Naval "Systems of Systems" Systems Engineering Guidebook
Volume I

Prepared by the Office of the ASN (RDA)
Chief Systems Engineer

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Naval SoS SE Guidebook, Volume I
Version 2.0

The Naval "Systems of Systems" Systems Engineering Guidebook (originally issued as the Naval Capabilities Evolution Process Guidebook) describes a comprehensive process for applying systems engineering principles to acquisition programs that may be characterized as systems of systems. This guidebook provides guidance on principles and recommended best practices to program managers and systems engineers in the design, development, deployment, and sustainment of such systems. It supports implementation of the guidance provided by the OUSD (AT&L) "Guide to System of Systems Engineering." In so doing, it combines the capability focus of JCIDS with the evolutionary acquisition strategy of the Defense Acquisition System to evolve to a networked, system of systems environment. This guidebook assumes that users are already familiar with JCIDS, the Defense Acquisition System, and systems engineering principles and best practices.

12/12/06

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i. Foreword

The Naval "Systems of Systems" Systems Engineering Guidebook, Volume 1, Version 2.0 has been developed by the ASN (RDA) Office of the Chief Systems Engineer to support the Naval acquisition community in implementing capability-based acquisition and systems engineering for systems of systems in accordance with SECNAVINST 5000.2C. The Guidebook focus is on a systems engineering process that enables the realization of successful "systems of systems" that provide needed capabilities and functionality within a Net Centric Operating and Warfare environment.

This Guidebook is particularly intended to be utilized by System of Systems (SoS) systems engineering integrated product teams (SE IPTs). It provides recommended processes, methods and tools to aid program managers, their system engineering integrated product teams (SE IPTs), support teams, and contractors in delivering systems that satisfy the originating capability needs documents and that are integrated and interoperable.

Volume I of the Guidebook describes the recommended capability-based systems engineering process activities and products for systems of systems acquisitions. Volume II of the Guidebook provides more in-depth descriptions of recommended methods and tools as well as use cases and lessons learned. The Guidebook is a living document and will be updated periodically.

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1. Process Overview

1.1. Introduction

The future of warfare can be characterized as having a near global battle space. Key features include global situational awareness achieved through distributed yet integrated and interoperable sensors, communications, and knowledge-management systems and highly responsive strike achieved by precision weapons with global reach. Global operations will be conducted by distributed integrated and interoperable forces that can be rapidly constituted and reconstituted to act and focus power with unity of purpose. The future of warfare is about capability delivered by "systems of systems" operating as a single system.

The term "system of systems (SoS)" is used in this document to describe an integrated force package of interoperable systems acting as a single system to achieve a mission capability. Typical characteristics include a high degree of collaboration and coordination, flexible addition or removal of component systems, and a net-centric architecture. Individual systems in the SoS may be capable of independent operations and are typically independently managed. An example would be an Expeditionary Strike Group acting to provide coordinated naval fires. The capabilities provided by each constituent system operating within the SoS are framed by the integrated force package architecture.

The OUSD (AT&L) "Guide to System of Systems Engineering[1]" provides the following definition for a SoS:

"a set or arrangement of systems that results when independent and useful systems are integrated into a larger system that delivers unique capabilities."

Unique challenges presented by the SoS are also identified as follows:

- <u>Governance Organization</u>: Institutions, structures of authority and collaboration to allocate resources and coordinate or control activity. A governance organization is critical to the synchronized and effective management and integration of multiple, independent program and systems into a system of systems.
- <u>Integration and Interoperability</u>: Assurance of interoperability between the constituent systems at multiple levels – physical, logical, semantic, and syntactic – to allow the necessary communication and connectivity across the system of systems.
- <u>Portfolio Management:</u> The availability of a diverse set of constituent and integrate-able systems is important to allow the necessary and potential configurations for the system of systems.
- <u>Flexibility and Agility</u>: The SoS will likely have to operate in the context of an evolving concept of operations to address an evolving threat. Flexibility and agility are often important characteristics for a SoS.

[1] Guide to System of Systems (SoS) Engineering: Considerations for Systems Engineering in a SoS Environment (Draft), 25 September 06

CJCSI 3170.01E also provides definitions for a family of systems and a system of systems:

- A family of systems is a set or arrangement of systems that provide similar capabilities through different approaches to achieve similar or complementary effects. For example, multiple weapon systems might be organized to achieve coordinated naval fires. Multiple sensor system types might be organized to achieve integrated air surveillance.

- A system of systems is a set or arrangement of systems that are related or connected to provide a given capability. The loss of any part of the system will degrade the performance or capabilities of the whole. An example is a shipboard air defense system consisting of one or more sensors, a weapon system, a launcher system, and a control system.

For the purposes of this Guidebook, the OUSD (AT&L) definition will be used as an all-encompassing term. In addition, the processes and principles described herein are structured to satisfy the requirements and procedures prescribed by the Joint Capabilities Integration and Development System (JCIDS)[2] and the Defense Acquisition System[3]. JCIDS applies Joint concepts and a systematic, analytically based approach to identify capability gaps, and to assess material and non-material solutions for filling gaps. Recommended material solutions are described in capability documents that are acquired in accordance with the Defense Acquisition System policies and guidelines.

The Defense Acquisition System establishes the management framework and processes for translating mission needs and technological opportunities, based on approved capability documents generated by JCIDS, into acquisition programs and strategies. Acquisition programs use an evolutionary strategy with the goal to rapidly capture and apply matured technology into systems and incrementally field capability quickly. Both the management framework and the processes of the Defense Acquisition System are focused on single system acquisitions and present difficulties when capability gaps require an integrated and interoperable "portfolio of systems" solution to be acquired and evolved.

Appendix A provides an overview of the Naval Force Development System (NFDS), a term used in this document to describe the Navy and Marine Corps planning, programming, resourcing, and acquisition processes within JCIDS and the Defense Acquisition System.

Implementation and operation of the Defense Acquisition System and JCIDS within the DoN is governed by SECNAV Instruction 5000.2C[4]. SECNAVINST 5000.2C provides the Navy's Acquisition Executive, the Assistant Secretary of the Navy for Research Development and Acquisition (ASN [RDA]), the authority to establish system engineering integrated product teams (SE IPTs) for an identified Navy or Marine Corps FoS or SoS with responsibility to derive, allocate, describe, and document system performance and interfaces among the affected programs in a System Performance Document (SPD).

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[2] CJCSI 3170.1E, Joint Capabilities Integration and Development System, 11 May 2005
[3] DODI 5000.2, Operation of the Defense Acquisition System, May, 2003
[4] SECNAVINST 5000.2C, Implementation and Operation of the Defense Acquisition System and the Joint Capabilities Integration and Development System, January, 2005

The ASN (RDA) Office of the Chief System Engineer (CHENG) is identified by SECNAVINST 5000.2C as the senior leadership and focus within the Naval acquisition structure on integration and interoperability, responsible to:

- Ensure that component systems are engineered and implemented to operate coherently with other systems as part of a larger force including a SoS or FoS,
- When directed by ASN(RD&A), conduct integration and interoperability assessments of SoS and FoS to determine adherence to interoperability requirements, architecture standards, joint technical architecture (JTA) technical standards, and interface specifications. Advise ASN(RD&A) and FoS/SoS management authorities, as appropriate, of the results of these assessments.
- Assess proposed architectural and JTA technical standards for their impact on acquisition programs. Advise ASN(RD&A) on the results of these assessments, and
- Provide architectural and JTA technical standards guidance to PMs via acquisition programs' established integrated product team/acquisition coordination team (IPT/ACT) processes.

In order to support and enable the implementation of the provisions of CJCSI 3170.01E, DODINST 5000.2, and SECNAVINST 5000.2C, this Guidebook has been created by ASN (RDA) CHENG to apply the principles of system engineering at the "systems of systems" level. This process is complementary to the system engineering process used by DoD program managers and their industry partners to develop component systems. The Guidebook describes a mission-oriented, capability-based acquisition and systems engineering approach to field Navy and Marine Corps combat, weapon, and command, control, communication, computer and intelligence (C4I) systems that must operate as elements of an integrated force package to deliver and evolve capability to the warfighter. This process is defined as the ***"Naval Capability Evolution Process (NCEP)."*** The NCEP is focused on system performance and integration and interoperability requirements between systems within a force package "portfolio of systems." The terms FoS or SoS are used to describe specific arrangements of systems within the portfolio of systems. Such systems are often resourced, acquired, and supported by multiple organizations, thus integration of the portfolio of systems is beyond the purview or authority of any single Program Executive Officer (PEO) or Program Manager. The additional complexities of the human element's capabilities and limitations in operating, maintaining, or supporting a FoS/SoS are key elements of total system performance and must be addressed in the aggregate.

This Guidebook is based largely on systems engineering principles and terminology as identified in the Defense Acquisition University (DAU) Systems Engineering Fundamentals Guidebook[5]. The Department of Defense Architecture Framework[6], known as DODAF, describes architecture views that are representations of the product of the systems engineering process, referred to as the system architecture. The NCEP provides a set of recommended practices that relies on the traditional systems engineering process to generate DODAF products for an integrated "systems of systems" architecture.

[5] Systems Engineering Fundamentals Guidebook, Defense Acquisition University Press, January, 2001
[6] Department of Defense Architecture Framework, 9 February 04

It is anticipated that this Guidebook will be implemented in particular by systems engineering IPTs for an identified SoS. Appendix B provides a discussion of SE IPT roles and responsibilities and governance process. The duration of the IPTs is expected to be through Milestone C.

1.2. Purpose

This document describes the Naval Capabilities Evolution Process and provides guidance for its use by the Department of the Navy (DoN) acquisition community. The NCEP provides the methodology and tools that allow PEOs and Program Managers to execute their assigned programs in a "systems of systems" system engineering environment with minimal disruption to program activities and resources.

It will assist collaboration between acquisition programs early in the design process to prevent time-consuming and costly integration and interoperability problems from occurring in later testing phases of a program. The NCEP provides for a flexible management and oversight approach to resolve problems that cross multiple resource sponsors, and acquisition stakeholders.

This document focuses on the engineering processes and documentation required to support capability-based SoS development. In this context, the integrated force package (systems of systems) architecture is used to frame SoS capabilities, and the contribution of each individual system towards realizing the required new capability.

In addition to this document and related Naval publications, there are additional guidebooks the PM can reference to aide in producing required systems engineering products. The ***Defense Acquisition Guidebook***[7] (DAG), issued by OUSD (AT&L) provides guidance on application of the systems engineering process within the DoD acquisition process. OUSD (AT&L) has also issued the ***Guide to Systems of Systems (SoS) Engineering***[8]**.** The ***Naval Systems Engineering Guide***[9] has also been issued by the Chief Engineers for the Navy and Marine Corps Systems Commands as a guide for individual system acquisitions.

1.3. Scope

Commanders assemble and fight with forces packages that are comprised of platforms and facilities (ships, aircraft, submarines, land vehicles, and spacecraft) organized to accomplish specific missions. In turn, platforms and facilities are comprised of systems (sensors, weapons, command and control, communications and support systems), and systems are comprised of subsystems or components. The war fighting capability delivered by a force package ultimately depends on how well the systems (hardware, software, middleware, and humans) installed on platforms and facilities operate together as an integrated and interoperable force. Traditionally, systems engineering practices have been applied at the system level, and to a lesser extent at the platform level. The NCEP addresses systems engineering at the force package (systems of

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[7] Department of Defense Acquisition Guidebook, 15 October 04

[8] Guide, op.cit.
[9] Naval Systems Engineering Guidebook, July, 2004

systems) level, and extends proven system engineering practices to the acquiring and fielding of capabilities that operate in a net centric systems environment.

Ensuring that the systems fielded are integrated and interoperable as a force demands that integration and interoperability requirements be addressed early in the Defense Acquisition System. Integration and interoperability are a system attribute like reliability and, therefore, acquisition programs that are a part of an ASN (RDA) SoS should enter the NCEP at program initiation.

1.4. Applicability

The NCEP and these guidelines apply to all components of the DoN executing acquisition responsibilities for the Assistant Secretary of the Navy for Research, Development and Acquisition (ASN (RDA)). In particular, the NCEP applies to all ASN (RDA) designated system engineering integrated product teams (SE IPTs). Appendix B provides a description of the SE IPT roles and products and a recommended NCEP governance approach. Program Managers responsible for acquiring platforms that have organic SoS should also apply the NCEP to assure integration and interoperability is achieved at the platform level. Other acquisition offices responsible for making engineering trades among systems that comprise a SoS for delivering a required capability should also use the NCEP guidelines.

1.5. Capability-Based Acquisition

The Marine Corps Expeditionary Force Development System (EFDS)[10] and the Navy Capability Development Process (NCDP)[11], implement JCIDS within the DoN to identify capability needs. Appendix A describes the Naval Force Development System (NFDS) which encompasses EFDS and NCDP, Naval activities within the DoD Programming, Planning, Budgeting, and Execution System (PPBES), and the Naval Acquisition Process.

Within the Navy, the NCDP identifies and prioritizes capability gaps using the Sea Power 21 construct of three mission areas, enabled by FORCEnet, that categorize eleven sub-missions providing over sixty discrete war fighting capabilities. The complexity of the system engineering challenge is illustrated in Figure 1-1.

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[10] Marine Corps Order 3900.15A, 26 November 02
[11] OPNAVINST 3050.23, 5 November 01

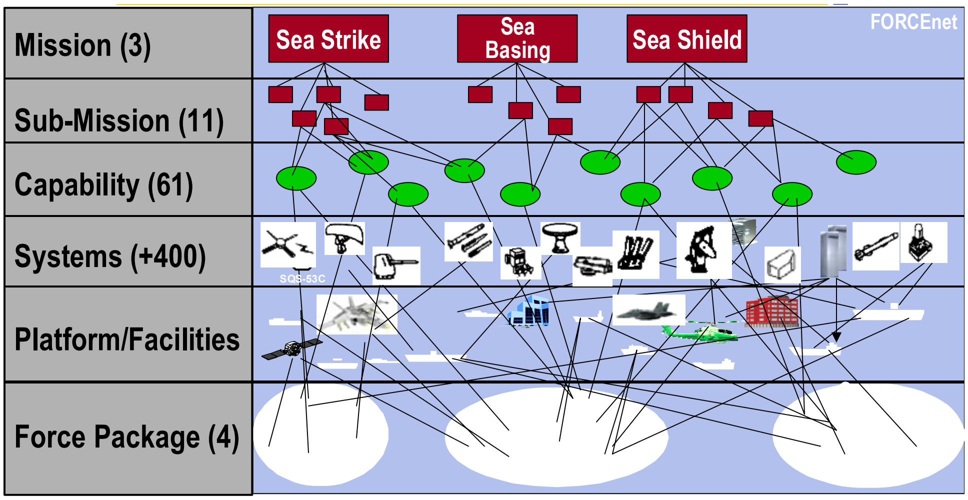

Figure 1-1: Capability-Based System Engineering Complexity

There are hundreds of systems, platforms, and facilities that contribute to these warfighting capabilities of which, at any given time, roughly twenty five percent are active acquisition programs or preparing to enter the acquisition process. These systems and platforms are constituted and deployed in four types of force packages based on current Navy operating doctrine. As illustrated, the future globally networked, distributed combat force will be composed of multi-mission systems installed on multi-mission platforms, deployed in multiple force packages. Future systems and force requirements also offer an opportunity rich environment to foster a corresponding evolution in personnel selection, assignment, and training strategies that can significantly increase individual system and SoS performance and reduce total ownership costs. Therefore, the NCEP is essential for engineering systems that will operate and deliver capability in the networked environment envisioned by FORCEnet.

Simply stated, capability-based acquisition combines the capability focus of JCIDS with the evolutionary acquisition strategy of the Defense Acquisition System to achieve the netted systems environment of the future. The goal of capability-based acquisition is to shift our emphasis from acquiring single, standalone systems to a new approach of acquiring systems as part of distributed, mission-oriented Joint forces with instances on the sea, in the air, and on land. The new approach is built on the following concepts.

Elevate systems engineering to the "Systems of Systems" Level. The challenge to the acquisition community is to effectively organize its systems engineering activities to deliver mission capability at the force package level. Figure 1-2 illustrates the capability-based acquisition approach of viewing Naval Force Packages as "systems of systems" acting as a single integrated system to achieve a mission capability. It applies a "portfolio of systems" perspective and systems engineering practices as the means of partitioning the problem across force package systems. The goal is to assess and balance performance and evolution to achieve capability objectives within resource constraints.

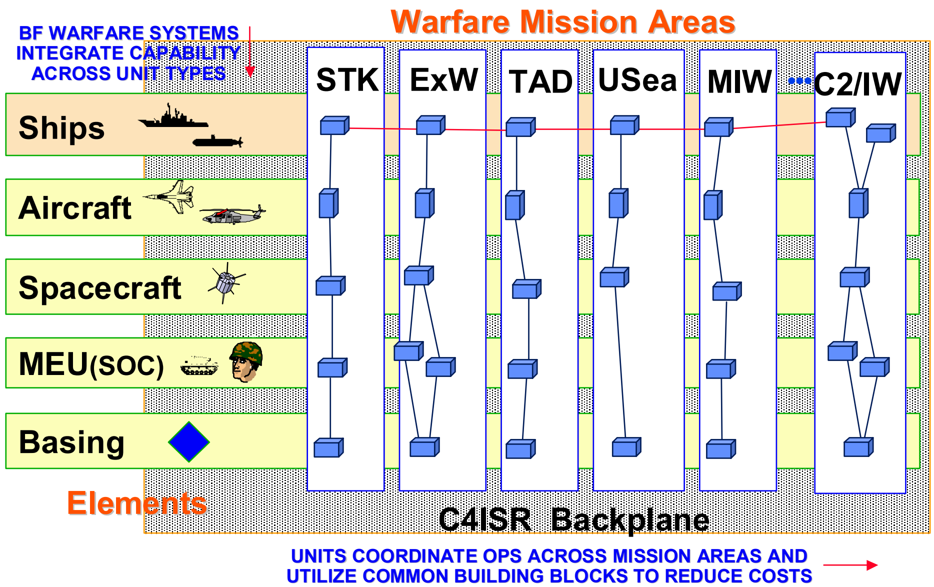

Figure 1-2: Naval Force Packages as Systems of Systems

Create capability-based acquisition portfolios as the basis for "Systems of Systems" system engineering. This element of capability-based acquisition creates a capability portfolio of platforms and systems (from the hundreds) that comprise a force package. The capability portfolio will change over time as platforms and systems are retired from service and new ones enter the Defense Acquisition System. An acquisition portfolio identifies the platforms and systems that are active in, or are soon to enter, acquisition, and the in-service systems that must be modified to integrate with the new systems being acquired. This sub-set of the capability portfolio encompasses a set of programs that, when fielded, provide a quantifiable increment of capability to the force package. The acquisition portfolio will be based on an engineering assessment that addresses integration and interoperability issues, the engineering risk associated with each program, and the relative importance of each to providing the capability increment. The resulting acquisition portfolio represents the SoS that fall under the purview of the NCEP.

Assess progress and risk of delivering capability at the portfolio level. This element of capability-based acquisition continuously monitors the execution of the acquisition portfolio programs from the systems of systems perspective. The primary focus is on providing visibility as to how the execution of the individual portfolio programs affect one another, and to provide a basis for collaboration among stakeholders when corrective action is required.

Implement the NCEP across acquisition, resourcing and operational stakeholder communities. The final element is the NCEP that implements capability-based acquisition within the DoN for managing Naval Capabilities by bridging the process by which the needs of the Operational Navy are converted into capability roadmaps that guide the Navy's investment in acquisition programs. Figure 1-3 depicts the NCEP and its relationship to SECNAV 5000.2C, which provides the Navy policy for implementing CJCSI 3170.01E and DODI 5000.2.

