectations and identify any deficiencies and corrective actions needed. Updated investment information is submitted to the OCIO and the investment undergoes a control review by the DOI IRB. The results of these reviews are used by the DOI IRB for management of the IT investment portfolio.

5.3.7 Maintain Current Project Cost, Schedule, Technical, and General Status Information

The project manager collects actual information on the resources allocated and expended throughout the Design Phase. The project manager compares the actual information collected to the estimated baselines developed during the Planning Phase and identifies root causes for any differences. The project manager reviews the security and infrastructure analyses for accuracy. The project manager maintains a record of changes to the initiative's technical components including hardware, software, security, and communications equipment. Technical component changes may trigger a new requirements review.

5.3.8 Review Documentation and Recommend Appropriate Action

The CIO prepares findings and recommendations based on project documentation and the results of the Critical Design Review and forwards the updated package to the bureau IRB for review. The bureau IRB reviews the investment and determines whether to provide continued support to the investment and forwards its recommendations to the DOI IRB for the final decision.

5.3.9 Make Final Control Review Decisions

The DOI IRB issues a decision, based upon the recommendations received from the bureau IRB. The decision is sent to the project sponsor and project manager.

5.3.10 Project Sponsor and Project Manager Implement Decisions

The project sponsor acknowledges and implements any corrective action recommended by the IRB.

Prior to the next scheduled review date, the project sponsor and project manager update the investment information and initiate another preliminary assessment. This formal monitoring of investment progress, and the determination of risks and returns, continues throughout the Control Phase.

5.4 Enterprise Architecture Considerations

During this phase, the following factors should be considered:

Examine the **Business Reference Model.** Are the functions being developed similar or identical to existing BRM functionalities? If so, consider the possibility of reusing existing functionality. In the case where the business functionality being developed is new, consider whether this functionality might be usable by other business elements. If so, consider adding the functionality under development to the Department's BRM and making it available to outside agencies.

Examine the current solution development in the context of the **Technical Reference Model.** Does any element of the new development conflict with the standards, specifications, and technologies described therein? If so, what considerations justify overriding these requirements?

Examine the **Service Component Reference Model.** Are services available that satisfy the solution requirements? Is it possible to reuse existing components by either making small changes to the requirements or developing small "translation" functions to allow this reuse? If so, consider how best to reuse these capabilities. Also, examine the new functional groupings being developed (see section 4.4). Are these functionalities

applicable to other solutions or existing systems? Would they be shareable with minor modifications? If so, consider making these services available to others by adding them to the SRM

Review the **Performance Reference Model.** Consider whether the solution under consideration is, in fact, improving strategic and daily decision-making and contributing to the needs of the business.

5.5 Exit Criteria

Prior to exiting the Analysis Phase, investments must execute the following activities:

- Complete the design of hardware and software configuration items.
- Develop test plans for each hardware and software configuration item.
- Ensure that every defined function is implemented.
- Ensure that every software or hardware configuration item function corresponds to a required solution function.
- Conduct a successful Critical Design Review.
- Demonstrate to the IRB conformance with any applicable guidance issued pursuant to an IT Modernization Blueprint.
- Demonstrate EA alignment.
- Obtain DOI approval to enter the Construction Phase.

Table 5-1 provides a summary of the documents generated during the Design Phase process, as well as the whether the document requires approval or whether the document is required only for the file for recordkeeping purposes.

Document	Required For File	Required For Approval
System Design Document	X	
Integration Test Plan	X	
Conversion Strategy	X	
Risk Assessment (updated)	X	
CDR Presentation Materials	X	
Maintenance Plan	X	
Product Baseline	X	

Table 5-1 *Summary of documents generated during the Evaluate Phase.*

6 Construction Phase

6.1 Purpose

The activities of this phase translate the solution design produced in the Design Phase into a working information system capable of addressing the solution requirements. The phase contains activities for building the solution, testing it, and conducting further functional qualification testing to ensure the solution satisfies the functional requirements in the functional requirements specification. At the end of this phase, the solution will be ready for the Integration and Test Phase.

This phase is usually carried out in parallel with the development of user procedures and user documentation from the Implementation Phase. Both of these will be required for module testing, upon the completion of the Build Phase. Coordination of the Build and Implementation Phase activities is a key responsibility of the project manager at this time.