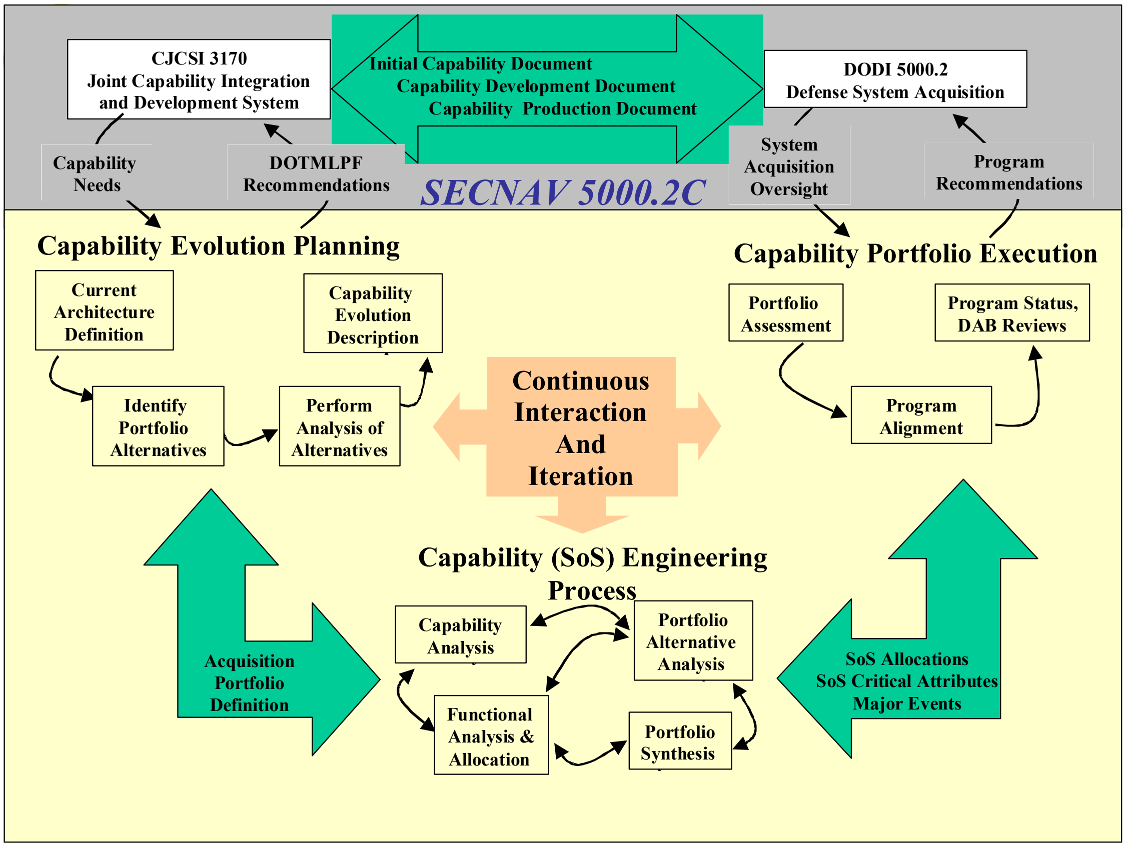

Figure 1-3: Naval Capability Evolution Process

The Capability Evolution Planning process addresses the creation of acquisition portfolios for SoS systems engineering, identifies the initial system performance allocations and interface relationships among the portfolio systems, and establishes capability increments and fielding plans based on the planned evolutionary development of systems, new acquisition programs entering the portfolio, and emerging technologies from science and technology investments. The output of the Capability Evolution Planning process is a Capability Evolution Plan (CEP) to be used as a guide in future investment decisions. The activities performed in the Capability Evolution Planning process support the pre-Milestone A activities for programs entering the Defense Acquisition System and are further described in Section 2.

The Capability Engineering Process applies the principles of the Defense Acquisition University (DAU) Systems Engineering Fundamentals Guidebook[12] and IEEE STD 1220-1998[13] to perform detailed functional and performance analyses, and design synthesis at the SoS level to allocate performance, and to identify key system interfaces and integration and interoperability requirements among portfolio systems. The product of the Capability Engineering Process is the System Performance Document (SPD) which serves as the functional baseline for the SoS.

[12] DAU, op.cit.
[13] IEEE 1220-1998, Management and Application of the Systems Engineering Process, Institute of Electrical and Electronics Engineers, Inc., September, 1998

The activities performed in the Capability Engineering Process support the pre-Milestone B activities of the Defense Acquisition System and are further described in Section 3.

The Portfolio Execution Process continuously monitors the execution of acquisition portfolio programs to ensure that the desired capability is being evolved according to the CEP, the SPD, and the direction provided to individual programs. The output of the Portfolio Execution Process are recommended courses of action to investment decision makers based on changes to one or more portfolio programs. The activities performed in the Portfolio Execution Process support the post Milestone B activities of the Defense Acquisition System and are further described in Section 4.

As part of the NCEP process, engineering models and DODAF Products are aids used to help transform future concepts and desired capabilities into detailed logical and/or physical descriptions that are assessed against the full spectrum of doctrine, organization, training, material, leadership and education, personnel, and facilities (DOTMLPF) issues, coordinated between DoD components, and allocated to the optimal material and/or non material solution. Engineering models and DODAF products form the foundation for determining material / nonmaterial solution viability, technical and funding feasibility of the solution, and serve as the bridge between Joint capability development and the Navy's material acquisition process.

Shown at the center of Figure 1-3 is the need for continuous interaction and iteration. Recommended courses of action that result from the portfolio execution process may require a regression to activities performed in the earlier sub-processes. Continuity of the engineering team and maintaining the engineering data are essential to the corporate memory, and limiting the time and expense associated with restructuring programs. The principal tool for achieving this is the Naval Collaborative Engineering Environment (NCEE), further described in Section 5.

As described above, the NCEP is a time-phased sequence of the three sub-processes. However, in operation it will be iterated episodically as new programs enter acquisition, existing systems evolve, and investments in science and technology mature. Figure 1-4 better illustrates how the NCEP will actually operate.

Material solutions to capability needs identified by the EFDS and NCDP and approved via the JCIDS process are documented as an Interim Capability Document (ICD), or as a Capability Development Document (CDD), and are prioritized, funded and referred to the ASN (RDA) for acquisition as pre-Milestone A or B programs, respectively. ICDs that address a SoS solution, and CDDs for programs that are part of a SoS solution, will enter the NCEP Capability Evolution Planning Process. Each acquisition program will undergo an analysis of alternatives in accordance with SECNAVINST 5000.2C[14] to assess how alternative approaches contribute to the mission capability of the SoS. The results of that analysis will be used to modify the CEP to reflect the contribution of the new program and serve as the entry point to the Capability Engineering Process. The results of the Capability Engineering Process are used to modify the portfolio of systems SPD to reflect the functional, performance and interface changes to the SoS that must be tracked during Portfolio Execution.

[14] SECNAV, op.cit.

As illustrated in Figure 1-4, approval of each ICD or CDD that affects a SoS delivered capability will trigger an iterative pass through the NCEP. For those systems that support multiple missions, the NCEP activities will be performed for each mission, or system that is affected.

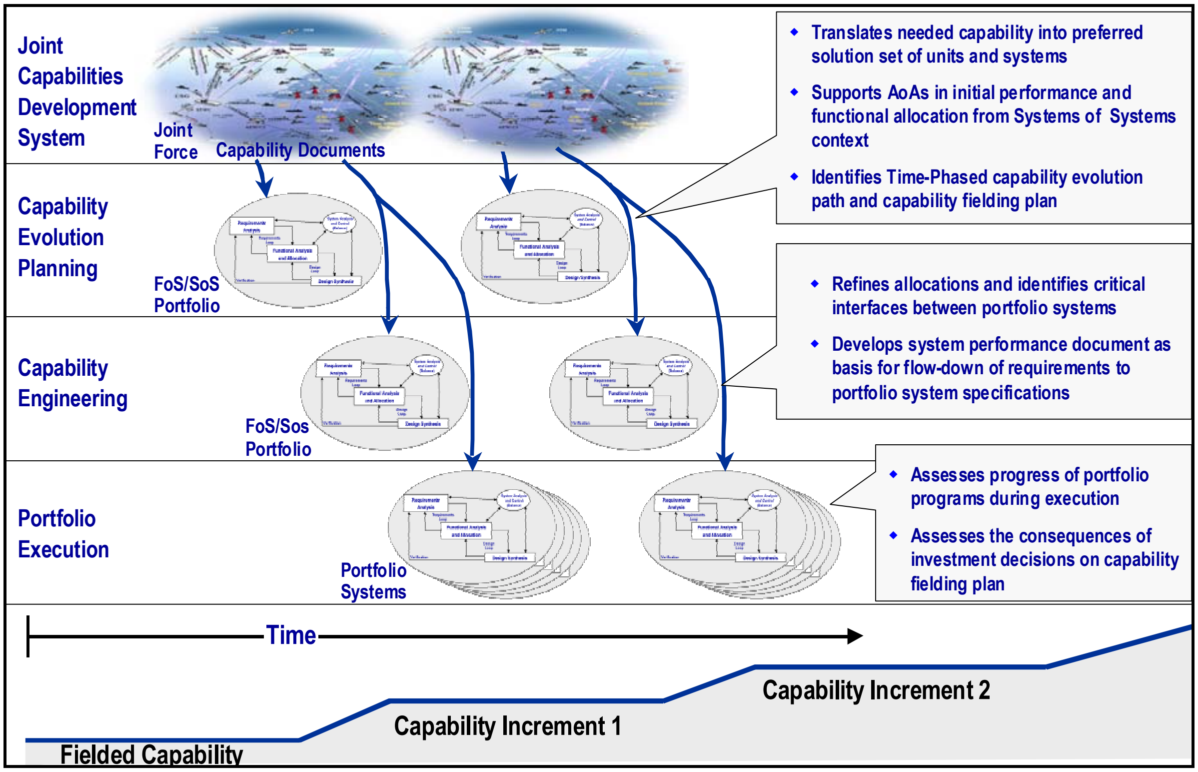

Figure 1-4: Naval Capability Evolution Process Model

1.6. Overall Flow of NCEP Products and Activities

The NCEP operates within the CJCSI 3170.01E and DoDI 5000.2 capability-based and evolutionary acquisition framework. Its principle activities and products are intended to comply with and support the JCIDS and DoD acquisition phases and milestone requirements. Figure 1-5 illustrates the flow of NCEP activities and products for the pre-Milestone B acquisition activities.

Highlighted in blue are those activities which are of ASN (RDA) interest or cognizance. These activities will typically be performed by SoS SE IPTs. Highlighted in orange are the activities typically performed by the individual programs in achieving their acquisition objectives.

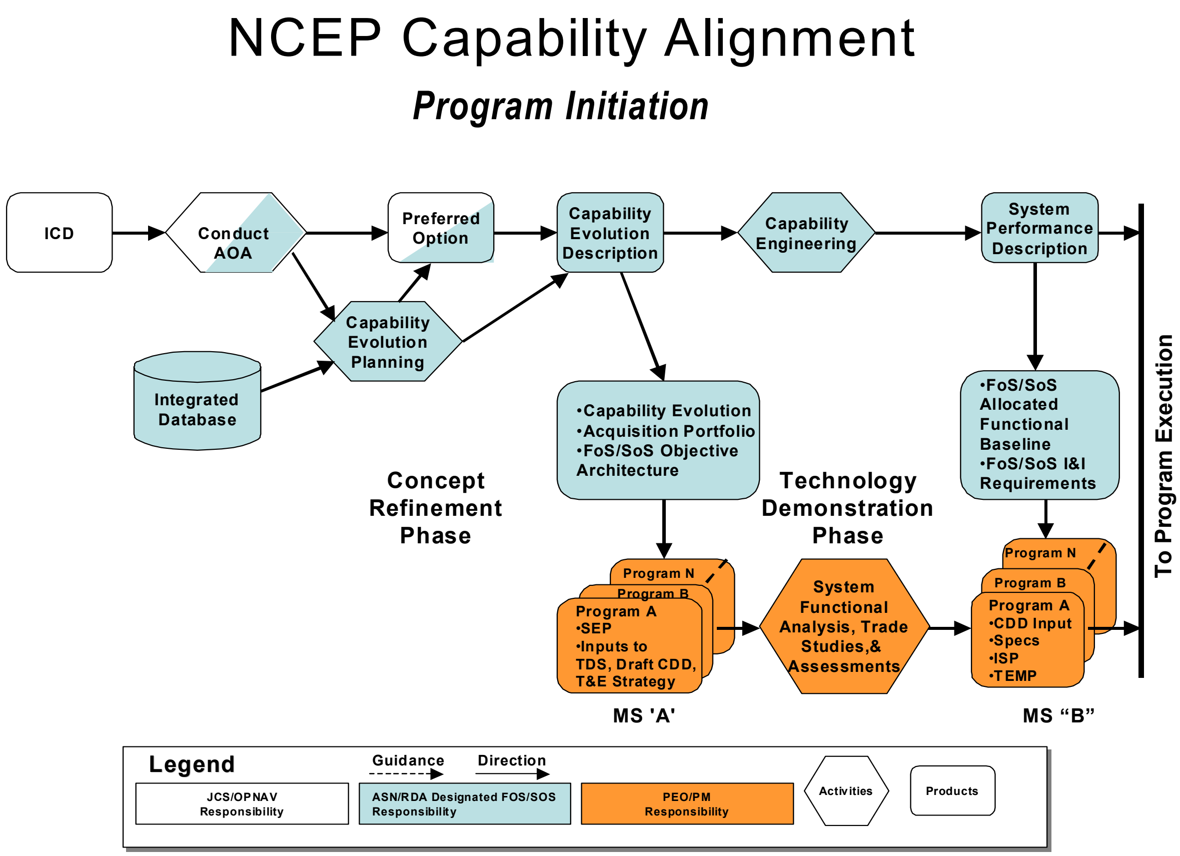

Figure 1-5: Pre-Milestone B NCEP Activities and Products

The primary role of the SE IPT in this phase is to provide guidance to the portfolio acquisition programs with regard to overarching SoS capability requirements for the portfolio of systems. The pre-Milestone B SE IPT activities are Capability Evolution Planning (discussed in Section 2.) and Capability Engineering (discussed in Section 3.). The execution of these activities is supported by the NCEE Integrated Database and toolset described in Section 5. Principal SE IPT products are the CEP and the SPD. These provide the basis for alignment of the portfolio programs to achieve the desired SoS capabilities identified by the ICD and the development of each portfolio program's CDD, ISP, and TEMP.

Figure 1-6 provides the post-Milestone B flow of NCEP activities and products during Portfolio Execution (discussed in Section 4). The primary SE IPT role in this phase is to assure program alignment to achieve the desired capabilities identified by the ICD and specified by the CDD. Principal SE IPT activities in this phase are Program Assessment, Program Alignment, Portfolio Risk Assessment, and Program Status Review. Principal SE IPT products for this phase are an Integrated Portfolio Schedule, an Interface Design Matrix (IDM), an Integration and Interoperability Test Matrix (IITM), and a Portfolio Risk Assessment. These support the portfolio programs as they move through their respective capability demonstrations and operational evaluations and into production and deployment. The SE IPT activities and products also support the Acquisition Decision Authority for milestone reviews.

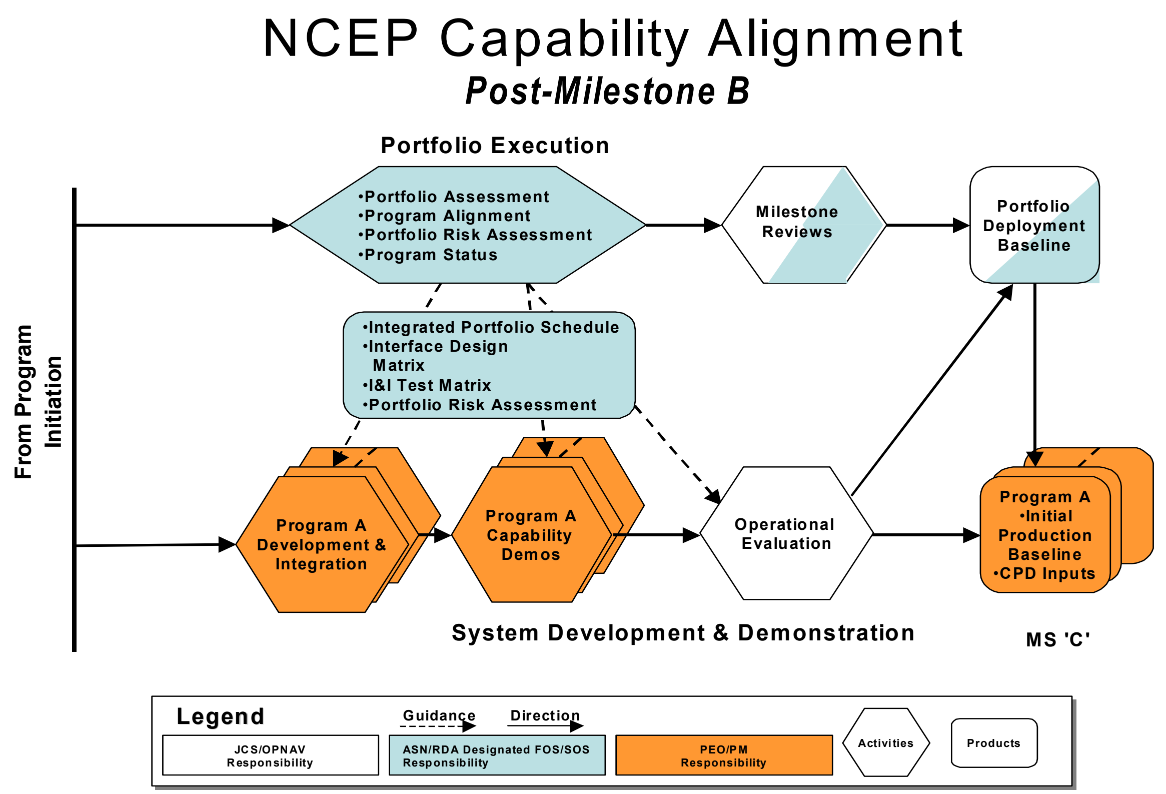

Figure 1-6: Post-Milestone B NCEP Activities and Product

2. Capability Evolution Planning

The Capability Evolution Planning process translates the warfighter's description of a required capability into the domain of the acquisition community, the systems and platforms that deliver capability in terms of hardware, software, and Sailors. Further, this phase establishes the acquisition portfolio that bounds and scopes the SoS engineering activities, and defines a time-phased plan to develop and deliver systems that provide that capability.

The activities performed in this phase represent the front-end of the NCEP. It applies the principles of system architecting to quickly identify and assess alternative strategies for implementing new capability within the constraints imposed by the need to interface with multiple existing in-service systems and systems that are already proceeding through the acquisition process. This phase is essential for the design of complex SoS if they are to be conceived, designed, tested, certified and operated in a way that assures their design integrity and performance. The need for capability evolution planning is driven by the increasing complexity and scale of the SoS that must operate as an integrated system to deliver capability, the continued evolution to computer-based systems that operate in networked environments, and the fact that many systems are multi-functional and are installed in multiple platforms or facilities. These factors also magnify the importance of incorporating the principles and practices of HSI in defense acquisitions.

During this phase, engineers use an iterative process to identify a number of potential SoS solution sets, i.e., alternative methods of allocating functionality and performance among the systems which comprise the SoS to achieve a war fighting capability, and apply heuristics based on experience and lessons learned from similar problem domains to limit the solution set to the most promising. The focus is to achieve a design that is resilient to satisfying competing demands such as: being adaptable and scaleable to support evolutionary or spiral development; retaining capability in multiple force packages; and addressing other constraints in manpower, personnel, human performance and reliability, training, cost and schedule. The goal is to establish a sound architectural framework at the outset that avoids expensive re-engineering and regression testing downstream in the acquisition process.

Figure 2-1 illustrates the flow of Capability Evolution Planning activities and products. The activities are normally performed by a Systems Engineering IPT to address SoS issues. Although these activities are depicted as flowing sequentially, in practice they are often performed concurrently and iteratively. The following paragraphs provide detailed descriptions of these SE IPT activities and products which are intended to provide guidance to the portfolio programs in assuring their integration and interoperability within a net centric force.

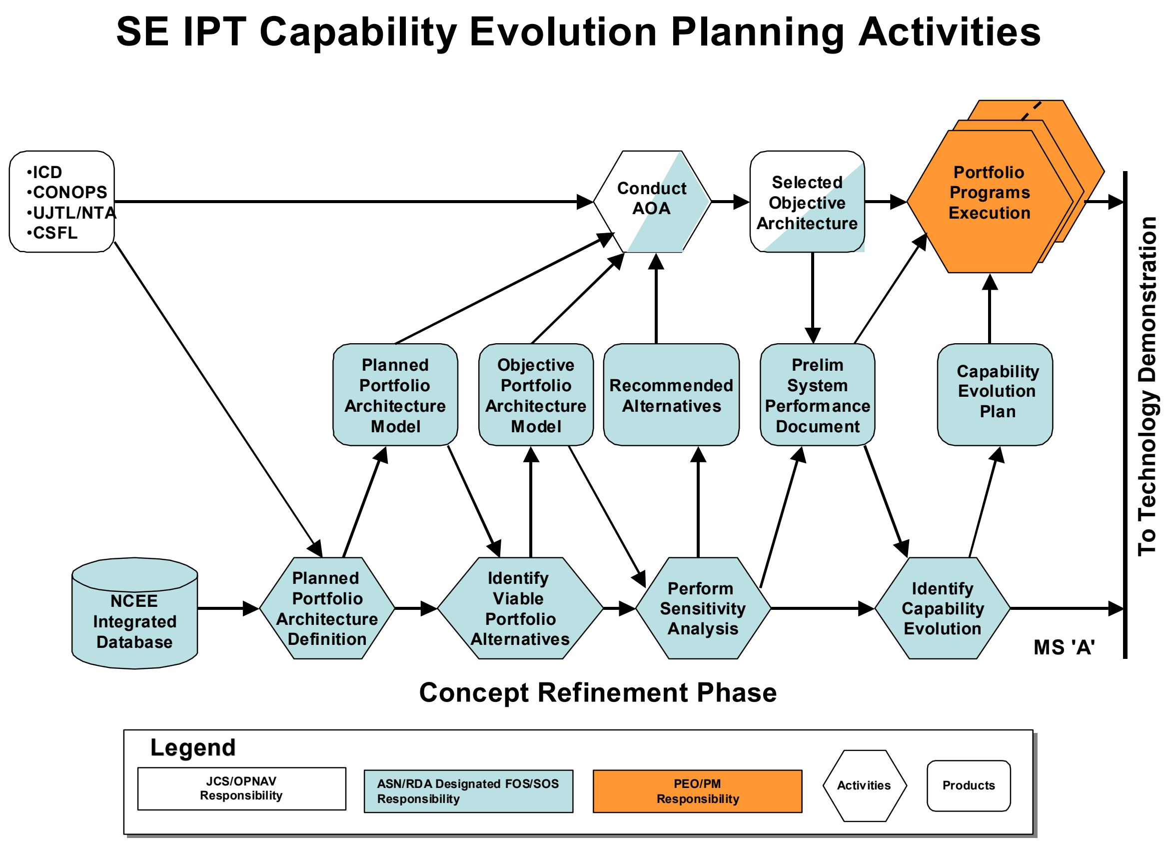

Figure 2-1: Capability Evolution Planning Activities and Products

2.1. Planned Force Package Architecture

The objective of this work is to identify all Naval systems, either in-service or in acquisition, and the important interrelationships between those force units and systems, that contribute to the mission capability identified in the approved Capability Document. When complete, the planned architecture represents the set of mission related systems that may have to be modified, or added to, to satisfy the capability need. If multiple Force Packages are involved in providing the desired capability, then the architecture of each Force Package should be captured.

The planned architecture consists of the operational architecture required to execute the mission capability; the functional decomposition of the operational architecture; the physical architecture for the in-service and funded acquisition systems related to the Force Package; and technical descriptions of the SoS interfaces. The data generated during this phase should be captured in the Naval Collaborative Environment (NCEE) integrated database (see Section 5). The NCEE can report the architecture data in a variety of formats, including the DODAF products (see Appendix C). The DODAF products provide a uniform format for communicating the Force Package architecture to the Joint service community. DODAF products are expected to be customized to suit the kind of representation needed by a particular program or team. DODAF views are just a visual representation of already generated data.

The use of automated capabilities to capture and manage the SoS data cannot be over-emphasized. The number and complexity of the SoS operational relationships, physical interfaces, and data flows exceeds reasonable capabilities to address using manual techniques. The NCEE provides a variety of systems engineering and architecting tools available to support automated generation of the SoS data and models. These available tools include DOORS, Core, Rational Rose, System Architect, and iUML.

2.1.1. Inputs

The Initial Capability Document,
Concept of operations (including force structure / package considerations)
Universal Joint Tasks List (UJTL)
Naval Task Activities (NTA)
Naval Architecture Element Lists
Naval Architecture Repository System

2.1.2. Outputs

A description of the Current Architecture of in-service systems and acquisition systems that represent the portfolio of systems, including data, models, and DODAF products.

Recommended products:
- OV-3, Operational Information Exchange Matrix
- OV-5, Operational Activity Model
- OV-6c, Operational Even-Trace Description
- SV-1, System Interface Description
- SV-3, System-System Matrix
- SV-4, System Functionality Description, and
- SV-5, Operational Activity to System Function Traceability Matrix
- SV-6, Systems Data Exchange Matrix
- SV-10c, Systems Event Trace Matrix

Optional products:
- SV-8 System Evolution Description
- SV-9, System Technology Forecast
- TV-1, Technical Standards Profile, and
- TV-2, Technical Standards Forecast

2.1.3. Operational Architecture Flow-down

Based on the concept of operations, identify the participating command organizations within the force package(s) that are to be deployed or used by Combatant Commanders in executing the mission. Identify the activities assigned to each operational node within the command organization that is responsible for performing operational activities associated with executing the mission. The timing, concurrency, and sequence of operational activities should be identified, and dependencies among the operational activities identified. The relationship between operational nodes should be identified as information exchanges and as inputs or outputs of operational activities, as depicted in Figure 2-2. When available, scenarios or operational threads should be developed utilizing subject matter experts to understand alternative approaches (or application of sensors & weapon systems) for executing the mission, including HSI experts who can assess these activities, relationships, and scenarios and translate individual/unit training and personnel assignment strategies. This task can be documented in the form of executable models or as OV-3, OV-5 and OV-6c products.

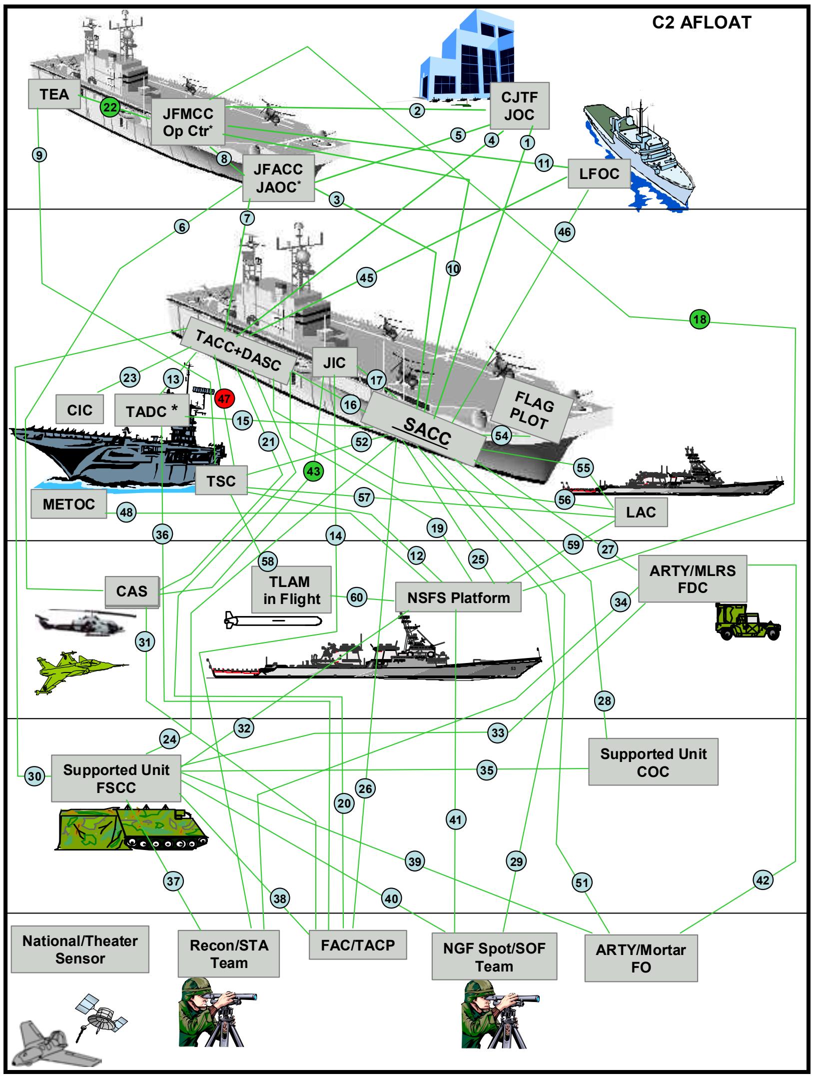

Figure 2-2: Information Exchange Relationships among Organizational Elements

2.1.4. Functional Decomposition of Operational Activities

Using the Common System Function List, translate operational activities into the functions that must be performed by systems, applications, or personnel, including maintenance and support. Identify the systems and operators that perform these functions, and the preferred sequence in which the functions are to be performed to deliver the mission capability. The data flow (inputs and outputs) among functions should be identified to depict how the operational information is processed, generated, and exchanged. The functional decomposition should generally be conducted down to the high level system interfaces. The result is the overarching planned force package functional architecture. This task can be documented in the form of executable models or as SV-4, SV-5, SV-6 and SV-10c products.

2.1.5. Planned Physical Architecture Definition

For the force package, identify the systems that are installed or planned to be installed on each participating platform or facility that is required to support the mission. The operational nodes (locations) should be identified within the platforms and facilities, and the systems installed within the operational nodes should be identified. Platform integration subject matter experts should be utilized to understand the interfaces among the systems, as well as internal and external platform networking and communication mechanisms. HSI experts should also be used to assist in optimizing human engineering design and human-in-the-loop interfaces. This task can be documented in the form of executable models or as SV-1, and SV-3 products.

2.1.5.1. In-service Physical Architecture

Based on the results of the functional decomposition of the operational architecture (Section 2.1.4), all systems that are currently installed on each platform or facility that contribute to a mission capability can be identified as part of a force package. Figure 2-3 represents a simplified combat system block diagram (similar to an OV-1) for a destroyer that is part of the force package shown in Figure 2-2.

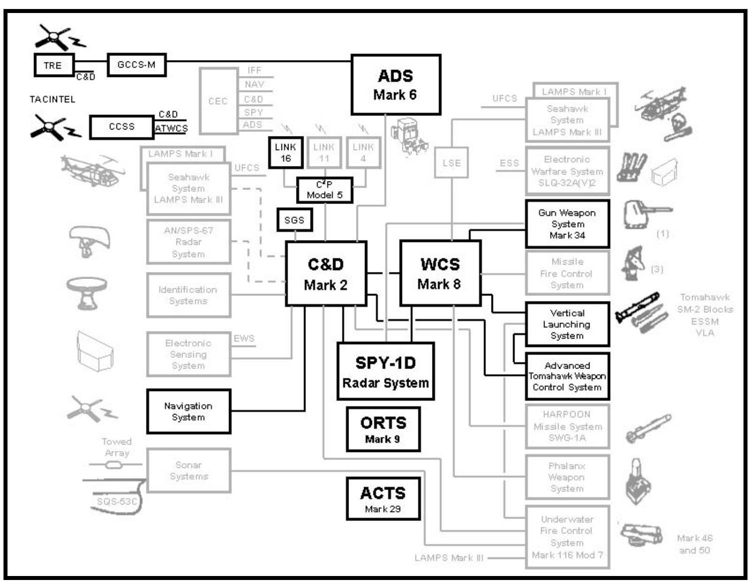

Figure 2-3: Simplified System Block Diagram for Multi-Mission Destroyer (Platform Level)

Highlighted are the installed sensor, weapon, command and control, communications and support systems that contribute to one of many missions supported by this platform. In order to understand the physical and functional inter-relationships between systems represented in this block diagram, each system must be further decomposed into its sub-system and component parts as illustrated in Figure 2-4 for the Command and Decision (C&D) System.

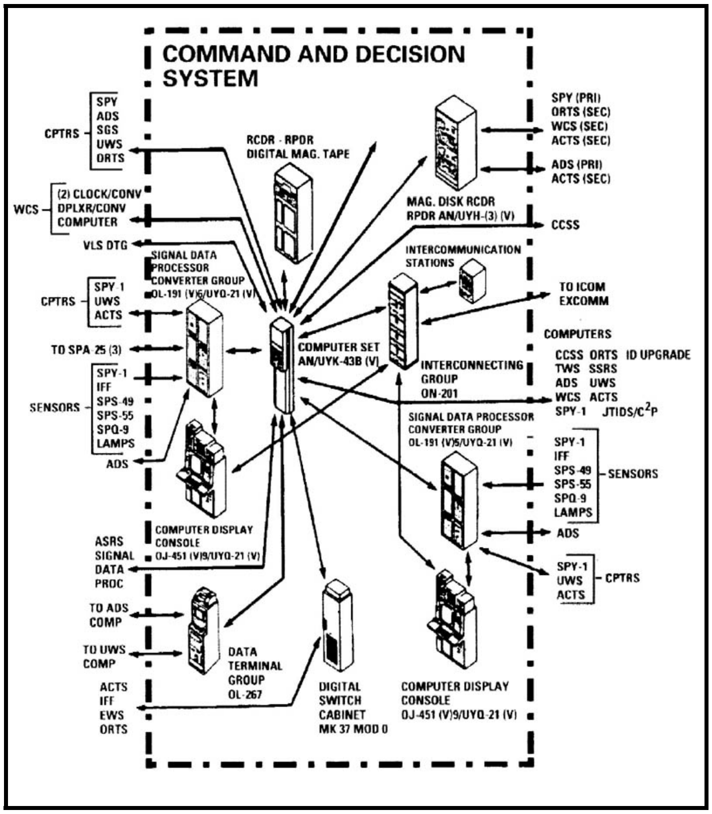

Figure 2-4: Simplified System Block Diagram for a Single System (System Level)

The objective is to capture the system functions performed, the external data needs and sources, the external users of data and the physical interfaces between the systems highlighted in Figure 2-3. This engineering data is readily available from the system specifications, interface design specifications, and interface control drawings maintained by Program Managers. This data represents the combat system "as-built" physical architecture for the platform, and should be captured and maintained in the NCEE data repository that supports SoS systems engineering activities (see Section 5).

The as-built combat system architecture for each platform forms the basis for building a force package physical architecture for any combination of platforms and facilities. Figure 2-5 illustrates a simplified force package system block diagram at a force package level.

Shown are the air, sea, land and space-based platforms, operational nodes, installed systems and the system interfaces (internal and external to the platforms) that constitute the force package. This level of abstraction is a useful tool for defining the force package SoS, and should be useful to Combatant Commanders in evaluating how best to constitute or re-constitute forces.

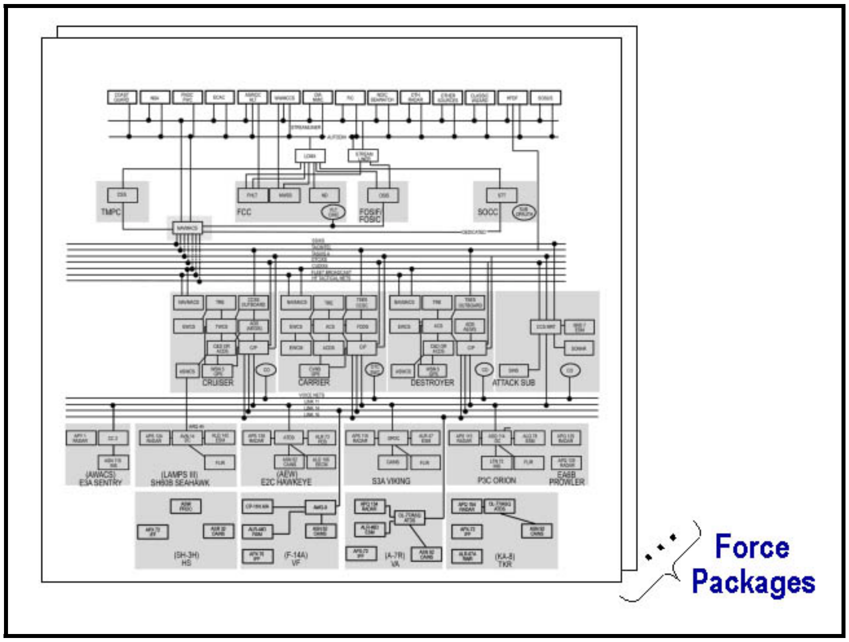

Figure 2-5: Simplified System Block Diagram for Force Package (Force Level)

2.1.5.2. Planned Physical Architecture

The planned (to be) force package physical architecture is the in-service (as built) architecture except that systems that are in acquisition as a program of record but not yet fielded are added or substituted for the in-service systems they replace. Figure 2-6 illustrates this relationship in a block diagram context. The evolution of the force package may also be described in the context of the SV-8 System Evolution Description.

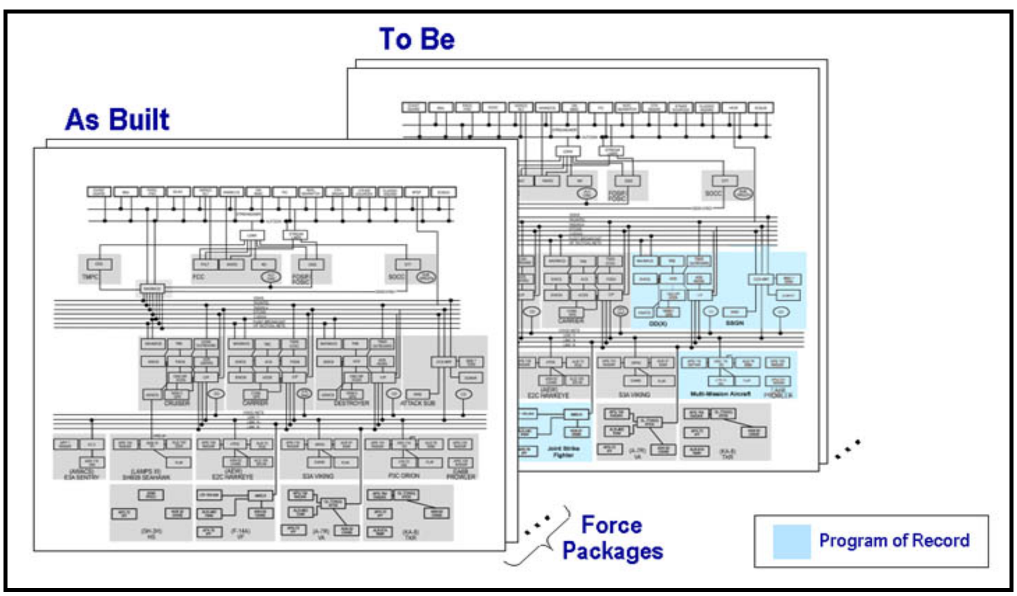

Figure 2-6: Simplified System Block Diagram for Planned Force Package

The shaded platforms represent programs of record that in many cases replace older platforms nearing end of service life. Depending on the maturity of the program, the systems and the related manpower and infrastructure to be installed on the platform may not be completely known, or fully defined. In other cases, new or significantly modified systems will be installed on in-service platforms. The objective is to capture the system functions performed, the external data needs and sources, the external users of data and the physical interfaces between the in-service systems and the systems that are programs of record to create the "planned " force package architecture. The shaded platforms and systems in the Figure 2-6 "to be" architecture and their interfaces to the in-service systems are the basis for establishing the Force Package acquisition portfolio. This level of abstraction is a useful tool for considering how best to introduce a new or significantly modified system into a SoS portfolio. It is an effective tool because it is tied directly to the engineering data repository that allows alternative approaches to be analyzed.

2.1.6. Planned Technical Architecture Definition

For each system and its interfaces, capture the technical standards, protocols, and messaging formats and content. The technical architecture should relate the operational information exchange requirements to the functional data flow requirements, to the physical interfaces and transmission mechanisms, to the technical standards, protocols, and messaging formats and content. This task can be documented in the form of a TV-1 product.

2.1.7. Planned Architecture Validation

Formally validate the completeness and consistency of the descriptions statically and dynamically for each force package architecture. The use of formal, validated executable models is preferred. The validated planned engineering models and architecture products focus on what operational elements make up the planned force that will implement the required capability if no changes are made. This serves as the baseline from which capability gaps are identified and the DOTMLPF and HSI alternatives are considered to mitigate those gaps.

2.2. Identify Viable Portfolio Alternatives

Candidate alternatives for satisfying the capability need should be identified, and evaluated by performing a sensitivity analysis to determine which solution sets represent viable alternatives. This includes not only how the solution set satisfies the capability objective, but also cost, readiness and sustainment objectives.

2.2.1. Inputs

Planned Force Package Architecture
Recommended alternatives (OSD[PA&E], PEOs and PMs)

2.2.2. Outputs

Candidate Objective Force Package Architectures
Viable Acquisition Portfolio Alternatives

QFD Matrices for viable alternatives, which can then be rendered as OV-3, OV-5, OV-6c, SV-1, SV-3, SV-4, SV-5, SV-6 and SV-10c products.

2.2.3. Identify Architectural Principles & Guidelines

The architectural principles and guidelines which will govern the design and evolution of the force package architecture shall be identified. The intent is to understand how the design will remain "open", and support capability evolution growth while maintaining a high degree of integration and interoperability. It is also necessary to assure that the architecture satisfies the Net-Ready KPP requirement for the planned capability. Chapter 5 of the DoD Architecture Framework Version 1.0[15] provides recommended principles and guidelines for developing architecture products.

An additional set of principles is summarized in Table 2-1. These were developed to support combat system engineering of SoS installed in multi-mission surface combatant ships. These principles should apply to all units and should be scaleable to force level SoS.

Modularity	Loosely Coupled Federation
Connectivity	Only essential communications between elements
Simplicity	Best for operation and acquisition
Economy	People, material and funding
Correspondence	Best match to Navy structure, mission, operations
Continuity	Consistent Information, decision Rules
Layering	Support Hierarchy – Command Thru Weapons
Sustainability	Maintain capability, survival and readiness
Compatibility	Constructive to existing systems
Security	Must be designed in

Table 2-1: Principles for System Segmentation

These principles support decisions related to allocating new functions to new and in-service systems and the physical partitioning of new systems to best fit within the planned Force Package architecture.

2.2.4. Identify Alternative Selection Criteria

The criteria against which the alternatives will be selected should be identified and documented. Selection criteria should consider compliance with the architectural principles and guidelines, affordability (Total Ownership Costs), current and future ability to meet manpower and personnel requirements, technology maturity, and timeliness for evolving to the capability.

[15] DODAF, op.cit.

2.2.5. Identify Alternatives

Alternative SoS solution sets that are responsive to the approved capability document should be identified along with the capability increments that will be evolved to full capability realization. Alternative solution sets to achieve the objective capability should address the broad range of stakeholders' interests. They may include adopting other service systems, developing a new system, and/or modifying one or more existing systems.

The objective is to evaluate and select alternative approaches for altering the planned portfolio of systems architecture. Proposed alternatives may be based on one or more themes. For example, adapt a Joint system, avoid modifying existing data links or the introduction of new links, or avoid impacting one or more systems currently in acquisition. Alternative solution sets should be developed around selected themes and by applying the principles of system segmentation. Furthermore, Forces evolve slowly over many decades paced by the life-cycle of the platforms, whereas systems evolve at a faster pace fueled by technology and evolutionary acquisition strategies. In this context, the as-built architecture represents capability that resides in the "Force of Today", and the planned architecture represents the capability of the "Next Force". Illustrated in Figure 2-7 is an approach that uses a vision architecture that looks to the "Force after Next" to help develop alternatives. Within the DoN this "vision" architecture is represented in part by the FORCEnet architecture. Thus, another theme for developing alternatives should also consider how well the future vision is supported by each alternative. Each alternative will imply an associated "objective" architecture to realize the required capability.