Any special procedures for data conversion and/or data warehousing are also developed and tested here. The process of developing and testing the data conversion and data warehousing modules is no different from that required for the system itself.

6.2 Entry Criteria

Prior to entering the Design Phase, the following areas must have been developed and documented in detail:

- Design Specification
- Test Plans and Procedures
- Conversion Strategy
- Maintenance Document
- Established a CPIC review schedule
- Management approval to enter the Construction Phase

6.3 Process

The IPT converts the design specifications into hardware and software components. Tests are performed on each individual component to verify the

components operation. Next, the components are integrated into progressively larger assemblies and re-tested to ensure that the individual components interact correctly. This process continues until the configuration items specified in the Design Phase have been created.

Parallel with component development and assembly, the IPT members complete the testing plans begun during the Development Phase. Meanwhile, other members of the IPT update conversion, implementation, and training plans and user, operator, and maintenance manuals.

6.3.1 Code and Test Software Components

Create and test the lowest level software components. Typically, individual engineers write and review (desk test) program modules or components, which are small routines that perform particular tasks within a larger application. Completed components are integrated with other components and reviewed, often by a group of engineers, to ensure the components properly interact. The process continues as component groups are progressively integrated and as interfaces between component groups and other systems are tested until the final software configuration items defined during the Design Phase have been created.

6.3.2 Conduct Software Qualification Testing

Testing is conducted to each software configuration item in accordance with the qualification requirements for the software item developed during the Design Phase. The implementation of each software requirement is tested for compliance. Support audit(s) are conducted to ensure that:

- as-coded software products (such as software item) reflect the design documentation;
- the acceptance review and testing requirements prescribed by the documentation are adequate for the acceptance of the software products;
- test data comply with the specification;
- software products were successfully tested and meet their specifications;
- test reports are correct and discrepancies between actual and expected results have been resolved; and
- user documentation complies with standards as specified.

The results of the audits are documented. If both hardware and software are under development or integration, the audits may be postponed until the system qualification testing.

6.3.3 Build and Test Hardware Components

Newly built or acquired hardware components are tested against the specifications developed during the Design Phase. Components are then assembled into larger groups and tested again to ensure the correct interaction. This process continues until the hardware configuration items specified during the Design Phase have been assembled.

6.3.4 Integrate Configuration Items

Integrate the software configuration items with hardware configuration items, manual operations, and other systems as necessary, into the system. The aggregates are then tested against their requirements. The integration and the test results are documented. For each qualification requirement of the system, a set of tests, test cases (inputs, outputs, test criteria), and test procedures for conducting system qualification testing shall be developed and documented. Ensure that the integrated system is ready for system qualification testing.

6.3.5 Conduct System Qualification Testing

Conduct system qualification testing in accordance with the qualification requirements specified for the system. Ensure that the implementation of each system requirement is tested for compliance and that the system is ready for delivery. Document the results.

6.3.6 Develop a Contingency Plan

The Contingency Plan, which contains emergency response procedures; backup arrangements, procedures, and responsibilities; and post-disaster recovery procedures and responsibilities is prepared. Contingency planning is essential to ensure that DOI systems are able to recover from processing disruptions in the event of localized emergencies or large-scale disasters. It is an emergency response plan, developed in conjunction with application owners and maintained at the primary and backup computer installation to ensure that a reasonable continuity of support is provided if events occur that could prevent normal operations. Contingency plans are routinely reviewed, updated, and tested to enable vital operations and resources to be restored as quickly as possible and to keep system downtime to an absolute minimum.

6.3.7 Prepare for Integration Testing

The integration test plans created during initial project phases are extended and enhanced in preparation for integration testing. These plans describe the interactions between the configuration items and between the configuration items and the outside world. The integration testing is planned using either a top-down or bottom-up approach. A bottom-up approach tests smaller components first and progressively adds and tests additional components and systems. A top-down approach first tests major components and connections and progressively tests smaller components and connections. The progression and definitions of completed tests vary between organizations.

The test environment is constructed. Testing groups composed of technicians and end users assemble and load representative test data into a testing environment. Procedures are established to ensure programmers correct defects quickly and document all corrections or modifications.