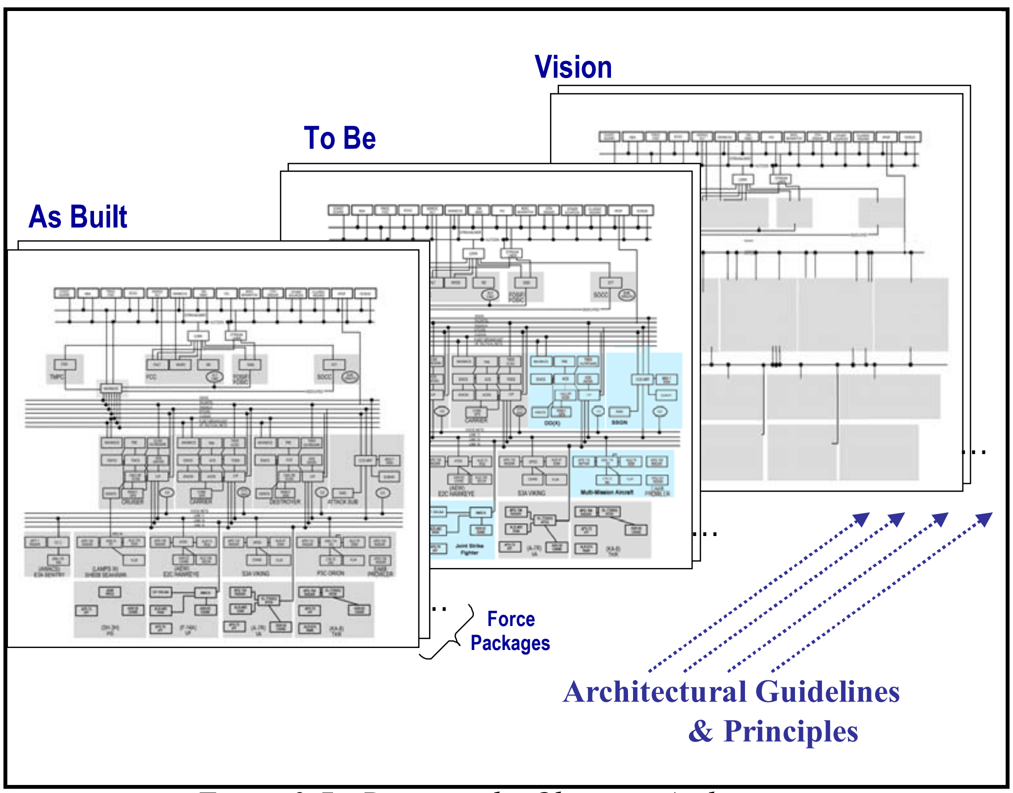

Figure 2-7: Deriving the Objective Architecture

2.2.6. Perform Sensitivity Analysis

In this step, sensitivity analysis is performed on the identified feasible alternatives (2.2.5) to relate operational objectives/requirements to technical design attributes. A widely used approach for performing sensitivity analysis across a variety of factors is the Quality Function Deployment technique (QFD)[16]. QFD permits the operational objectives/requirements to be related to technical design attributes against which alternatives can be evaluated to show how:

Capability performance attributes are satisfied by Mission Thread Characteristics (Platforms, Organizational Elements, Weapons, Sensors, etc.), and provide Mission Thread Performance Requirements, Measures of Effectiveness (MOE), and Improvement Recommendations. Mission Thread Characteristics are supported by Operational Activities (performed by Organizational Elements), and provide the Activity Performance Requirements, and Measures of Performance, and Improvement Recommendations. This task can be documented in the form of a QFD Matrix which can then be rendered as an OV-5 product.

Operational Activities are satisfied by Operational Information Exchanges, and provide Connectivity Performance Requirements and Improvement Recommendations. This task can be documented in the form of a QFD Matrix which can then be rendered as an OV-3 product. Operational Activities are satisfied by Functions (System, Operator, and Applications), and provide Functional Performance Requirements and Improvement Recommendations. This task can be documented in the form of a QFD Matrix which can then be rendered as an SV-5 product. Functions are satisfied by Systems, Operators, and Applications, and provide system Element Performance Requirements and Improvement Recommendations. This task can be documented in the form of a QFD Matrix which can then be rendered as SV- 4 and SV-10c products. Connectivity Performance Requirements are satisfied by Systems/Applications interfaces, as well as the Connectivity Standards and Protocols Requirements and Improvement Recommendations. This task can be documented in the form of QFD Matrices which can then be rendered as SV-1, SV-3, and SV-6 products.

Under QFD, the strength of the relationship between "Whats" and "Hows" is rated and assigned a numerical value, and a weighted score is then calculated to determine the relative importance of each "How" in meeting the collection of "Whats" (See Figure 2-8). Through this sensitivity analysis process the mission success criteria, top-level performance measures, critical objectives, mission critical functions and associated attributes can be identified.

A series of matrices based on the Planned Architecture definition resulting from 2.1.2 may be constructed using the QFD technique. Operational users are the best source of operational requirements/concepts, while Systems Command representatives are the best source of technical requirements/concepts. Subject matter experts should assess the relative impact on mission effectiveness measures as key architectural attributes are varied over a reasonable range. Similar sets of QFD matrices may be developed to address Force Package Readiness and Sustainment concepts. Volume 2 of this Guidebook provides detailed descriptions of the application of the QFD technique for sensitivity analysis of feasible alternatives.

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[16] Systems Engineering Handbook, International Council on Systems Engineering, June, 2004.

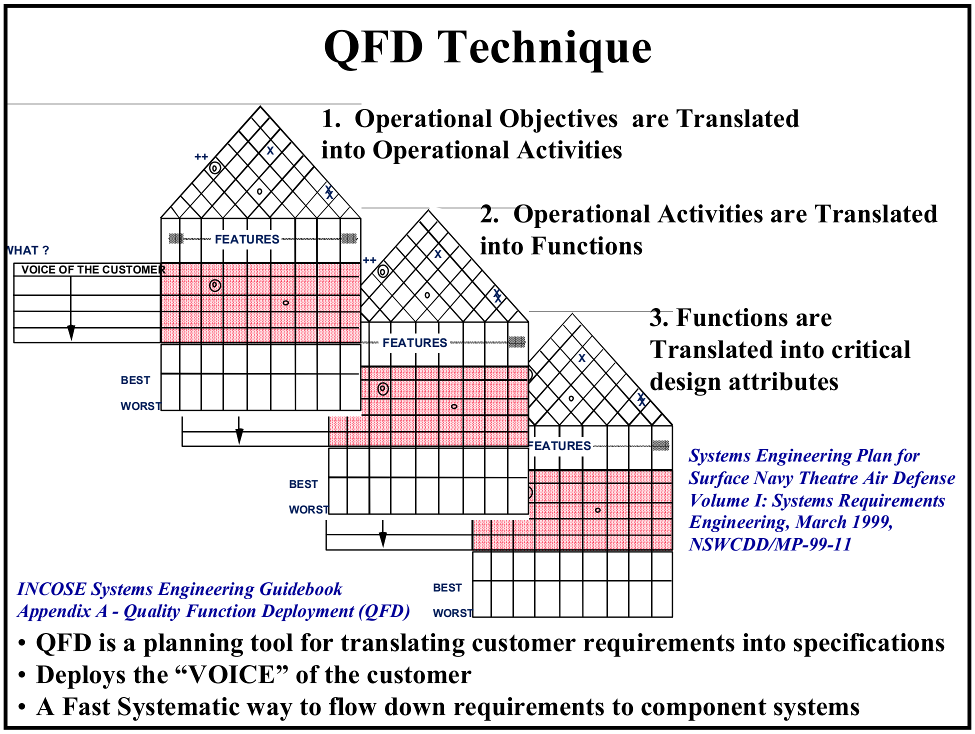

Figure 2-8: The SoS House of Quality

2.2.7. Rank and Recommend Alternatives for Analysis of Alternatives

The identified portfolio alternatives should be evaluated, ranked and prioritized. An initial assessment of technological availability, risks, costs, and performance measures for identified options should be documented. The number of alternatives carried forward for detailed analysis should be limited to a set that can be analyzed given schedule and resource limitations.

2.2.8. Integrate Alternatives into the Planned Architecture

The portfolio alternatives should be integrated into the planned architecture to generate instances of the objective architecture. This effort will produce a set of data, models and associated architecture products for each alternative. These objective architecture instances are captured in the NCEE integrated database.

The planned architecture (Section 2.1.5) provides the basis for integrating each of the alternatives recommended for analysis into a new "objective" architecture. Using the planned architecture as a tool, the impact of the new system (in response to a single system ICD) or systems (in response to a multi-system ICD), and the impact of a major modification to an in-service system as part of the Force Package, in terms of the physical, functional and data integration can be assessed using the NCEE data repository. Figure 2-9 illustrates the case for four recommended options to modify the planned architecture for analysis of alternatives. Each option has different cost, schedule, performance and risk that must be assessed using a SoS perspective.

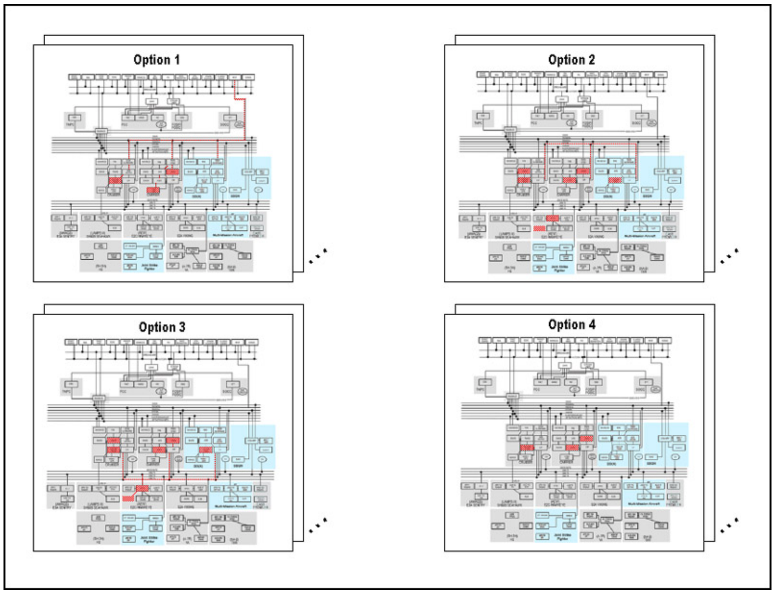

Figure 2-9: Alternative Force Package Improvement Strategies

Each of the four instances shown represent proposed changes to the planned architecture and provide the basis for the Analysis of Alternatives from a SoS perspective. The changes for each alternative to the operational, functional and physical relationships with other systems of the planned architecture must be captured in the NCEE integrated database to support the analysis and to serve as the basis for the objective architecture when the analysis is complete and the preferred alternative is selected.

2.3. Analysis of Alternatives (AoA)

An AoA will be performed to provide the analytical basis for selecting the preferred solution set that provides the needed capability. The identified material solution alternatives, combined with the business processes needed to support them, are assessed to determine the best overall method for closing a capability gap. The AoA will be tailored based on the scope of the changes being introduced to the SoS, if programs are entering the acquisition process at pre-Milestone A or pre-Milestone B.

2.3.1. Inputs

ICD, CDD (if available)
Candidate Objective Architecture Alternatives (Section 2.2.7)
Pre-defined selection criteria (Section 2.2.4)

2.3.2. Outputs

Preliminary SPD
Selected Objective Architecture data, models, and DODAF products.

Recommended DODAF products: OV-3, Operational Information Exchange Matrix
OV-5, Operational Activity Model
OV-6c, Operational Even-Trace Description
SV-1, System Interface Description
SV-3, System-System Matrix
SV-4, System Functionality Description, and
SV-5, Operational Activity to System Function Traceability Matrix
SV-6, Systems Data Exchange Matrix
SV-10c, Systems Event Trace Matrix

Optional products: SV-8 System Evolution Description
SV-9, System Technology Forecast
TV-1, Technical Standards Profile, and
TV-2, Technical Standards Forecast

2.3.3. Evaluate the Alternative Architectures

Solution sets in response to an ICD that contain one or more new programs entering Concept Refinement Phase will under go a formal AoA as prescribed in SECNAVINST 5000.2C[17] using the guidelines provided by the DAG[18].

Solution sets in response to a Capability Development Document (CDD) that represent a major modification to an existing Naval system, or the introduction of an existing Joint system within a Force Package, may require a formal AoA depending on the scope of the changes and impact on other systems within a SoS. Solution sets in response to minor modifications to existing Naval systems, particularly those that have previously been assessed as part of the SoS AoA, may only need to revisit the original AoA to determine if any significant changes have been made.

2.3.4. Prepare Preliminary System Performance Document (SPD)

The preferred solution identified by the AoA represents a first order functional and physical allocation between portfolio systems and their interdependencies, and provides an initial assignment of performance objectives and requirements to portfolio systems. The key attributes of the preferred solution are documented in a Preliminary System Performance Document (SPD) using the format described by Appendix D. The SPD should provide the allocation of functional and performance requirements among the portfolio of systems and the key interfaces between systems that deliver the future capability. The SPD is a governing document for the SoS per paragraph 7.1.9.1 of SECNAVINST 5000.2C. Volume 2 of this Guidebook provides a detailed example of an SPD for a SoS.

It is likely that the SPD will levy additional requirements against the individual programs in addition to their respective originating requirements documents. When refined during Capability

[17] SECNAV, op.cit.
[18] DAG, op.cit.

Engineering, the SPD will be the basis for flowing-down requirements to the system specifications of a new or modified portfolio of systems. The SPD in essence serves as the functional baseline for the acquisition portfolio. Figure 2-10 illustrates the relationship. It is expected that the SPD will be signed by the appropriate OPNAV resource sponsor(s) as well as the participating PEOs and PMs.

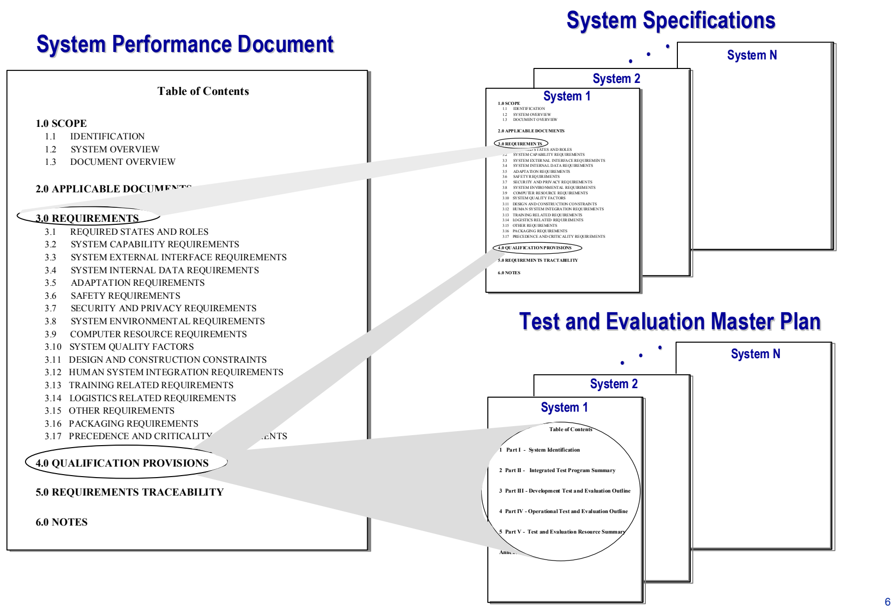

Figure 2-10: System Performance Document Requirements Flow-Down

In addition to the requirements flow-down, key integration and interoperability testing requirements will be identified at the SoS level for capture in portfolio system test plans and Test and Evaluation Master Plans, when required. This provides traceability of future system level test objects to acquisition portfolio integration and interoperability test objectives.

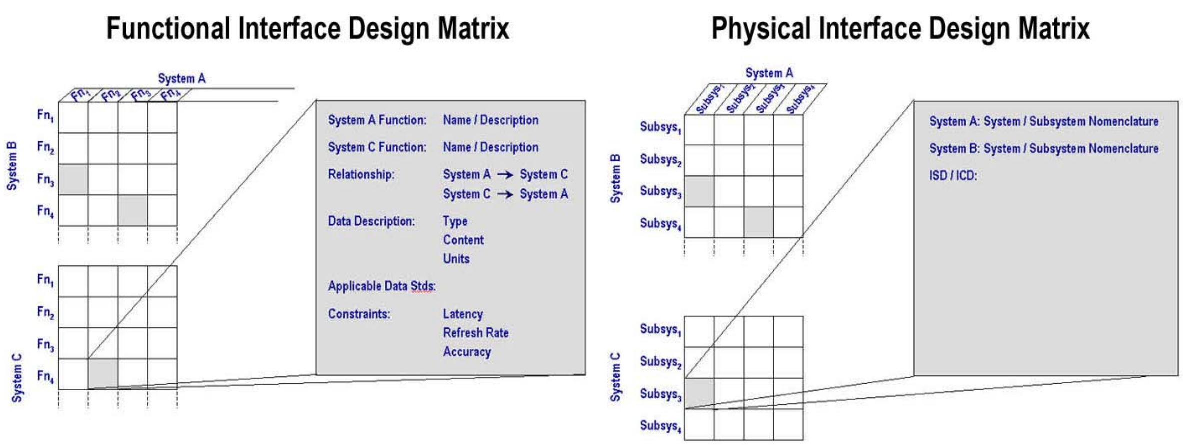

Figure 2-11: Functional and Physical Interface Design Matrices

Functional and Physical Interface Design matrices shall be developed to capture known functional and physical relationships identified during the AoA along with known design standards, protocols, and associated data requirements. Figure 2-11 is representative of the type of matrices that might be created.

The amount of information available following the AoA will be limited, but useful in identifying issues for future refinement and tracking in subsequent phases and iterations of the Naval Capability Development Process.

2.3.5. Acquisition Portfolio Definition

The Acquisition Portfolio is defined as the subset of the Force Package associated with the military capability identified by the ICD that includes the platforms, facilities, systems, networks, and interfaces which will be acquired, modified, or enhanced.

2.3.6. Capture the Objective Architecture

As a result of the AoA, the preferred alternative's architecture should be documented as the Objective Architecture. The engineering data related to the objective architecture should be captured in the NCEE integrated database for use and further refinement in Capability Engineering. The data includes the relationships among operational activities, information exchanges among organization elements, functions allocated to system, application or humans, and the platforms, facilities, personnel, systems and interfaces that provide the capability. The objective architecture will become the new planned architecture at the completion of Capability Engineering and a successful Milestone B.

2.4. Establish the Capability Evolution Plan (CEP)

The Capability Evolution Plan (CEP) documents the results and decisions associated with the Capability Evolution Planning effort. The CEP is a significant document which will evolve over time as the capability is managed, assessed, and updated. It combines the nine (9) elements (Sections 2.4.3 – 2.4.11) of a capability evolution roadmap to tie together system acquisition plans, technology adoption plans, manning and training plans, and investment profiles to show how the Force Package will evolve and the level of capability it will provide over time given the level of investment. The CEP must be developed to align the planned acquisition with the Naval Force Structure Strategy, Naval PPBE Investment Strategy, Naval Human Capital Strategy, and Naval Acquisition Strategy/Roadmap since a SoS will not move as one unit from the planned architecture to the objective architecture. The CEP will define logical capability steps that will take place in 2-3 year increments. Each step in the evolution processes brings the Force Package closer to the capability objectives in the objective architecture.

The nature of evolutionary development dictates that a Force Package will be made up of a diverse set of legacy and newly developed systems. Additionally, each capability increment will bring unique requirements for manning, tactics, techniques, and procedures (TTP). These factors, plus system supportability, logistics, and communication needs must be considered just as important as what systems make up the Force Package for a given increment. Finally, this process enables the developers to roll out a coordinated effort to achieve a capability within a given timeframe while keeping budgetary and development schedule constraints in mind. To support capability evolution planning, the following architecture products are useful:

SV-8: captures the development schedules for each system within the acquisition portfolio for a given capability increment. This product allows the developers to understand what systems will be available and in general, what the warfighting capabilities of the combined force package will be.

SV-9: For each material solution option or capability increment, the SV-9 defines the technologies that must be matured and fielded to enable the capability. Many times, the desire to incorporate new capabilities is tempered by the need for new technology to enable the capability. The information in the SV-8 will usually be dependent on the expected availability of a new technology or technical standard. This helps ensure each potential solution is measured against the same technical baseline for a given time period. This product is strongly tied to the SV-8.

2.4.1. Inputs

The Objective Architecture
Analysis of Alternative Results
System acquisition documents and modernization plans

2.4.2. Outputs

The Capability Evolution Plan (CEP)
Recommended products: OV-1, High-Level Operational Concept Graphic
SV-8, System Evolution Description
SV-9, System Technology Forecast
TV-2, Technical Standards Forecast

2.4.3. Identify the Force Package Concept of Operations

Describe the Force Package concept of operations in terms of how the force package is organized, its composition in terms of number and types of platforms, and its connectivity to other Force Packages, Theatre, Joint, National and/or Coalition/Allied organizations. This task can also be documented in the form of an OV-1 product.