6.3.8 Finalize Transition Plan

Any special procedures for data conversion and/or data warehousing are finalized and tested. Testing procedures for existing external systems are developed to ensure that these systems perform as expected. Any commercial off-the-shelf or Government off-the-shelf are tested to verify their correct operation

6.3.9 Finalize Documentation

All documentation necessary for implementation and operation is updated to reflect the as built state of the system, in particular:

- Training Manuals
- Maintenance Manuals
- System Operations Manual
- User and Operator Manuals

6.3.10 Review Project Documentation

The bureau sponsor reviews the tests performed to ensure that the system has been implemented according to the design. The bureau sponsor also reviews all integration testing, contingency planning and other documentation to ensure that the system is ready for integration and test. The bureau sponsor forwards this information, along with his recommendations, to the bureau CIO.

6.3.11 Review Project and Recommend Appropriate Action

The bureau CIO reviews both the project documentation and the bureau sponsor's findings and recommendations. The CIO forwards it to the bureau IRB for review. The bureau IRB reviews the project to determine whether it continues to support mission or user requirements and the Department's strategic direction. The bureau IRB determines whether the project should be granted authorization to proceed or should be held back due to deficiencies. The bureau IRB then forwards its recommendations to the DOI IRB.

6.3.12 Make Final Project Decision

The DOI IRB approves or disapproves the bureau IRB recommendation and directs the project sponsor how to proceed.

6.4 Enterprise Architecture Considerations

Particular care should be given to the construction of any data structures or processes that will be shared by other systems. Additional testing should be performed on these elements to ensure that they perform in the exact manner specified in the DRM and the SRM. The TRM should be reviewed t6o ensure that all enterprise policies, procedures and mandates have been observed.

6.5 Exit Criteria

The investment remains in the Construction Phase until the DOI IRB or management grant authorization to proceed. This will be based on:

- A complete design of every software and hardware configuration item
- Test plans for every configuration item function
- Finalized documentation
- Finalized Transition Plan

Table 6-1 provides a summary of the documents generated during the Construction Phase process, as well as the whether the document requires approval or whether the document is required only for the file for recordkeeping purposes.

Document	Required For File	Required For Approval
Detailed Integration Test Plans	X	
Transition Plan	X	
User Manual	X	
Operator Manual	X	
Maintenance Manual (Updated)	X	
System Operations Manual	X	
Training Manual	X	
Contingency Plan	X	

Table 6-1 *Summary of documents generated during the Construction Phase.*

7 Integration and Test

7.1 Purpose

The purpose of Integration and the Test Phase is to ensure that the individual system components that successfully completed unit and integration testing during the Build Phase:

- Satisfy the functional requirements;
- Satisfy the business needs;
- Adhere to all mandates, physical constraints and service level agreements; and
- Operate as described in the User and Operator Manuals.

7.2 Entry Criteria

Before entering the Integration and Test Phase, the entire system must be ready for assembly and subsequent integration testing. This means:

- All software and hardware configuration item components have been constructed and successfully tested.
- All integration test plans are prepared.
- The Transition Plan for existing data and processes that will be reused is complete.

7.3 Process

During this phase, detailed testing is carried out to ensure that the developed solution satisfies the requirements defined in the functional requirements specification. Several types of tests will be conducted in this phase. First, system tests are executed and evaluated by the development team to prove that the program components integrate properly into the subsystems and that the subsystems integrate properly into an application. Next, the testing team conducts and evaluates system tests to ensure the developed system meets all technical requirements, including performance requirements. Next, the testing team and the security program manager conduct security tests to validate that the access and data security requirements are met. Finally, users participate in acceptance testing to confirm that the developed system meets all user requirements as stated in the functional requirements specification. Acceptance testing is then carried out in a simulated “real” user environment with the users interacting with a collection of simulated and real external systems, data and infrastructures.

7.3.1 Prepare for Testing

The test team creates and loads the test database(s) and prepares any programs simulating external users or systems.

7.3.2 Conduct System Testing

All components that are new, changed, affected by a change, or needed to form the complete application are tested to verify their correct operation as a unit and to ensure that the system performs according to the functional requirements specification. Interactions with outside systems are avoided at this point to reduce the risk of externally-induced problems. As errors are encountered, they are corrected and the tests rerun. This process continues until the following exit criteria are met:

- The system satisfies all documented business and functional requirements;
- No known critical defects prevent the transition to the Integration Testing; and
- All appropriate parties have approved the completed tests.