2.4.4. Identify the Readiness Concept

A description of the Readiness Concept for the Planned Force Package Architecture, and how it will be evolved along with the Objective Force Package Architecture, should be documented.

2.4.5. Identify the Sustainment Concept

A description of the Sustainment Concept for the Planned Force Package Architecture, and how it will be evolved along with the Objective Force Package Architecture, should be documented. A Support Equipment Section can be included in this document to identify any unique support equipment and support personnel training profiles per year for each version/evolution of the systems that make up the acquisition portfolio.

2.4.6. Identify the Capability Evolution Objective

The Capability Evolution Objectives provide a long-term view of how the Force Package capability will be evolved over time, the level of capability achieved at specified time increments, and the fielding of new systems, enhancements, upgrades or increments that provide the capability increments.

2.4.7. Identify the Portfolio Acquisition Roadmap

The Portfolio Acquisition Roadmap details the acquisition milestones and significant DT&E/OT&E events which lead to fielding the portfolio of systems over time. It should address how individual systems are developed, evolved, enhanced, or upgraded. This task can be documented in the form of an SV-8 product.

2.4.8. Identify the Technology Adoption Roadmap

The Technology Adoption Roadmap details the key technologies, their maturation milestones (Demonstrators, etc.), and fielding plans where the technology is integrated into the Portfolio Acquisition Roadmap. This task can also be documented in the form of SV-9 and TV-2 products.

2.4.9. Identify the Portfolio In-Service Life Roadmap

The Portfolio In-Service Life Roadmap details the portfolio of systems in terms of their initial deployment milestones for the Force Package, the total force manpower structure required to operate and support the systems, and the associated upgrade and retirement milestones associated with the Portfolio of systems.

2.4.10. Identify the Force Training & Transition Plan

The Force Training and Transition Plan details the Training System Acquisition roadmap and personnel training profiles per year for each version/evolution of the systems that make up the portfolio. In addition, the training requirements and skills of operators associated with individual systems shall be documented. Systems transitioning into Operational use are dependent upon there being available, trained operational and support personnel, and this document is prepared to align the training of operational and support personnel with system fielding.

2.4.11. Identify the Portfolio Investment Profile

The Portfolio Investment Profile should be developed to depict how much funding is allocated for each system in the portfolio for the planned and long-term horizon. Funding by category should address Research, Development, Test & Evaluation (RDT&E), Operation & Maintenance, Personnel & Training, Production, Fielding (Installation & Checkout), Ship Construction, etc. A portfolio summary of investment costs should be captured to identify how much investment is being made by the Navy in order to maintain and evolve the capability.

2.4.12. Obtain Approval for the Capability Evolution Plan

The Capability Evolution Plan must be coordinated among the Naval Acquisition community to gain approval for implementation. This involves coordinating the CEP among the various PEOs, PMs, DASNs, and the Virtual SYSCOM as well as gaining the approval of the CEP by the appropriate N8 resource sponsor.

3. Capability Engineering Process

During this phase, engineers use an iterative process to establish the allocation of functional and performance requirements to the portfolio of acquisition systems. The objective is to identify how the planned portfolio of systems can be integrated into the Current Force Package Architecture, and how these new systems, modifications, or enhancement will provide the desired military capability. In addition, special attention will be paid to integrated testing and training, readiness, and logistic and support concepts.

During this process, the Objective Architecture will be modeled and analyzed to understand how the functional and performance allocation to the portfolio of systems will affect the Force Package's ability to satisfy the desired capability. In addition, engineering analysis should be conducted as necessary, and time and error budgets established and allocated among the systems.

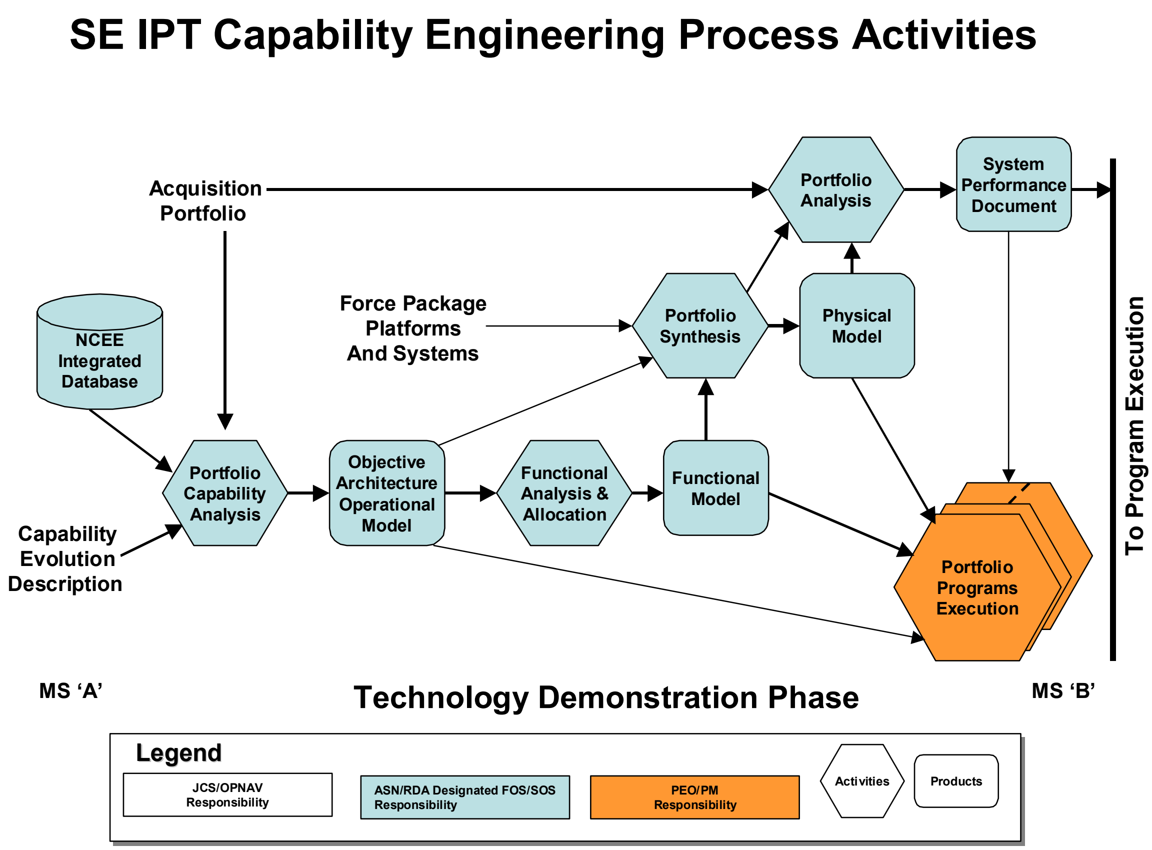

Figure 3-1: Capability Engineering Process Activities and Products

At each step in the Capability Engineering Process, the Objective Architecture supports the analysis of multiple options to achieve a given capability. Further, the integrated architecture model of the Objective Architecture brings people, processes, and systems together in one place to support investment analysis and decision-making. The integrated architecture model is contained in the NCEE integrated database including the data, models and DODAF architecture product descriptions (see Appendix C).

Figure 3-1 illustrates the flow of activities and products for the Capability Engineering Process. These activities are typically performed by a SE IPT designated by ASN (RDA) to address SoS issues. Although a sequential flow of activities is indicated, in actual practice the SE IPT would typically perform these in an iterative and possibly concurrent fashion. The following paragraphs describe these SE IPT activities and products which are intended to provide guidance to the portfolio programs in assuring their integration and interoperability within a net centric force.

It should also be noted that the activities described in this Section are highly interactive with the Section 2 activities. The Capability Engineering Process is directly supportive of Capability Evolution Planning and the two may be conducted concurrently. However, Capability Engineering will generally be conducted in significantly more depth than similar activities conducted in Capability Evolution Planning. Likewise, Capability Engineering will depend on the products of Capability Evolution Planning as key inputs.

3.1. Portfolio Capability Analysis

The purpose of Portfolio Capability Analysis is to identify the portfolio system requirements that must be satisfied in order to be responsive to the JROC capability document. An engineering (executable) model should be developed that relates a model of the Force Package Operations to the functions performed at the system, operator, and application level. Functional relationships, in terms of allocation, should be identified and a physical model developed to the physical elements of the Force Package (Platforms, Facilities, Operational Nodes, Systems, Interfaces and Operators). Figure 3-2 depicts the integrated architecture model.

3.1.1. Inputs

The Objective Architecture
JROC Capability Document(s)
AoA Analysis results
Mission threads or Scenarios
Capability Evolution Plan

3.1.2. Outputs

An Operational Model of the Objective Architecture which can then be rendered as OV-3, OV-5 and OV-6c products
Force Package Sustainment Concepts
Force Package Readiness Concepts
Force Package Integrated Training Concepts

3.1.3. Develop the Operational Model

The Operational Model is an executable representation of the Operational Force, how it is organized, and how it performs its integrated processes/activities to achieve mission objectives.

3.1.3.1. Organizational Structure

The organizational structure of the force should represent the chain of command associated with the organizational elements which comprise the Force Package. The organizational structure also should identify the location of each of the organizations in terms of the platforms and facilities where the organization will operate (Operational Nodes). Note that the organization of military units typically has two perspectives, an administrative chain of command, and an operational chain of command. We may need to consider both chains of command if coordination along the administrative chain of command is part of the operational procedures. However, we are most interested in the Operational perspective when preparing the operational model.

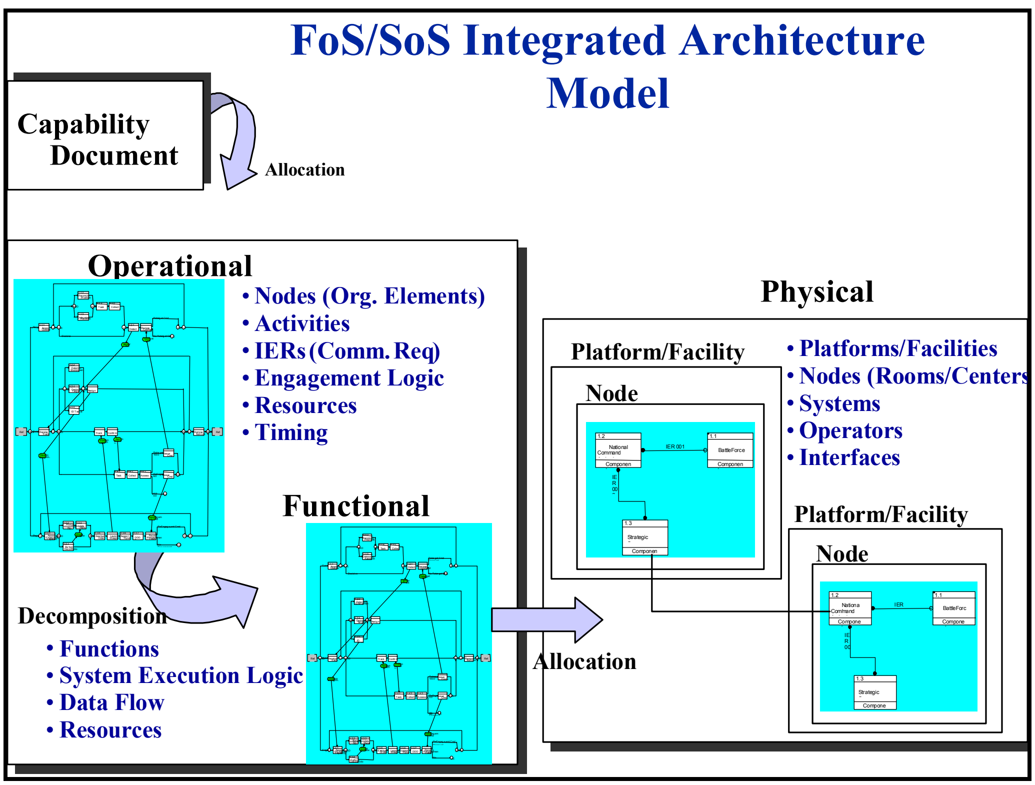

Figure 3-2: The SoS Integrated Architecture Model

3.1.3.2. Operational Activities

The activities conducted by each of the Organizational Units from a single starting point until the mission is completed should be captured. The sequential or parallel nature of organizations performing activities should be identified to represent the concurrent nature of military operations. Operational Activities are abstracted functions which are performed by an organization, and can be decomposed to describe how the organization's personnel utilize systems to perform their tasks. Thus, Operational Activities will be decomposed into functions which are performed by systems, applications or personnel during Functional Analysis (3.2). This aspect of the Operational Model can be derived from the OV-5 and OV-6c products of the Objective architecture (See Paragraph 2.3.6).

3.1.3.3. Information Exchanges

The information exchanged among organizational elements should be captured and represented as an input or output to an Operational Activity. In some tools, inputs which are required prior to an operational activity being initiated act as a trigger to indicate the data dependency. This aspect of the Operational Model can be derived from the OV-3 product of the Objective architecture (See Paragraph 2.3.6).

3.1.3.4. Execution Performance

Each operational activity should be defined in terms of the time or duration required to perform the activity. Durations can be defined as a constant time, or based on probabilistic equation (e.g., 10 seconds plus or minus 3 seconds to denote a range in duration between 7 and 13 seconds). For each thread through the Operational Model, the associated time and error budgets need to be identified and allocated to the activities.

3.1.3.5. Resource Utilization

Resource availability may also determine when an operational activity can be performed. If an operational activity needs specific resources to be conducted, and the resource is being utilized by another activity, this indicates a resource contention. The solution to removing the delay is to increase the amount of resources that are available. However, in some cases, this simple solution cannot be accommodated, and other solutions must be sought. Resources come in two varieties: those which are consumed when an activity is performed, and those which are captured temporarily while the activity is executing and then released when the activity concludes.

3.1.3.6. Control Logic

Capture the conditions or business rules under which different courses of action will be taken, and how each course of action involves the execution of different operational activities. It is best to assume a positive outcome, and not to make too many excursions to address the many possible situations that may arise during the conduct of a mission.

3.1.4. Verify the Operational Model

The operational model needs to be verified that it is correct and reflects how the Operational Force would actually carry out the mission. This verification step is necessary for the results of the analysis to be accepted by the operational and acquisition communities. Verification is best accomplished by having the Operational Model reviewed by Operational Naval organizations that train or have been trained and certified to conduct the mission.

3.1.5. Assess the Operational Model

The Operational Model will provide a basis for describing the "Capabilities" associated with the Force Package in terms of how efficiently and effectively it can accomplish a mission. The initial assessment of the Operational Model is to verify that it is logically complete and correct. The Assessment of the Operational Model involves assessing the mission timeline, Information Exchange Requirements, and organizational processes to determine how the Force Package needs to perform the mission to achieve the capability requirements.

3.1.6. Sustainment Concepts

The logistics and support concepts for the Force Package must be modeled and analyzed to ensure that the Force Package can maintain the necessary level and duration of operations to achieve military objectives. Sustainability is a function of providing for and maintaining those levels of ready forces, materiel, and consumables necessary to support military effort.

3.1.7. Readiness Concepts

The readiness concepts for the Force Package must be modeled and analyzed to identify the deployment and employment options for positioning the Force Package in a Theatre of conflict. Readiness involves three (3) key aspects: 1) trained and available personnel; 2) deployment concepts depicting how the Force Package will be delivered to the theatre of conflict; and 3) the preparation time once in theatre to set-up systems, networks, etc., to be prepared to conduct operations as an integrated and interoperable force.

3.1.8. Integrated Training Concepts

Integrated training requirements must be modeled and analyzed to identify how the Force Package will be able to train as an integrated force. Integrated training will require an understanding of the overall integrated testing approach and allocation of training functions among the portfolio of systems during Functional Analysis and Allocation. The training infrastructure necessary to provide the personnel to operate and support the Force Package must be defined and analyzed to ensure that the required quantity of the type of personnel necessary can be provided. Areas of overlap or commonality between components of the Force Package may be identified to promote efficiencies in the training infrastructure. The total force manpower structure expected to be required to operate and support the Force Package must be predicted and compared with the projected future inventory.

3.1.9. Develop the Interface Test Matrix

The information exchanges identified in the operational model should be evaluated to determine if they require formal testing at the Force Package level or sub-level (Platform to Platform, System of Systems). Those interfaces that require formal verification and validation should be included in the interface test matrix. The interface test matrix will drive the Qualification Requirements specified in the System Performance Document (SPD) for these interfaces.

3.2. Functional Analysis & Allocation

The purpose of Functional Analysis & Allocation is to understand how elements of a Military Force perform their operational activities.

3.2.1. Inputs

The Operational Model generated by Portfolio Capability Analysis.
The Common System Function List (CSFL).

3.2.2. Outputs

Functional Models which can then be rendered as SV-4 and SV-5 products.

3.2.3. Develop Functional Models

To further understand how the mission is executed, it will be necessary to decompose operational activities to discover how the personnel utilize systems, applications, and resources to conduct the activity.

3.2.3.1. Functional Decomposition of Operational Activities

Operational activities represent a transformation of operational inputs into operational outputs. The functional model of the activity represents how the transformation is performed. It should depict the sequential and parallel functions that occur, the data that flows among the functions, and the behavior or control logic associated with the functional processes. These functional models show how the personnel interact with or utilize systems or applications to transform the operational inputs into operational outputs. The Common System Function List (CSFL) hosted on the NCEE should be the basis for identifying the appropriate functions to be utilized in the functional model.

3.2.3.2. Functional Performance

Each function should be allocated a time duration specifying how long it should take to perform the function. The behavioral summation of functional durations will determine the duration of the operational activity given that some functions can be performed in parallel. For each thread through the Operational Model, the associated time and error budgets need to be allocated to the Functions.

3.2.3.3. Data Flow between Function

The data flow among personnel, and system functions should be specified. In addition, data accessed from data stores, such as databases, should be depicted as necessary data in order to accomplish the transformation of operational inputs into operational outputs.

3.2.3.4. Functional Allocation to Systems & Operators

Functions must then be allocated to or assigned to personnel, systems or applications for traceability purposes. These allocations will form a basis for conducting trade-studies when desiring to provide improved capabilities by combining system functionality, or automating manual functions. It may be necessary to further decompose and allocate functionality to sub-systems or components. As an example, the SV-4 is useful for assessing Human Systems Integration (HSI) issues. Specific functionality needed to implement a capability can be allocated to the operator, to the system the operator uses, or more likely, a combination of the two. Functions that make up a process or mission scenario can be allocated between the operator and the systems during analysis to determine what combination best meets the metrics associated with the business process while staying within cost, schedule, training, technology, and manpower constraints.

3.2.3.5. Allocation of Data to Physical Interfaces

Data flowing between systems must be allocated to or assigned to interfaces among systems or applications for traceability purposes.

3.2.3.6. Sustainment Functionality

The logistic and support concepts should be analyzed to understand the functionality required to implement the logistics and support concepts. The functional requirements will drive portfolio synthesis as design concepts, components, technologies, etc., are considered to satisfy the logistic and support functional requirements.

3.2.3.7. Readiness Functionality

The readiness and deployment concepts for the Force Package should be analyzed to understand the functionality required to implement them. The functional requirements will drive portfolio synthesis as design concepts, components, technologies, and training concepts are considered to satisfy readiness and deployment.

3.2.3.8. Integrated Training Functionality

The need for integrated training concepts should be analyzed to understand the functionality required to implement them. The functional requirements will drive portfolio synthesis as design concepts, components, technologies, etc., are considered to satisfy the integrated training concepts.

3.2.4. Verify the Functional Models

The Functional Model needs to be verified that it is correct and reflects how the Operational Force would actually perform each operational activity. This verification step is necessary for the results of the analysis to be accepted by the acquisition community. Verification is best accomplished by having the Functional Model reviewed by Operational Naval organizations which train or have been trained and certified to conduct the mission.

3.2.5 Revise the Functional Interface Matrix

Functional analysis will result in second and third tier allocations between portfolio programs that need to be added to the Functional Interface Matrix. The Functional Interface Matrix should be updated to reflect the functional relationship among sub-systems and components where the functional interfaces are to be implemented.

3.3. Portfolio Synthesis

The purpose of portfolio synthesis is to understand how the Force Package platforms, facilities, operational nodes, systems, personnel, and system interfaces are organized and integrated. Portfolio synthesis provides a physical model of the force package, and supports alternative trade-studies by understanding how new systems or technologies should be integrated into the existing Force Package infrastructure.

3.3.1. Inputs

- Operational and Functional models developed in 3.1 and 3.2.
- Platforms and systems which make up the Force package, and related information on their performance and interfaces.
- Information on proposed enhancements to the portfolio of systems can be an input to portfolio synthesis to help formulate analysis of alternatives or trade studies.

3.3.2. Outputs

A complete physical model of the Force package depicting how the force package platforms, facilities, system nodes, systems, personnel, and interfaces are arranged, and can then be rendered as SV-1, SV-3, TV-1, and TV-2 products.
Alternative physical models can be developed to support the analysis of alternatives or trade studies supporting capability assessments.

3.3.3. Develop the Physical Model

The Physical Model is not a detailed design drawing, but rather a conceptual representation of the Force Package and portfolio of systems, where they are located (on a platform (mobile) or in a facility (fixed)), and their interfaces/interconnectivity.

3.3.3.1. Force Package Identification (Platform & Facility)

The first layer of the Physical Model is the depiction of the platforms and facilities that support the mission execution, and the platform and facility interconnections.

3.3.3.2. Operational Nodes Identification

Within each platform or facility, the operational nodes (centers, rooms, quarters, etc.) should be identified. Operational nodes represent the working locations of organizational elements performing operational activities.

3.3.3.3. System Identification

The systems that reside within each operational node should be identified.

3.3.3.4. Personnel Identification

The key personnel or teams that are stationed within each operational node should be identified. Key personnel relates to those identified operational personnel who perform functions or operate systems to conduct operational activities.

3.3.3.5. Interface Identification

The interfaces between systems should be identified. Note that if a system interfaces with a system on another platform or within another facility, then there is either a hardwired connection between the two systems (which means there are connections between the associated Operational nodes and platforms/facilities) or a communication mechanism is used to transmit and receive the data passed between the two systems.

3.3.3.6. Network Identification

Networks within and among Platforms or Facilities should be identified and assigned to the appropriate operational node.

3.3.3.7. Sustainment Physical Model

The sustainment elements associated with the Force Package should be identified in a sustainment physical model, with an emphasis on the inventory stores, special test equipment, tools, maintenance personnel, shore or distance support, etc., necessary to sustain the Force Package. The portfolio of systems design should trace to the sustainment functional requirements and concepts derived earlier in the process.

3.3.3.8. Readiness Physical Model

The readiness elements associated with the Force Package should be identified in a readiness physical model, with an emphasis on the Training Facilities, instructors, training systems/simulators, transport vehicles, etc., necessary to maintain a skilled and proficient work force, the basing facilities, and the ability to deploy the Force Package to the theatre of operation in a timely manner. The portfolio of systems design should trace to the readiness functional requirements and concepts derived earlier in the process.

3.3.3.9. Integrated Training Implementation

The portfolio of systems should be designed to ensure that the Force Package can support the integrated training requirements and concepts derived earlier in the process. The portfolio of systems design should trace to the integrated training functional requirements and concepts derived earlier in the process.

3.3.4. Assessing Measures of (System) Performance

The measure of system performance should be assessed to determine where queuing may occur or resource contention affect the operational process. Given that functions are allocated to personnel, systems, and applications, the physical model should provide a basis for assessing the measures of performance of the portfolio of systems. Functions allocated to systems can have their performance affected given enhancement or upgrades to the systems. Faster processors, streamlined communication paths, and other enhancements will affect the physical model and the measures of system performance.

For each operational thread, the associated time and error budgets need to be identified and allocated to the systems.

3.3.5. Revise the Physical Interface Design Matrix (IDM)

The results of the Portfolio Synthesis will identify the second and third tier functional allocations between portfolio system sub-systems and components. These allocations need to be added to the physical IDM developed under Section 2.3.4. The physical IDM should be updated to reflect the physical relationship among sub-systems and components where the interfaces are to be implemented. It should reflect the design standards, protocols, and associated data requirements associated with each interface. From this IDM the SV-1, SV-3, and TV-1 views can be rendered.

3.3.6. Develop the Systems Performance Document

The Systems Performance Document (SPD) should be developed to document the baselined allocation of functional and performance requirements among the Portfolio of Systems and their evolution. This document is intended to provide a Portfolio of Systems specification against which the portfolio will be evaluated as the individual systems are developed, tested and fielded. The Functional, Physical and Integrated Test Design Matrices should be included in the SPD as appendices. The Preliminary System Performance Document (2.3.4) developed during the AoA should be the baseline for generating the SPD. Volume 2 of the Guidebook provides an SPD example for a SoS.

3.4. Portfolio Analysis

The purpose of Portfolio Analysis is to analyze the Force Package architecture to: 1) determine the best allocation of functionality among personnel, systems, and applications; 2) assess technology availability; 3) identify the risks associated with the Portfolio of Systems; and 4) assess integration and interoperability challenges, including HSI issues. The engineering models and architecture products captured in the NCEE integrated database are vital enablers to the Portfolio Analysis process.

3.4.1. Inputs

Operational concepts and models developed in 3.1.
Functional models and allocations developed in 3.2.
Physical models developed in 3.3.
Preliminary System Performance Document.

3.4.2. Outputs

Trade study results which will document identified deficiencies, Integration and Interoperability challenges, available technology, identified risks, material alternatives, and HSI issues.
Updated Capability Evolution Plan.
Updated System Performance Document.

3.4.3. Perform Portfolio Analysis and Trade Studies

Portfolio Analysis provides an iterative assessment of the Force Package architecture as it evolves over time. Portfolio Analysis can be conducted utilizing any one or combination of the Operational, Functional, or Physical models. The iterative process results in the allocation of the functional decomposition of operational activities to physical resources. The product is a fully specified, integrated and interoperable Force Package. Portfolio Analysis can be done at any time to evaluate alternatives and ensure the acceptability of design decisions concerning the Force Package configuration, how the architecture will be intended to support operations, and functional allocations among systems, personnel and applications that results in a balanced, cost effective, and integrated, interoperable solution, with an acceptable level of risk.

It should be noted that functions allocated to humans must be within their capability. Concepts and designs must be simplified or enhanced to reduce any contributions to conditions of uncertainty, time stress, or workload stress that may contribute to mishap or degraded system performance. Human physical and cognitive performance can also be influenced through personnel selection and training.

3.4.3.1. Capability Trade-off Analysis

As the Force Package architecture evolves, the architecture should be analyzed to ensure that it can achieve the level of capability established by Capability Evolution Objectives (Section 2.4.4). If capability deficiencies are identified, then alternatives should be pursued unless it is cost prohibitive or technologically infeasible to resolve the deficiency. The results of these analyses should be maintained in an Integrated Database.

3.4.3.2. Integration & Interoperability Analysis

Integration and Interoperability Analysis should be conducted prior to adopting a change to the base-lined Force Package configuration. This analysis is intended to ensure that the portfolio has been designed properly so that the systems will be able to act as an integrated and interoperable system. If integration and interoperability issues are identified, then alternatives should be pursued unless they are cost prohibitive or technologically infeasible to resolve the deficiency. The results of these analyses should be maintained in the Integrated Database (see Section 5.2).

3.4.3.3. Technology Availability Analysis

The emerging technologies that may have significant impact on the level of capability delivered by the portfolio should be evaluated to identify ways of maturing the technology, and to develop appropriate technology transition plans that provide an acceptable level of risk to the realization and fielding of the desired capability. This task will provide the data necessary to generate a TV-2 product.

3.4.3.4. Risk Analysis

The risk associated with the portfolio of systems should be analyzed prior to adopting a change to the baselined Force Package configuration. Identified risks should be documented and evaluated to determine the probability of the risk occurring and the resulting consequences of that risk occurrence. From a HSI perspective, a primary focus is to reduce human error that could lead to serious system error or damage. Unacceptable risks should be evaluated and the cause of the risks identified. Possible resolutions should be identified by iterating through the Capability Analysis, Functional Analysis and Allocation, and Portfolio Synthesis processes. A risk mitigation plan should be developed for unacceptable risks and its status tracked.

3.4.3.5. Alternative Trade-off Analysis

When capability deficiencies, Integration and Interoperability issues, or unacceptable risks are identified, then material alternatives should be analyzed to identify reasonable solutions. Identified alternatives should be evaluated and the preferred solution recommended that results in a balanced, cost effective, and integrated, interoperable solution that is consistent with future manpower and personnel availability, all with an acceptable level of risk.

3.4.3.6. Human/System Integration Analysis

The human engineering associated with the portfolio of systems should be analyzed to ensure that humans can perform their allocated functions and can operate, maintain and support the systems within assigned performance thresholds (minimum) and objective (desired). Anticipated users (operators and maintainers) must be defined by their desired physical and cognitive, training and education level, and level of expertise. Thus, gaps in existing versus desired user knowledge, skills, and abilities can be identified. HSI high-driver functions shall be identified (e.g., those that are labor intensive, are anticipated to impose high risk, workloads, and performance complexities, are error prone, require excessive training, or are unsafe). Identifying the preliminary target user population and anticipated physical and cognitive workload leads to preparation of the preliminary Manpower Estimate and Training System Plan.

3.4.3.7. Cost of Ownership Analysis

The cost of ownership of proposed alternatives should be analyzed so that total life-cycle cost of ownership can be utilized in making informed decisions. Life cycle cost of ownership includes the cost to develop, acquire, operate, support, and dispose of an alternative, and the related manning, training and logistics infrastructure.

3.4.4. Modeling and Simulation

Models and simulations should be established as needed to support requirements definition, analyze the Force Package configuration and design, mitigate identified risks through engineering analyses, thereby ensuring that the portfolio of systems can satisfy operational needs and provide the desired level of capability. This effort supports the assessment of functional and performance characteristics, integration and interoperability, network throughput & bandwidth, supportability, and HSI issues such as maintainability, usability, operability, and safety.

3.4.5. Update the Capability Evolution Plan

The Capability Evolution Plan (CEP) should be updated to document the results and decisions associated with the outcomes of the Capability Engineering Process. This updated CEP should be provided to the organization responsible for conducting Capability Evolution Planning so that they are cognizant of any changes made and the rationale for the changes.

4. Portfolio Execution Process

The Portfolio Execution Process supports post Milestone B activities of the Defense Acquisition System. It informs decision makers of the consequences of decisions on individual portfolio programs, or the effect of changes during program execution. This phase assists decision makers in moving toward achieving the performance, integration and interoperability requirements prescribed in the SPD, and toward achieving the CEP fielding plan. The activities performed in this phase continuously measure the health of the portfolio from a SoS perspective as individual portfolio programs execute the design and testing of their systems. The primary focus is on providing visibility into how the execution of individual portfolio programs affects one another and provides the basis for collaboration between program managers when corrective action is required.

This phase takes the interdependencies between portfolio programs identified in the SPD, establishes a mutually supportive time-phased integrated portfolio schedule to assure program interdependencies are effectively addressed across the portfolio, and further refines the program interdependencies based on engineering activities within the portfolio programs. It is characterized by the application of formal assessments to measure the progress of portfolio programs relative to each other in specific system engineering disciplines. It measures confidence at the portfolio level that the required capability will be achieved and that the CEP fielding plan can be met.

Where the assessments reveal that significant technical or programmatic problems exist between two or more programs in the portfolio that affect the requirements allocations of the SPD, options will be developed and/or recommended courses of actions prepared for the appropriate decision authority.

The engineering models and architecture products generated in the Capability Evolution Process and the Capability Engineering Process provide information needed to conduct risk management, schedule alignment, and the evaluation of new technologies for single systems. These products are directly available from the NCEE integrated database to support the Portfolio Execution Process. These are readily viewed from the NCEE database.

Figure 4-1 illustrates the flow of activities and products for the Portfolio Execution Process. These SE IPT activities are typically performed concurrently and iteratively to assure the alignment of portfolio programs and to support the acquisition programs as they move through capability demonstrations, operational evaluation, production and deployment. The SE IPT activities and products also support the Acquisition Decision Authority for key milestone reviews.

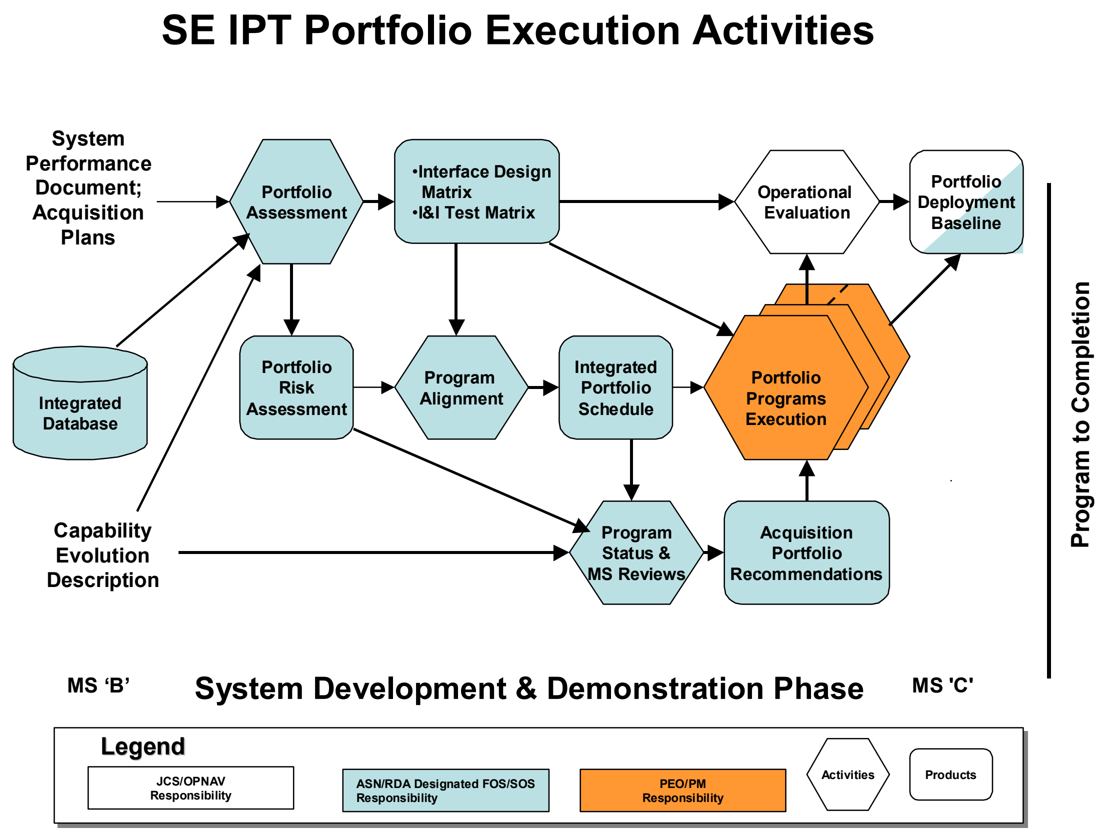

Figure 4-1: Portfolio Execution Activities and Products

4.1. Portfolio Assessments

Formal assessments will be performed in the following disciplines: design, test and evaluation, configuration management, technology readiness and risk. The purpose of Portfolio Assessments is to assess progress of the execution of portfolio acquisition programs, relative to one another, and the impact of acquisition and PPBE decisions toward satisfying the requirements of the SPD.

4.1.1. Inputs

Capability Evolution Plan.
System Performance Document.
Portfolio systems acquisition plans.
Technical architecture and design disclosure data for each portfolio acquisition program (e.g., results of SRRs, PDRs, CDRs, TRRs and IPRs).

4.1.2. Outputs

Assessment results.

4.1.3. Assess Progress of Design Definition

The objective of this activity is to assess the design convergence and design maturation across portfolio systems in terms of satisfying SPD requirements. Representative design attributes to be assessed include: implementation of SoS operating states and modes, progress toward human system integration, achievement of integrated training goals within and between systems, the maturity of critical interfaces between systems, the appropriate use of prescribed interface design standards and protocols, and compliance with the SoS Architectural Principles and Guidelines.

4.1.3.1. Design Documentation Review

This activity is a review of the design documentation developed for each acquisition portfolio program against the performance and the integration and interoperability requirements specified in the SPD. The objective of this review is to gain confidence that the underlying designs of individual programs are compatible with the other portfolio systems such that integration and interoperability problems are identified and resolved early in the design process. The product of this review is refined portfolio interface design matrices (IDMs, Sections 2.3.4) that identify the functional and physical interfaces of each portfolio system relative to the other portfolio systems, the applicable interface design standards and protocols, and the associated data requirements for each element of the matrix.

4.1.3.2. Design Reviews

This activity includes participation in the system requirements reviews (SRRs), system software reviews (SSRs), system design reviews (SDRs), preliminary design reviews (PDRs), and critical design reviews (CDRs) for each portfolio system identified in the portfolio IDM. In addition, a formal in-process review (IPR) process will be implemented between portfolio programs that specifically address elements of the IDM. The objective is to gain confidence that integration and interoperability objectives can be met, to identify potential design deficiencies and the integration and interoperability consequences if not adequately addressed, to ensure compatibility of manpower and personnel requirements with the future total force manpower structure, and to assess the relative maturity of the design relative to other systems in the portfolio. Table 4.1 identifies areas of the design domain that have contributed to integration and interoperability problems in the past. The design reviews must be conducted at a sufficient level of detail to assure inconsistencies in design implementation between programs are identified.

• Time	• Correlation/Decorrelation
• Navigation	• Identification
• Sensors/Trackers	• Distributed Threat Evaluation/ Weapons Assignment
• Connectivity	• Displays
• Data Registration	

Table 4-1: Representative Integration and Interoperability Problem Domains

4.1.4. Portfolio Testing

This activity establishes a fully integrated time-phased portfolio test plan from the SoS integration and interoperability perspective prescribed in the SPD, and assesses the progress and execution of test events across portfolio programs. Fleet users should conduct tests for functional purposes and user familiarity. Test events of interest represent a progression from early verification of the detailed design of selected high integration and interoperability interest components, to testing between portfolio systems and, eventually, fully integrated SoS capability demonstrations. Representative design attributes for assessment in testing include: demonstration of critical interfaces, error propagations, data exchange, senescence, and latency.

4.1.4.1. Test Planning Reviews

This activity reviews the test plans of each portfolio system against the integration and interoperability requirements and quality assurance provisions of the SPD. The objective of this review is to gain confidence that the individual test programs are time sequenced to allow any integration and interoperability problems to be identified and resolved early in the design process, and to assure that test results and test data can be shared among portfolio programs when the design of one system depends on verification of the design choice of another. The product of this review is a refined portfolio Integration and Interoperability Test Matrix (IITM) that identifies the test events of each portfolio system that supports other portfolio systems, and the integration and interoperability test objectives for each test in the matrix and the associated data requirements.

4.1.4.2. Test Readiness Reviews (TRRs)

This activity includes participation in the TRRs for each portfolio system test identified in the portfolio IITM to assure that test objectives address integration and interoperability objectives for the test event, the adequacy of the test setup, data collection and instrumentation, and that the test analysis plan addresses integration and interoperability requirements. The product will be an assessment of the confidence that integration and interoperability test objectives can be met, suggested changes to achieve objectives, and an assessment of the integration and interoperability consequences if the changes are not adopted.

4.1.4.3. Post-Test Data Analysis

This activity includes participation in post-test data analysis for each portfolio system test identified in the portfolio IITM. The objective of this assessment is to determine if the integration and interoperability test objectives were met, and where they were not met, to assess the potential consequences and recommend corrective action. Corrective actions may include relatively short term actions such as how future matrix tests should be modified, or whether new tests should be added to mitigate these consequences, and where necessary, longer term actions requiring training, doctrine, hardware and software solutions. The product of the activity is an integration and interoperability test report.

4.1.5. Configuration Management

The objective of this activity is to capture the functional and physical interfaces between systems that are important to achieving an integrated and interoperable SoS. This activity takes the results of the design synthesis allocation process and establishes inter-program configuration management procedures to maintain the design integrity of the SoS. For change control purposes, changes to these high interest interfaces will be reviewed by all parties and RDA CHENG.

4.1.5.1. Computer Program Version Control

Guidance must be provided to all organizations on their control of software development, maintenance and release processes. Prototyping, configuration management, change control, and design revision can reduce design volatility and the need for regression testing. The configuration management process should support the traceability of the requirements through design, coding, and testing as well as from testing back to the requirements.

4.1.5.2. Commercial Off-the Shelf (COTS) Refresh

Guidance should be provided to all organizations on the frequency and strategy for COTS refresh. Prototyping, configuration management, change control, and design revision can reduce design volatility and the need for regression testing. This is particularly true for SoS installed on platforms or within facilities.

4.1.6. Technology Insertion

The objectives of this activity are to assess the rate of technology maturation supporting the capability increment for portfolio programs in acquisition, to assess the rate of technology maturation related to future capability increments described in the CEP and to identify areas for science and technology investment that further support the capability evolution

4.1.6.1. Technology Road Maps

This activity reviews the evolving road maps prepared by the Functional Capability Boards of the Joint Staff, road maps prepared by OSD and the other services, and those prepared by PEOs and product developers to identify technology opportunities for future capability increments and to assess alignment of the portfolio evolution with road maps, where applicable.

4.1.6.2. Survey of S&T Programs

This activity surveys DARPA and ONR sponsored S&T programs and Future Naval Capabilities to identify technologies insertion opportunities that support future capability evolution.

4.1.6.3. Portfolio Program Technology Reviews

This activity includes participation in the technology reviews of each portfolio system. The objective is to gain insight into the S&T investment strategy of the program office and its contractor(s) that support future increments of the capability evolution, to assess the consistency of these investments with related DoD and DoN road maps, and identify any potential impact from a portfolio perspective.

4.1.7. Portfolio Risk Assessment

The activity objectives are to assess technical risk at the portfolio level as the likelihood of achieving the requirements prescribed by the SPD, ensuring compatibility of the portfolio's overall manpower and personnel requirements within the future total force manpower structure, and to evaluate the risk mitigation plans of the portfolio programs to assure concordance from a portfolio perspective.

4.1.7.1. Portfolio Program Risk Reviews

This activity includes participation in the risk assessment process for each portfolio system. The primary focus will be technical and schedule risk (cost risk will ultimately be reflected in schedule risk). The objective is to gain insight into each program's self-assessment, to insure that risk is assessed for each of the elements of the IDM and the IITM, and to understand risk mitigation plans. In addition, for those acquisition portfolios that are approaching a decision before proceeding to the next capability increment, a technology readiness assessment will be provided from a portfolio perspective.