7.3.3 Conduct Integration Testing

The integration testing process verifies that the system interacts correctly with other systems and applications, including those owned by outside vendors, external partners, or the customer. Because integration testing must validate both functional and non-functional requirements, several types of tests may be performed, including the following:

- Compatibility testing ensures that the system performs correctly with differently configured systems based on what the users have or may have. When testing a web interface, for example, this means testing for compatibility with different browsers and connection speeds.

- Performance testing verifies the system's scalability. This is particularly important for identifying bottlenecks in high usage applications.

- Stress testing evaluates the system's performance at higher than normal simulated loads. Stressing runs the system or application beyond the limits of its specified requirements to determine the load under which it fails and how it fails. This test is arguably the most important test for mission-critical systems.

- Load testing evaluates the system's response under "normal" production conditions and measures the response times for critical transactions or processes to determine if they are within limits specified in the business requirements and design documents or that they meet service level agreements.

As errors are encountered, they are corrected and the tests rerun. This process continues until the following exit criteria are met:

- All systems involved passed integration testing and meet agreed upon functionality and performance requirements;
- Outstanding defects have been identified, documented, and presented to the business sponsor;
- Stress, performance, and load tests have been satisfactorily conducted;
- The implementation plan is final draft stage; and
- A testing transition meeting has been held and everyone has signed off.

7.3.4 Conduct User Acceptance Test

The User Acceptance Test (UAT) is performed before a new system is accepted by the customer. The UAT is performed by the actual system users; it is based on the specifications developed during the Design Phase, which were drawn from the original business needs. The focus of the test is a final verification of the required business function and flow of the system. The tests are conducted so as to emulate real-world usage of the system with the goal of verifying (and demonstrating to the user) that if the system works as intended and without issues during normal use.

Results of these tests will allow both the customers and the developers to be confident that the system will work as intended.

7.4 Enterprise Architecture Considerations

During the Integration and Test Phase problems with interfaces, data structure and functions are frequently discovered that require rework. It is critical to ensure that no changes are made to shared processes or data structures without changes to the reference models that describe them.

7.5 Exit Criteria

To exit the Implementation and Test Phase, it is necessary that all major testing be complete to the satisfaction of the business, technical and management stakeholders. In particular, the following tests must complete successfully:

- System Test
- Integration Test
- User Acceptance Test

Table 7-1 provides a summary of the documents generated during the Integration and Phase process, as well as the whether the document requires approval or whether the document is required only for the file for recordkeeping purposes.

Document	Required For File	Required For Approval
Integration Test Results	X	
System Test Results	X	
User Acceptance Test Results	X	

Table 7-1 Summary of documents generated during the Integration and Test Phase.

8 Implementation Phase

8.1 Purpose

The purpose of Implementation Phase is: first, to install the system in the production environment and to bring it into operation; and second, to ensure that the system, as developed:

- Satisfies the functional requirements;
- Satisfies the business needs;
- Adheres to all mandates, physical constraints and service level agreements; and
- Operates as described in the User and Operator Manuals.

8.2 Entry Criteria

The system must successfully complete system, integration and user acceptance and have been judged acceptable by the business, technical and management stakeholders.

8.3 Process

In this phase, the system is installed and made operational in the production environment. The phase is initiated after the system has been tested and accepted by the user and project manager. Activities in this phase include notification of implementation to end users, execution of the previously defined training plan, data entry or conversion, and post implementation review. This phase continues until the system is operating in production in accordance with the defined user requirements.

At the conclusion of the Implementation Phase, the CPIC Evaluate Phase is entered. The goal of this phase is to examine the fielded and solution and determine:

- Whether the IT investment met its performance, cost, and schedule objectives.
- The extent to which the IT capital investment management process improved the outcome of the IT investment.

This feedback is used to modify the CPIC Process and the SDLC to incorporate lessons learned during the development process.

8.3.1 Notify Users of New Implementation

An implementation notice is sent to all users and organizations affected by the implementation. The notice should include:

- The schedule of the implementation;
- A brief synopsis of the benefits of the new system;
- The difference between the old, if any, and the new system;
- Responsibilities of end users affected by the implementation during this phase; and
- The process necessary to obtain system support, including contact names and phone numbers.

8.3.2 Perform System Training

All users of the system are thoroughly trained according to the training plans developed in earlier phases. Operators, maintainers and system users are given the specific training contained in these plans. An orientation program is presented to management, stakeholders and other interested parties.

8.3.3 Perform Data Entry or Conversion

Carry out the transition plan developed during the Construction Phase to transfer any existing data necessary to the new system. Perform the necessary data input and data verification.

8.3.4 Perform Product Verification Testing

As a final step before operation, mock production runs are assembled and run through the system to verify that the existing business process flows, interfaces, and batch processes continue to run correctly. Alternatively, a parallel testing strategy can be employed in which the old and new systems are run side-by-side. This testing continues until all developers, users and stakeholders are satisfied that the system is ready for operational use.

8.3.5 Perform Post-Implementation Review and Begin CPIC Evaluation Phase

After the system has been fielded, conduct a post-implementation review to determine the success of the project through its implementation phase. The purpose of this review is to document implementation experiences, to recommend system enhancements and provide to guidance for future projects. Upon completion of this review, notify the CPIC team that the system is ready for CPIC Evaluation.

8.3.6 Update Project Documentation

Revise and finalize all project documentation to reflect the as-built system configuration.

8.4 Enterprise Architecture Considerations

Once the solution is successfully operating, the Performance Reference Model should be revisited to evaluate the actual "line of sight" achieved; that is, how well the fielded solution has (or has not) met the business goals assigned to it. The results of this examination should be made available for future projects.

8.5 Exit Criteria

The Implementation Phase completes when the system has been successfully made operational and demonstrates the satisfaction of all business and technical requirements.

Table 8-1 provides a summary of the documents generated during the Implementation process, as well as the whether the document requires approval or whether the document is required only for the file for recordkeeping purposes.

Document	Required For File	Required For Approval
Maintenance Plan (updated)	X	
Operator Manual (updated)	X	
User Manual (updated)	X	
System Introduction Presentation	X	
Training Manual (updated)	X	

Table 8-1 Summary of documents generated during the Implementation Phase.

9 Steady State Phase

9.1 Purpose

The Steady State Phase is the operational lifetime of the system. During this phase, the primary focus is on making changes to hardware, software, and documentation to support its operational effectiveness. It includes making changes to improve a system's performance, correct problems, enhance security, or address user requirements.

9.2 Entrance Criteria

The system has completed implementation testing and is successfully performing in the operational environment.

9.3 Process

Because more than half of the life cycle costs are attributed to the Steady State Phase of a system, it is essential that all facets of operations and maintenance are carefully performed. The system is continuously scrutinized to ensure that it meets the needs initially stated in the Planning Phase. Problems are detected and new needs arise. This may require modification to existing code, new code to be developed and/or hardware configuration changes.

User support is also a significant ongoing activity. New users will require training and others will require re-training as well. A major emphasis of this phase is to ensure that the user needs are met and the system continues to perform as specified in the operational environment. Additionally, as operations and maintenance personnel monitor the current system they may become aware of better ways to improve the system and therefore make recommendations. Changes will be required to fix problems, possibly add features and make improvements to the system. This phase will continue as long as the system is in use.

While the SDLC Steady State Phase concerns itself with systems operations, user training, maintenance and change management, the CPIC steady state monitors the system from an investment perspective.

9.3.1 Support System Operations

The system support team carries out the tasks defined in the Systems Operation Manual, which defines the tasks, activities and responsible parties necessary to maintain system operation. Systems operations activities on a scheduled, recurring basis, to ensure that the production environment is fully functional and is performing as specified. The following is a checklist of systems operations key tasks and activities:

- Ensure that systems and networks are running and available during the defined hours of operations;
- Ensure all processes, manual and automated, are documented in the operating procedures. These processes should comply with the system documentation;
- Perform backups (day-to-day protection, contingency);
- Perform the physical security functions including ensuring adequate UPS, personnel have proper security clearances and proper access privileges etc.;
- Ensure contingency planning for disaster recovery is current and tested;
- Ensure users are trained on current processes and new processes;
- Ensure that service level objectives are kept accurate and are monitored;
- Maintain performance measurements, statistics, and system logs. Examples of performance measures include volume and frequency of data to be processed in each mode, order and type of operations; and
- Monitor the performance statistics, report the results and escalate problems when they occur.