4.1.7.2. Assessment Synthesis

This activity combines the results of all assessments across all portfolio programs. The focus is to assess technical risk between portfolio programs and identify where problems in one program may affect another program in the portfolio. The objective is to measure the likelihood of satisfying each of the elements of the IDM and IITM.

Figure 4-2 illustrates the portfolio risk assessment process. Each portfolio program periodically performs a self-assessment and reports results to ASN (RDA) in a standard format.

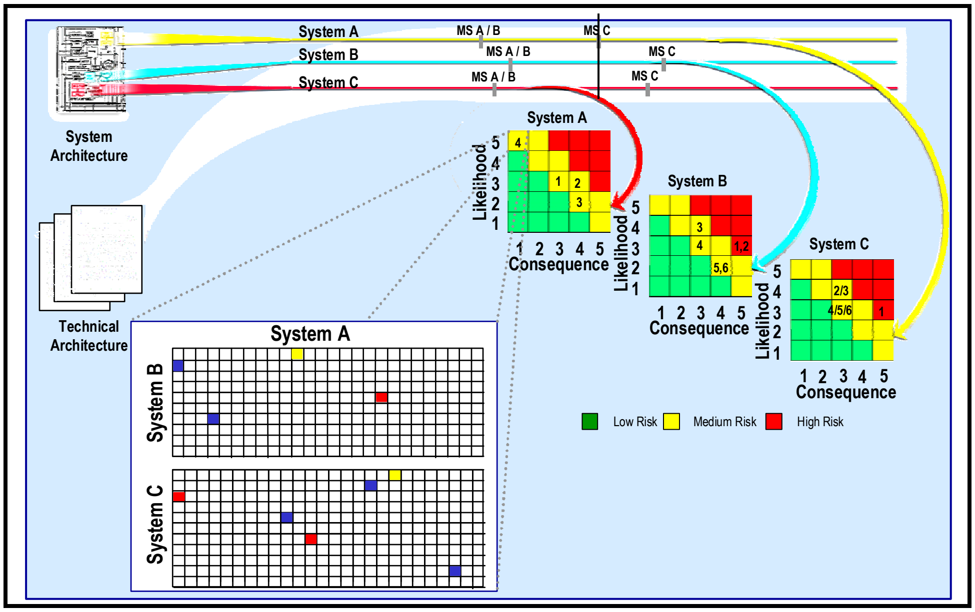

Figure 4-2: Portfolio Risk Assessment Process

Participation in these assessments and synthesizing the results of these and the other analyses will allow a portfolio assessment that looks across the individual programs and enable the two or more affected programs to develop coordinated mitigation plans. Figure 4-3 represents an example of an integration and interoperability risk to System A caused by Systems B and C in the portfolio. In this example, the program manager for System A approaching Milestone C might not have known he was at risk since the problems were associated with programs outside his purview.

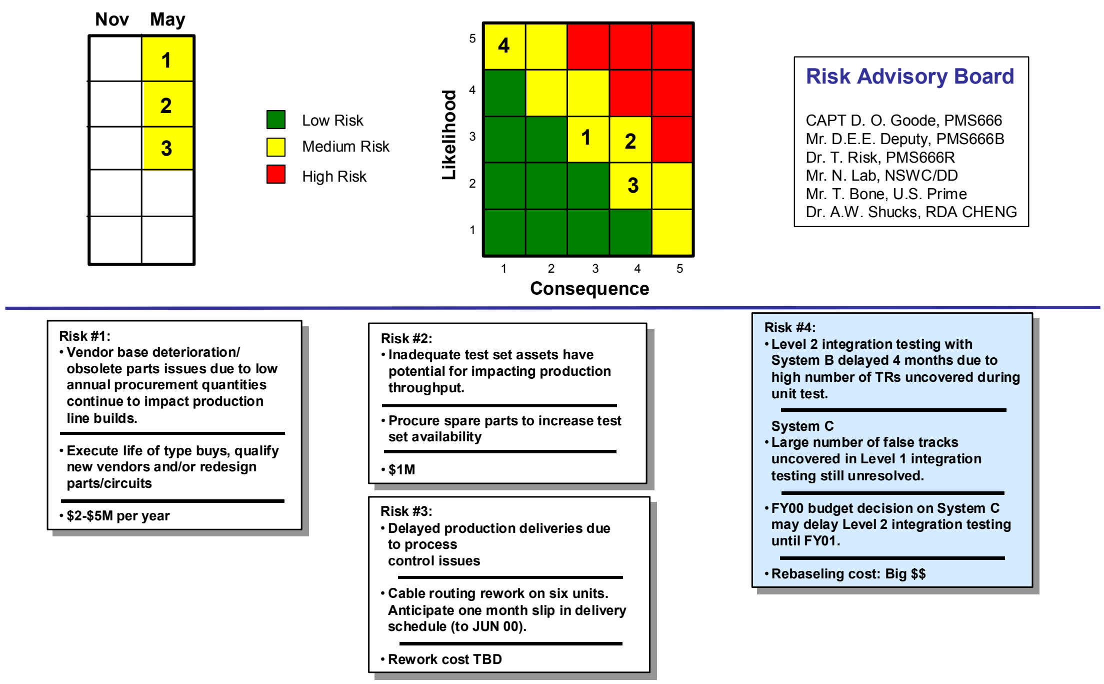

Figure 4-3: An Integration and Interoperability Risk to the Portfolio

4.2. Program Alignment

The first objective of Program Alignment is to assess progress of the execution of portfolio programs, relative to one another, toward satisfying the CEP fielding plan. The second objective is to assess decisions made during the PPBE process to identify emergent portfolio capability shortfalls, and their impact on the CEP fielding plan

4.2.1. Inputs

CEP.
Technical assessments from Section 4.1.
Portfolio program schedules and PPBE actions or decisions.

4.2.2. Outputs

Recommended program realignment options, and revised CEPs.

4.2.3. Integrated Portfolio Schedule

The objective of this activity is to develop and maintain an integrated portfolio schedule that identifies the important time phased interdependencies between portfolio programs that are essential to fielding fully integrated and interoperable systems that deliver the required capability. Important interdependencies include such things as establishing and demonstrating intersystem behavioral criteria, interface requirements and designs, and shared database requirements and designs.

4.2.3.1. Integrated Schedule Development

This activity is an iterative process among the portfolio programs that combines the elements of the functional and physical IDMs and IITM with the individual portfolio system schedules to achieve properly sequenced design and test activities between programs. The important relationships between portfolio programs will be captured along with supporting rationale regarding how an output from one program event will be used as an input to a related portfolio program.

A representation of an integrated portfolio schedule is shown in Figure 4-4. Five programs are shown with interdependencies captured. The approach is to have individual program offices maintain the program schedules and maintain the interrelationships at the portfolio level.

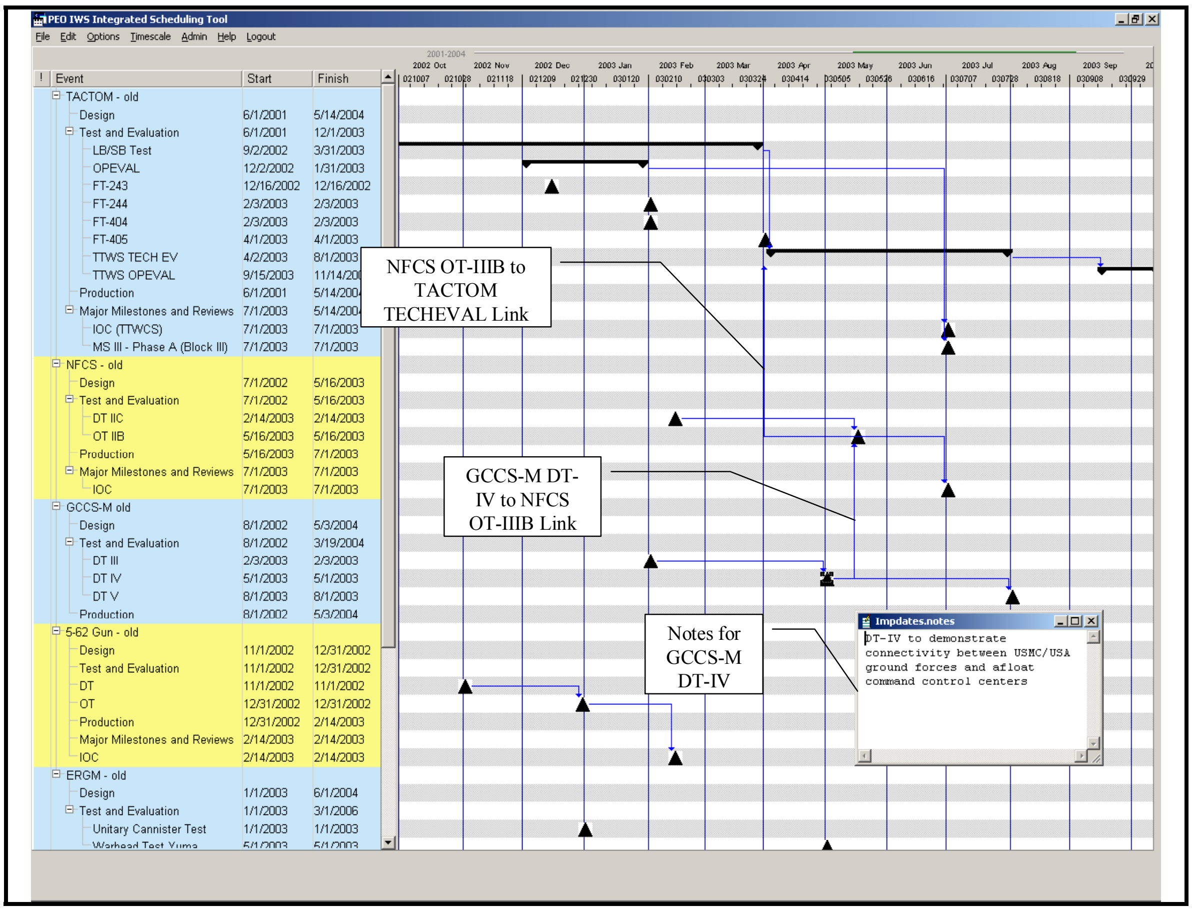

Figure 4-4: Example of an Integrated Portfolio Schedule

4.2.3.2. Integrated Schedule Tracking

This activity provides for updating the integrated portfolio schedule based on changes to individual portfolio program schedules. Program schedules will change as a result of the rate of progress experienced during program execution or as a result of PPBE decisions that affect program funding. This activity will identify the important relationships between portfolio programs that are affected by the change so that the impact of changes to one program can be assessed relative to its related portfolio programs.

Figure 4-5 represents the same portfolio as Figure 4-4, but now shows the affect of a schedule slip in one program impacting two others. The first and second order affects are shown in red and yellow, respectively. When necessary, this activity will identify schedule risk mitigation options and recommended changes to the integrated portfolio schedule.

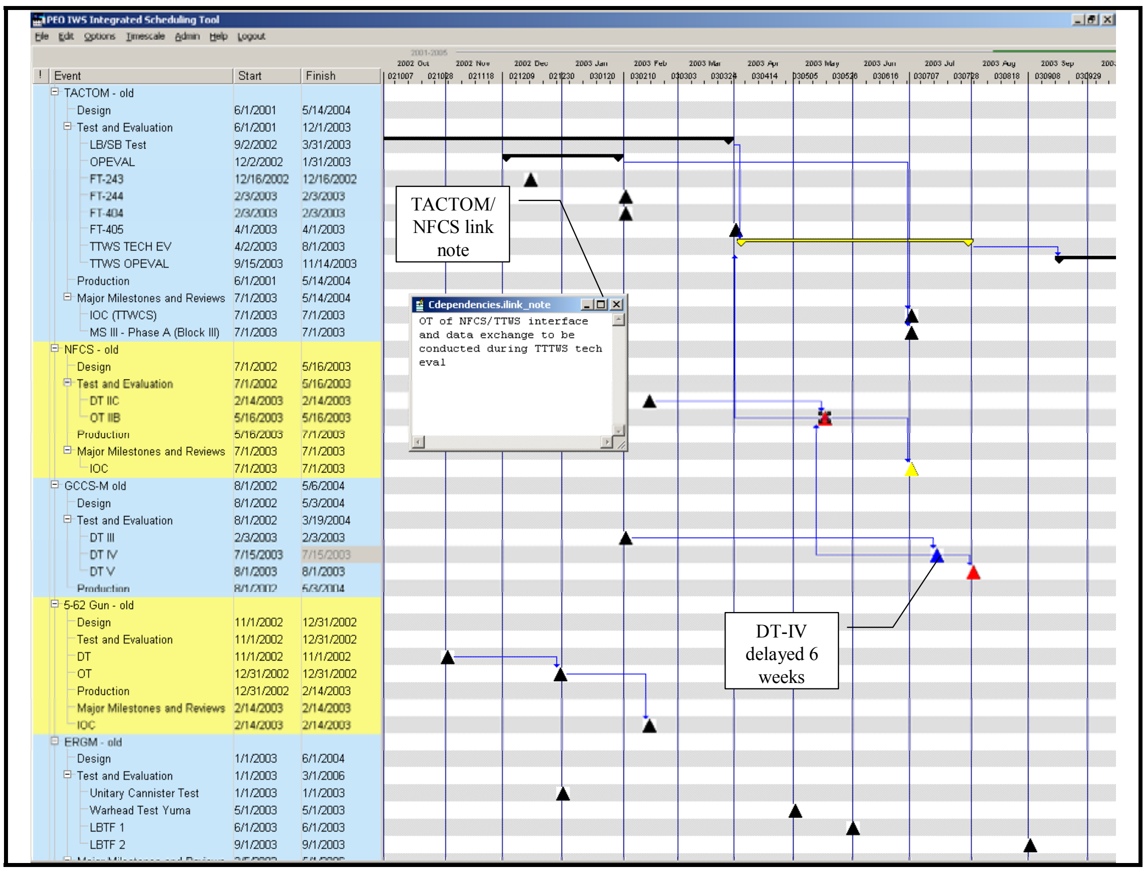

Figure 4-5: Managing Acquisition Program Dependencies

4.2.3.3. Schedule Risk Assessment

This activity provides a technical assessment of the important interrelationships between programs caused by a change in one in order to estimate the confidence of continuing on the planned integrated portfolio schedule. This assessment will use each portfolio program's self-assessment (Section 4.1.7.1) as a starting point. The assessment will look at both the first order effects between the affected programs, as well as the potential for cascading downstream effects to third parties.

4.2.4. CEP Assessment

The objective of this activity is to periodically assess the current CEP to support Naval investment decision-making processes. This assessment uses the current schedule risk assessment to determine the "wellness" of the CEP, identify weaknesses in the capability fielding plan and potential capability shortfalls, and recommend where corrective action can be taken.

4.3. Program Status and Milestone Reviews

The objective of this activity is to provide an unbiased assessment of the integration and interoperability health of the acquisition portfolio to the milestone decision authority and make recommendations for corrective actions. Corrective action may involve such things as reallocating functional and physical interfaces within the portfolio, rescheduling or calling for additional integration and interoperability testing, or realigning portfolio program schedules to reduce integration and interoperability risks, while retaining synchronized capability fielding plans. This step uses the SoS architecture data, models, and views produced during the Capability Evolution and Capability Engineering processes and captured in the NCEE integrated database. The focus is on how well the acquisition portfolio programs are meeting allocated functional and performance requirements.

4.3.1. Inputs

Portfolio Assessments (Section 4.1).
Acquisition documents that supports the program or milestone decision.

4.3.2. Outputs

Recommended in-puts to acquisition documents prepared by portfolio programs.
Recommendations to the milestone decision authority at program and milestone reviews.

4.3.3. Acquisition Documentation Preparation

This activity provides support to portfolio programs in the preparation of acquisition documents prior to a program or milestone review. The objective is to evaluate the results of the Portfolio Assessment Process (Section 4.1) with respect to the program undergoing review and to identify important considerations that should be included as part of the review process available to the program.

4.3.4. Acquisition Portfolio Recommendations

This activity takes the issues and problems identified in the Portfolio Assessment Process (Section 4.1) and develops solution sets for their resolution. The objective is to provide investment decision makers with technically sound, unbiased options to acquiring capability where the options are beyond the purview of individual programs, PEOs, DASNs, and OPNAV resource sponsors. The issues and problems will be characterized as resulting in an inability to deliver the required capability if not resolved, i.e., violating the SPD, requiring a solution that affects two or more portfolio programs, violating the CEP, or requiring re-alignment of resources.

4.3.4.1. Options Development

This activity establishes options for resolving portfolio issues and provides the technical and analytical basis for selecting options for presenting to senior decision makers. The activities will be specific to issues being addressed, but must consider the technical (e.g., performance or functional re-allocations, re-definition of system interfaces, and / or re-alignment of the integration interoperability test program), schedule, and cost implications of each option. In extreme cases, it may be necessary to return to capability evolution planning or capability engineering.

4.3.4.2. Option Vetting Process

This activity creates and administers the forums needed to fully vet the recommended options with affected stakeholders within DoN, DoD, and the Joint Staff. The objective is to permit broad participation so that informed decisions result. The vetting process may result in new or re-defined options being identified for development.

5. Naval Collaborative Engineering Environment

ASN (RDA) CHENG has implemented a Naval Collaborative Engineering Environment (NCEE) to support the acquisition community in achieving the Navy's objectives for an integrated and interoperable force. The NCEE provides a Decision Support Environment for collaboration, information sharing and work support, an Integrated Engineering Environment containing commercially available architecting and systems engineering tools, and an Integrated Data Management and Analysis capability. These capabilities are implemented in both classified and unclassified versions.

5.1. Background

The NCEE enables execution of the NCEP by systems engineering IPTs that are focused on defining and assessing integrated capabilities for portfolios of systems. The SE IPTs must necessarily engage in continuous interactions and collaboration in order to accomplish their task. They must also utilize common, authoritative data and a robust systems engineering toolset. The NCEE provides modern information technology capabilities to network across distributed information sources, information users, information suppliers and the diverse talents needed for developing and implementing the integrated and interoperable force envisioned by the networked systems environment of FORCENet.

The NCEE provides an open-systems, standards based infrastructure of communications, data processing and resource management services. The NCEE provides collaborative methods, tools and simulations to evaluate and assess architectures, specific application domains, and the force systems integration and interoperability body of knowledge. Functional capabilities within the NCEE will include:

- Core set of collaboration tools for planning, scheduling, documentation/information management and sharing;
- Engineering tools and system data repository for requirements and design synthesis and assessment, simulation, data visualization, product and process capture and data management, and workflow management; and
- Interoperability engineering specific tools, including advanced interface consistency checking, interface modeling, and interface management.

5.2. Integrated Engineering Environment

The core of the NCEE is the Integrated Engineering Environment (IEE), which enables a multi-disciplinary development team to address all engineering activities in a comprehensive and integrated manner. Within this environment, the typical domain specific tools share common design information regardless of which activities of the process they support. The advantage is to minimize unnecessary assumptions that would be made during the development of different analysis models within each tool, hence, providing consistent analysis results. By allowing the design information to be shared among various domain specific tools and the relationship among the design activities to be defined, the environment enables the seamless transition from one design activity to another. This, in-turn, provides the potential for full traceability of design information throughout the development process.

A recommended set of engineering, development and analysis tools to support force systems architecting and engineering activities are integrated within the IEE in order to provide a seamless flow of information between tools, utilizing an object-oriented database management system. Figure 5-1 illustrates the current implementation of the IEE. The CHENG integrated data repository is hosted on an Interchange^{SE} server. “Plugins” have been developed between Interchange^{SE} and the individual domain specific tools and authoritative databases in order to enable exchange of data. Interchange^{SE} maintains consistent and interrelated data that can be extracted from multiple domains including requirements, conceptual operational design, functional design, implementation design, manufacturing, and project management. A consistent, integrated database means that the common data needs to be captured only once and shared across domains. This aspect dramatically reduces the inefficient manual transfer of design information into various forms needed to support the broad spectrum of engineering and assessment tools and activities. The object-oriented database construct also enables Interchange^{SE} users to define algorithms and formulate the available data to answer questions required by the SE IPTs. These users can view the composite results through the Interchange^{SE} client interface or via a web services report. Furthermore, should the users reside in different organizations, a customizable “plugin” can be readily developed to push/pull appropriate results directly across databases within their own environment.