9.3.2 Conduct Data/Software Administration

The data/software administration process ensures that input data and output data and data bases are correct and continually checked for accuracy and completeness. Software and data bases should be maintained at (or near) the current maintenance level. Backup and recovery process of the data bases is a data/software administration task by a data administrator. A checklist of data/ software administration tasks and activities includes:

- Performing a periodic verification/validation of data, correct data related problems;
- Performing production control and quality control functions (Job submission, checking and corrections);
- Installing, configuring, upgrading and maintaining data base(s);
- Developing and performing data/database backup and recovery routines for data integrity and recoverability;
- Developing and maintaining a performance and tuning plan for online process and data bases; and
- Performing configuration/design audits to ensure software, system,

parameter configuration are correct.

9.3.3 Maintain Documentation

At this phase of the SDLC all security activities have been completed. An update is made to the system security plan; an update and test of the contingency plan should be completed. The project manager ensures that security operating procedures are kept updated accordingly. Documentation from the previous phase is again reviewed and updated as necessary; In particular, the Operations Manual and Contingency Plan need to be updated and finalized.

9.4 Enterprise Architecture Considerations

The alignment of the solution with the overall enterprise architecture should be measured at regular intervals to ensure that the solution continues to contribute effectively to the achievement of enterprise strategic goals.

9.5 Exit Criteria

The system remains in the Steady State Phase until the CPIC process determines that its operation is no longer cost-effective.

Appendix A: Glossary of Terms and Acronyms

A.1 Glossary of Terms

Acquisition Plan	Description of the acquisition approach including: ■ Contract strategy (definition of government and contractor roles and responsibilities) ■ Use of COTS software ■ Major milestones (such as software releases, hardware delivery and installation, and testing).
Actual Cost of Work Performed	The costs actually incurred and recorded in accomplishing the work performed within a given time period.
Architectural Alignment	Degree to which the IT initiative is compliant with DOI's information technology architecture.
Architecture	An integrated framework for evolving or maintaining existing technologies and acquiring new technologies to support the mission(s).
Benefit	Quantifiable or non-quantifiable advantage, profit, or gain.
Benefit-Cost Ratio	The Total Discounted Benefits of an investment divided by the Total Discounted Costs of the investment. If the value of the Benefit-Cost Ratio is less than one, the investment should not be continued.
Budget at Completion	The sum of all budgets established for the contract.
Budgeted Cost for Work Performed	The sum of the budgets for completed work packages and completed portions of open work packages, plus the applicable portion of the budgets for level of effort and apportioned effort.
Budgeted Cost of Work Scheduled	The sum of all WBS element budgets that are planned or scheduled for completion.
Business Case	Structured proposal for business improvement that functions as a decision package for organizational decision-makers. A business case includes an analysis of business process performance and associated needs or problems, proposed alternative solutions, assumptions, constraints, and risk-adjusted cost-benefit analysis (CBA). The Exhibit 300 business case is this document for DOI purposes.
Business Process	A collection of related, structured activities or chain of events that produce a specific service or product for a particular customer or group of customers.
Business Process Reengineering	A systematic, disciplined approach to improving business processes that critically examines, rethinks, and redesigns mission delivery processes.
Capital Asset	Tangible property, including durable goods, equipment, buildings, installations, and land.

Control Phase	Capital planning phase that requires ongoing monitoring of information technology investments against schedules, budgets, and performance measures.
Cost-Benefit Analysis	An evaluation of the costs and benefits of alternative approaches to a proposed activity to determine the best alternative.
Cost Performance Index	Earned value divided by the actual cost incurred for an investment.
Cost Variance	Earned value minus the actual cost incurred for an investment.
Customer	Groups or individuals who have a business relationship with the organization; those who receive or use or are directly affected by the products and services of the organization.
Data Documentation	Compilation of materials including data dictionary, decomposition diagrams, and data models.
Design Documentation	Document that includes system design diagrams.
Discount Factor	The factor that translates expected benefits or costs in any given future year into present value terms. 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 initiation date for the program or policy until the given future year.
Discount Rate	The interest rate used in calculating the present value of expected yearly benefits and costs.
Earned Value Analysis	A structured approach to project management and forecasting including comparisons of actual and planned costs, work performed, and schedule.
Estimate at Completion	The actual costs incurred, plus the estimated costs for completing the remaining work.
Estimate to Complete	The cost necessary to complete all tasks from the actual cost of work performed end date through the investment's conclusion.
Evaluate Phase	Capital planning phase that requires information technology investments to be reviewed once they are operational to determine whether the investments meet expectations.
Expected Outcome	Projected end result of the initiative (e.g., system(s) being replaced or improved customer service) that is directly linked with performance measures.
Feasibility Study	Preliminary research performed to determine the viability of the proposed initiative by performing an alternatives analysis, including market research and extensive interviews with subject matter experts. Also includes a proposed technical approach and preliminary cost, scope, and schedule data.
Functional Requirements	A description of system capabilities or functions required to execute a required process such as a communication link between several locations and generating specific reports.

Hardware or Equipment	Includes any equipment used in the automatic acquisition, storage, manipulation, management, movement, control, display, switching, interchange, transmission, or reception of data or information (e.g., computers and modems); capital and non-capital purchases or leases.
Independent Verification and Validation	An independent review conducted by persons separate from the management and operation of the investment or system.
Inflation	The proportionate rate of change in the general price level, as opposed to the proportionate increase in a specific price. Inflation is usually measured by a broad-based price index, such as the implicit deflator for Gross Domestic Product or the Consumer Price Index.
Information System	A discrete set of information resources organized for the collection, processing, maintenance, transmission, and dissemination of information in accordance with defined procedures, whether automated or manual.
Lifecycle	The duration of the system life typically organized into four phases: initiation, development, operation, and disposal.
Information Technology	Any equipment or interconnected system or subsystems or equipment used in the automatic acquisition, storage, manipulation, management, movement, control, display, switching, interchange, transmission, or reception of data or information.
Infrastructure	The IT operating environment (e.g., hardware, software, and communications).
Lifecycle Benefits	The overall estimated benefits for a particular program alternative over the time period corresponding to the life of the program including: ■ Cost or expense reduction (productivity and headcount), ■ Other expense reductions (operational), ■ Cost or expense avoidance, and ■ Revenue-related savings.
Lifecycle Cost	The overall estimated cost for a particular program alternative over the time period corresponding to the life of the program, including direct and indirect initial costs plus any periodic or continuing costs of operation and maintenance.
Management Reserve	The amount of the total allocated budget withheld for management control purposes rather than designated for the accomplishment of a specific task or set of tasks; not part of the performance measurement.
Net Present Value	The difference between the discounted present value of benefits and the discounted present value of costs. Also referred to as the Net Present Value.
Opportunity Costs	Cost of not investing in the initiative or cost of a forgone option.
Payback Period	The number of years it takes for the cumulative dollar value of the benefits to exceed the cumulative costs of an investment.
Performance Indicator	Description of: ■ What is to be measured, including the metric to be used (e.g.,

	conformance, efficiency, effectiveness, costs, reaction, or customer satisfaction) ■ Scale (e.g., dollars, hours, etc.) ■ Formula to be applied (e.g., percent of "a" compared to "b," mean time between failures, annual costs of maintenance, etc.) ■ Conditions under which the measurement will be taken (e.g., taken after system is operational for more than 12 hours, adjusted for constant dollars, etc.)
Performance Measurement Baseline	The time-phased budget plan against which investment performance is measured.
Performance Measures	Method used to determine the success of an initiative by assessing the investment contribution to predetermined strategic goals. Measures are quantitative (e.g., staff-hours saved, dollars saved, reduction in errors, etc.) or qualitative (e.g., quality of life, customer satisfaction, etc.).
Post-Implementation Review	Evaluation of the information technology investment after it has been fully implemented or terminated to determine whether the targeted outcome (e.g., performance measures) of the investment has been achieved.
Pre-Select Phase	Capital planning phase that provides a process to assess whether information technology investments support strategic and mission needs.
Project Plan	A document that describes the technical and management approach to carrying out a defined scope of work, including the project organization, resources, methods, and procedures and the project schedule.
Project Charter	A document issued by senior management that provides the project manager with the authority to apply organizational resources to project activities
Return	The difference between the value of the benefits and the costs of an investment. In a cost-benefit analysis it is computed by subtracting the Total Discounted Costs from the Total Discounted Benefits, and is called the Total Net Present Value.
Return on Investment	Calculated by dividing the Total Net Present Value by the Total Discounted Costs. To express it as a percentage, multiply by 100. It can also be expressed as (Total Discounted Benefits minus Total Discounted Costs) divided by Total Discounted Costs.
Risk	A combination of the probability that a threat will occur, the probability that a threat occurrence will result in an adverse impact, and the severity of the resulting impact.
Risk Management Plan	A description of potential cost, schedule, and performance risks, and impact of the proposed system to the infrastructure. Includes a sensitivity analysis to articulate the effect different outcomes might have on diminishing or exacerbating risk. Provides an approach to managing all potential risks.
Risk Management	The process concerned with identifying, measuring, controlling, and minimizing risk.

Schedule Variance	Earned value minus the planned budget for the completed work.
Security	Measures and controls that ensure the confidentiality, integrity, availability, and accountability of the information processes stored by a computer.
Security Plan	Description of system security considerations such as access, physical or architectural modifications, and adherence to Federal and DOI security requirements.
Select Phase	Capital planning phase used to identify all new, ongoing, and operational investments for inclusion into the information technology portfolio.
Sensitivity Analysis	An analysis of how sensitive outcomes are to changes in assumptions. Assumptions about the dominant cost or benefits elements and the areas of greatest uncertainty deserve the most attention.
Software	Any software, including firmware, specifically designed to make use of and extend the capabilities of hardware or equipment.
Steady State Phase	Capital planning phase that provides the means to assess mature information technology investments to ensure they continue to support mission, cost, and technology requirements.
Sunk Cost	A cost incurred in the past that will not be affected by any present or future decisions. Sunk costs should be ignored in determining whether a new investment is worthwhile.
Technical Requirements	Description of hardware, software, and communications requirements associated with the initiative.
Variance at Completion	The difference between the total budgets assigned to a contract, WBS element, organizational entity, or cost account and the estimate at completion; represents the amount of expected overrun or under run.

A.2 Acronyms

AB	Annual Benefit
AC	Annual Cost
ACWP	Actual Cost of Work Performed
AS	Agency Sponsor
BAC	Budget at Completion
BCR	Benefit-Cost Ratio
BCWP	Budgeted Cost for Work Performed
BCWS	Budgeted Cost of Work Scheduled
BPR	Business Process Reengineering
CBA	Cost-Benefit Analysis
CCA	Clinger-Cohen Act
CFO	Chief Financial Officer
CIO	Chief Information Officer

COTS	Commercial-off-the-shelf
CPI	Cost Performance Index
CPIC	Capital Planning and Investment Control
CPWT	Capital Planning Working Team
CSBR	Cost, Schedule, Benefit, and Risk
CV	Cost Variance
DB	Discount Benefit
DC	Discount Cost
DF	Discount Factor
EAC	Estimate at Completion
EBT	Electronic Benefit Transfer
IRB	Investment Review Board
ETC	Estimate to Complete
EWG	Executive Working Group(s)
FASA	Federal Acquisition Streamlining Act
FM	Functional Manager
FTEs	Full-Time Equivalents
FY	Fiscal Year
GAO	Government Accountability Office
GISRA	Government Information Security Act of 2000
GPEA	Government Paperwork Elimination Act of 1998
GPRA	Government Performance and Results Act
GSA	General Services Administration
IPT	Integrated Project Team
IRM	Information Resource Management
ISSPM	Information System Security Program Manager
ISTA	Information System Technology Architecture
IT	Information Technology
eCPIC	Information Technology Investment Portfolio System
IV&V	Independent Verification and Validation
MNS	Mission Needs Statement
MR	Management Reserve
NIST	National Institute of Standards and Technology
NPV	Net Present Value
O&M	Operations and Maintenance
OCFO	Office of the Chief Financial Officer
OCIO	Office of the Chief Information Officer
OMB	Office of Management and Budget
PIR	Post-Implementation Review
PMB	Performance Measurement Baseline
PRA	Paperwork Reduction Act
RFP	Request for Proposals
ROI	Return on Investment
SV	Schedule Variance

SME	Subject Matter Expert
DOI	United States Department of the Interior
VAC	Variance at Completion
VPN	Virtual Private Network
WBS	Work Breakdown Structure

Appendix B: References

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