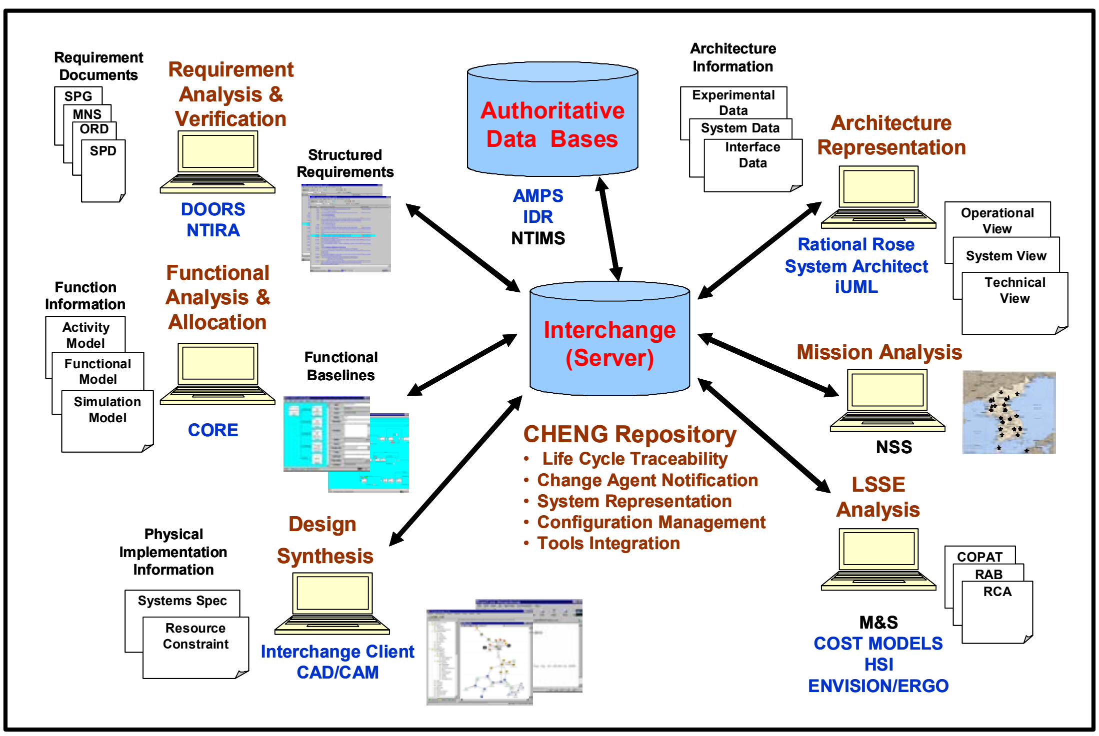

Figure 5-1: Integrated Engineering Environment

5.2.1. Capabilities to Support the NCEP

The NCEE Integrated Engineering Environment (IEE) provides a broad range of capabilities to support NCEP implementation by SE IPTs. These are available at both the classified and unclassified level. Web-based access to the IEE tool servers is available from the NCEE home page (**https://ncee.navy.mil**). A summary description of the IEE capabilities to support the NCEP is provided as follows:

- **Capability Analysis.** The IEE provides a toolset that enables the capture and analysis of force level required capabilities, concept of operations, operational scenarios, and force structure to establish a requirements baseline for a portfolio of systems. The traceability of the resulting requirements baseline to architecture descriptions, resource allocations, modeling and simulation, and test and evaluation can consequently be configuration managed and flowed throughout the NCEP activities. Force level metrics could be implemented within the IEE to support capabilities analysis. The IEE also provides a significant requirements data management capability through a classified DOORS database of parsed MNS and ORDs that are aligned with NMETLs, NTAs, KPPs and MOEs.

- **Capability Modeling.** The IEE provides a toolset that enables the development of engineering models for evaluation and assessment of alternative implementations of the planned and objective architectures for portfolios of systems. This toolset supports structured analysis and object-oriented analysis approaches in support of model development for portfolios of systems. It also supports the flow of engineering models to modeling and simulation tools for performance assessments.

- **Importing/Exporting Data among Tools.** Interchange provides for flexible importing and exporting of data from any tool or database through plug-ins. Support is provided for various industry standard tool interface approaches including CDIF, CORBA, XML, XMI and UML. Plug-ins currently exist for systems engineering and architecture tools such as DOORS, CORE, Rational Rose, iUML, System Architect, Visio and .CSV based format.

  A summary description of the capabilities and uses for the key tools within the IEE is provided as follows:

  - ***DOORS*** - DOORS (a Telelogic AB product) is ideal for managing requirements throughout development life cycles. Requirements are handled within DOORS as discrete objects. Each requirement can be tagged with an unlimited number of attributes (text, integer, boolean, real, date, enumeration, etc.) allowing easy selection of subsets of requirements for specialist tasks. DOORS allows objects to be linked. Hence, traceability can be maintained among text documents from original requirement through design specification, implementation and test plans. DOORS also supports impact reports, compliance matrices, orphan reports and completeness checks through information traceability. The latest release of DOORS includes Internet access (DOORSnet) capabilities as a read only access.

It also allows users to submit change requests for any suggested modification. The current version of DOORS that is utilized by the NCEE is DOORS 5.2.

- ***CORE*** - CORE (a Vitech Corporation product) is used to capture operational, system function and high-level physical models. Operational models reflect how the Organizational Elements perform operational activities, interactions among these activities, the control logic and the sequence of operation of the activities, and performance and timing associated with the activities. Functional models reflect function decomposition, data flow among these functions, the control logic and the sequence of the functions, resource utilization and performance/timing associated with the functions. Physical models reflect platforms, facilities operational nodes, systems, personnel, and interfaces.

  CORE also supports hierarchical decomposition and a number of graphical formats to display data (e.g., Hierarchy View, Function Flow Bock Diagram, Enhanced Function Flow Block Diagram and IDEF0). Similar model elements can be generated for system function and physical models. CORE enforces consistency by interactively deriving and associating operational, system function and physical architectures. A discrete event simulator option (COREsim) provides an assessment of system performance and verifies the dynamic integrity of the conceptual design. The current version utilized in the NCEE is CORE 4.0, which includes the data structure to support the C4ISR architecture framework.

- ***iUML*** – iUML (a Kennedy Carter product) provides a multi-user application development environment that delivers sophisticated support for Executable UML modeling, simulation and code generation. Tailored to the needs of real projects, it provides support for the xUML formalism including a fully featured Action Language as well as support for model execution, test and debug. Full lifecycle support is provided through use case and textual requirements management and target code generation. In addition, there is built-in configuration management and open interfaces to support integration with third party products.

- ***Interchange^{SE}*** – Interchange^{SE} (a Trident Systems, Inc. product) provides a central design repository for all project and design data while preserving the semantic meaning of the data. Engineering tools can easily be integrated into the repository to provide access to a common system design representation, facilitating data sharing and design configuration management across the entire project. Interchange^{SE} provides a powerful mechanism, which enables the capture of multiple design variants and baselines throughout the system life cycle. User access control can be enforced at the attribute, relationship, and method property-level. User-specified agents can be created to monitor repository objects and respond appropriately to actions providing an advanced approach for coordination and collaboration. The current version that is utilized in the IEE is Interchange^{SE} 2.0.

- ***Rational Rose*** - Currently marketed by IBM as Rational Rose Developer, this tool allows model-driven development with the Unified Modeling Language (UML). It's ideal for commercial software products and systems, including real-time and embedded applications. It allows the user to build class models, data models, interaction diagrams, use-case diagrams, etc., and generate skeleton code for Java and C++/C.

- ***System Architect® with C4ISR Option*** **-** System Architect (a Telelogic AB product) provides comprehensive support for the US Department of Defense's Architecture Framework (DoDAF, formerly C4ISR Framework). The C4ISR option to System Architect offers complete support for operational, systems, and technology modeling to produce required C4ISR applications at both the enterprise and project level.

5.3. Authenticated Databases

A key capability of the NCEE is to provide access to appropriate authenticated DoD and DoN databases containing technical and programmatic data for platforms, networks, C4I, sensors and weapons. Figure 5-2 illustrates a notional concept of authenticated databases. Both component and concept level resources should be represented in authenticated databases. Examples of information needed in these authenticated, configuration managed and access controlled databases include baselines, versions, scheduling data, cognizant organizations and funding associated with platforms, systems, and network configurations. Access to this information is vital to defining force level architectures and to performing engineering assessments.

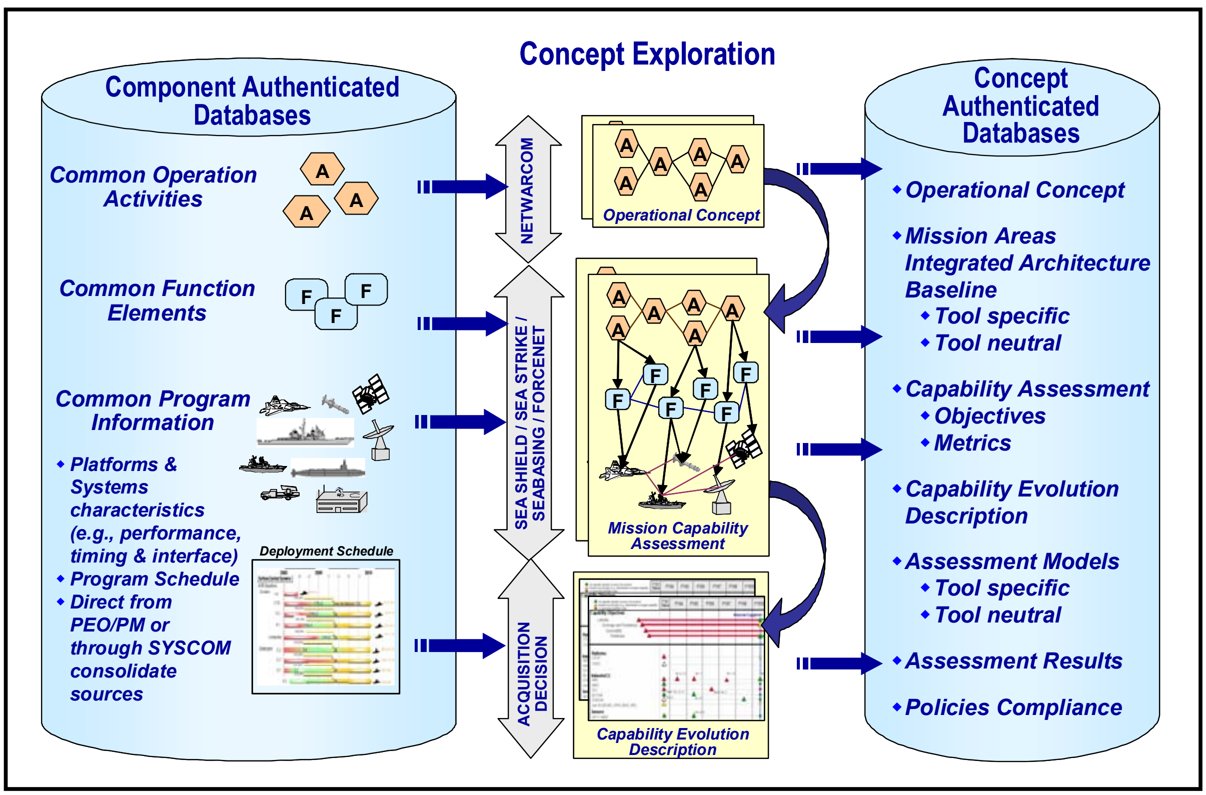

Figure 5-2: Notional Authenticated Databases

As new concepts are being explored by different organizations to enhance naval operations, to assess mission area capabilities, or to maximize acquisition strategy, “Concept Authenticated Databases” are often established and populated with data from “Component Authenticated Databases.” Various organizations including Joint, OSD, DoN, SYSCOMs, and Fleet Commands establish authenticated databases for both component and concept types of data. Challenges exist with the authentication issues of the data being populated, the consistency and completeness of the utilized data sources, the relationship among the existing databases, provisions for access control, and the level of participation to maintain these databases.

Capabilities to facilitate the establishment of the authenticated databases and the automation of information exchange across them are essential to the Navy and DoD communities in order to support capability-based acquisition and systems engineering. The NCEE has addressed the automation of information exchange across the system design, development and assessment spectrum and can be used to support the Naval acquisition stakeholder communities.

5.3.1. Authenticated Database Examples

The key DoD and DoN authenticated databases that support various communities of interest are:

- ***DARS*** - Department of Defense Architecture Repository System: “will host accredited DoD architecture information to include legacy and newly accredited architecture segments. DARS will provide a centralized location for storing approved, accredited architecture segments, while allowing the DoD Services, unified commands, major commands and authorized echelons to maintain autonomous control over their data.”
- ***NAVSEA AMPS*** – NAVSEA Afloat Master Planning System: includes Ship, Sub, Air Wing & MEU Configurations, CS/C4I System Descriptions, and their points of contact and important and latest reference material.
- ***NAVAL IDR*** – Naval Interoperability Data Repository: includes Naval MNS, ORDs, CRDs, C4ISPs; avionics configurations of Naval aircraft and important and latest reference material.
- ***Marine Corps Architecture Support Environment (MCASE)*** – “The mission of MCASE is to provide a central database and visual source for USMC enterprise architecture information, as it pertains to operational and systems engineering, design, interoperability and other issues of a similar nature that may require resolution. It also serves as the authoritative source for the USMC Rationalized List and other significant information for all USMC applications currently in use.”
- ***SPAWAR VPO*** – SPAWAR Virtual Program Office Website provides links to many of the SPAWAR programs. The Virtual Program Office (VPO) application is designed to enable geographically dispersed teams to work collaboratively via the web. It can be used for short-term projects or for the management of ongoing programs. It is divided into functional Sections that can be used in combination to assign and track tasks, manage group schedules, create and revise documents, disseminate information, interactively discuss topics of interest, and manage the VPO Site itself.
- ***FITS*** – FORCENet Implementation Tool Suite is an under-development database and associated tool set that will be used to provide a one stop authoritative source for network centric compliance documentation to support FORCENet technical compliance analysis,

to quickly help identify reasons for FORCENet non-compliance, and to help minimize data collection across compliance criteria.

5.3.2. Access Requirements

The NCEE provides access to a number of these databases via the NCEE website (**https://ncee.navy.mil**) and associated links. Note that since these are under the cognizance of various organizations, access to a specific database usually requires approval of an access request which can normally be accomplished electronically.

5.4. Collaboration and Decision Support

The purpose of the NCEE Collaboration and Decision Support capability is to provide support to SE IPTs for continuous interaction and collaboration in the capability planning, FoS/SoS engineering, and acquisition oversight activities for a portfolio of systems. The NCEE Decision Support Environment (DSE) provides a web site (https://asnrdacheng.navy.mil) that includes a substantial amount of public information with regard to DoD and DoN standards, policies and guidelines concerning force systems acquisition and integration and interoperability. It also includes collaborative workspaces that provide capabilities to support working groups and integrated product teams. These capabilities include calendaring, action items tracking, document library, discussion threads and access to engineering tools and databases.

5.4.1. CHENG Website

The CHENG web site supports a variety of user communities and their initiatives, including CHENG Staff, CHENG Directorates, and various outside organizations. There are two versions of the web site, a classified and an unclassified site. Access application for each site is required separately. The web sites are password protected and require a Public Key Infrastructure (PKI) certificate. The individual's unique login ID and password determine the workspace areas and information he/she may access. The RDA CHENG Website User's Guide provides a detailed description of the RDA CHENG Website, including each of the menus and content links available. The CHENG web site has a number of features, among which are included:

- **Organizational Entity and Partner Overviews** – This Section provides general information about each of the RDA CHENG Directorates, Specialized Workgroups, Advisory Groups, and Partners. Charters, organization charts, POCs, and biographies are also included where available.

- **RDA CHENG Workspaces** – These are collaborative workspaces that are used by RDA CHENG personnel for business operations and issues.

- **Partner Workspaces** – These collaborative workspaces support organizations that are external to RDA.

The following basic capabilities are provide for each workspace:

- **Document Library capability** – Users may upload documents into the workspaces to enhance collaboration among workgroup members. Uploading a document alleviates the need to e-mail the file to a large number of people. Another advantage is that the e-mail inboxes will not become overloaded by multi-MB files, which is especially important if a person is on travel trying to download e-mails over a dial-in connection. If comments on a document from other users are desired, a threaded discussion may be begun. A search capability allows users to search within a specific workspace or within a specific library for a particular document.

- **Threaded Discussion capability** – Each workspace has a threaded discussion capability, in which users may post and reply to discussions as part of the collaborative work process. This eliminates long streams of e-mail conversations, which can be difficult to follow.

- **Calendar capability** – Each workspace has a calendar to list important upcoming meetings and events. By using the calendar capability, team members do not have to send out a special e-mail announcing the meeting nor follow-up e-mails with updates.

- **Task List capability** – Each workspace has a task list, which allows the team leader to assign tasks to team members, specify due date and priority, and indicate status and progress.

- **News Announcements capability** – Each workspace has a news announcements area, which contains important information team members should see when they first log-in to their workspace. The five most recent active announcements are displayed on the workspace home page, but all the announcements are available on the News Announcements page. Expiration dates for announcements may be set to improve organization. When the expiration date is reached, the announcement disappears from the workspace home page automatically.

- **Contacts capability** – Each workspace contains a listing of contact information to allow for easier communication between team members. Everyone on the team can utilize the information, eliminating the need for each member to maintain his/her own point of contact information.

- **Links capability** – Each workspace contains an area for posting hyperlinks to web pages of interest to the team. Users can post descriptive information about the links so other team members can easily navigate through them.

- **Subscriptions** – Auto-notifications enable users to be notified by e-mail of any changes made to the content of the various areas of the workspace. This is an effective means of determining what new information is available on the workspace. Members may subscribe to whichever areas are of particular interest to them, and at what interval they want to receive the notification (e.g., whenever the change occurs, once a day, etc.).

The URL address of the CHENG website is:

NIPRNET – https://asnrdacheng.navy.mil
SIPRNET – http://asnrdacheng.navy.smil.mil

The CHENG website homepage provides access to a number of web-enabled tools through the toolbox menu. This includes links to the Unclassified NCEE Tools and Collaboration Website, links to the Navy/Marine Corps telephone directory, hyperlinks to video bridging services at other commands/locations, and hyperlinks to various Authoritative Data Sources within DoN, DoD and Joint commands.

The CHENG toolbox includes a list of collaborative and engineering tools that are web-accessible. It is accessible from the "Toolbox" selection on the left-hand side menu bar on the RDA CHENG website homepage. Current available selections include: Associated Links, Authoritative Databases, Conference Room Calendars, "CORE, DOORS, and other Engineering and Collaboration Tools," Facilitate, Frequently Asked Questions (FAQs), Interchange^{SE} (for web access), PhoneBook, QuickStart Instructions, Video Services, and Workspace Tips. Detailed Descriptions, an Installation Guide, and a link to launch the tool are available for each tool where appropriate.

5.4.2. User Access

The RDA CHENG NCEE website is password protected and consequently requires a user password and ID in order to access its capabilities. This can be achieved by accessing "Account Request" on the left-hand side menu bar. A user's guide is also available at:

https://ncee.navy.mil/

6. SE IPT Capability Management

Appendix B provides general guidance on the role of SE IPTs in implementing the SoS engineering process described by this Guidebook. This includes a recommended governance process for addressing and resolving management issues that arise due to conflicting technical and resource requirements across the acquisition portfolio.

This Section describes the tasks performed by a SoS SE IPT to properly interact with the Naval Force Development System (see Appendix A), consisting of the Joint Capability Integration and Development System (JCIDS), the OPNAV Naval Capability Development Process (NCDP), the Planning Programming Budgeting and Execution System (PPBES), and the Naval Acquisition System.

6.1. JCIDS Interactions

The tasks in this Section address how the SoS SE IPT interacts with the Joint Staff's Functional Capability Boards in the development of the Initial Capability Document (ICD), Capability Design Document (CDD), and Capability Production Document (CPD). This is necessary to ensure that the Capability Evolution Planning remains synchronized with current Defense Planning Guidance, strategy, doctrine, and tactics.

6.1.1. Identify Alternative Material Solutions to Identified Capability Needs

The SoS SE IPT collaborates with the other services, Joint Forces Command, and the Joint Staff to identify potential solution alternatives that are technically feasible, cost-effective, and will provide the war fighter with an effective military capability. This is accomplished after the Functional Capability Board has completed its Functional Needs Analysis and has determined that a material solution is required. The potential solution alternatives are identified prioritized, and selected for further consideration and assessment.

6.1.2. Support the Functional Solutions Analysis

The SoS SE IPT collaborates with the other services, Joint Forces Command, and the Joint Staff to analyze potential solution alternatives and documents the results in the Initial Capability Document (ICD).

6.1.3. Support System CDD Approval

As each program in the Acquisition Portfolio moves through their respective acquisition cycle, the SoS SE IPT collaborates in the preparation, coordination, and approval of the respective program's Capability Development Document (CDD) as a precursor to Milestone B. Each program CDD shall also identify other CDDs and/or CPDs that are required to fully realize the ICD capabilities pertaining to the given program and describe the synchronization required between programs. The program CDD should also indicate any additional overarching

DOTMLPF and policy changes necessary to enable the program to fully support an effective SoS capability.[19]

6.1.4. Support System CPD Approval

As individual programs in the Acquisition Portfolio move through their respective acquisition cycle, the SoS SE IPT collaborates in the preparation of the program's Capability Production Document (CPD) as a precursor to Milestone C. The given program's CPD should also provide the linkages to related CDDs/CPDs and supporting analyses (e.g., AoA) to ensure the system production is synchronized with the related systems required to fully realize the ICD capabilities.[20]

6.1.5. Support the SoS Interoperability & Supportability Certification

The SoS SE IPT, as part of its role in supporting program milestone reviews for the capability acquisition portfolio (see Section 4.1.3.2), should conduct a formal IPR between portfolio programs to assure that integration and interoperability objectives can be met. The results are documented as a Capability SoS Interoperability Assessment Report and should be submitted to the Joint Staff J-6 to support the Interoperability and Supportability Certification process[21] that is conducted prior to each capability portfolio acquisition program milestone review. This assessment is performed for each portfolio acquisition program to determine if the program is being designed to conform with all required DISR mandated GIG KIPs identified in the program's KIP declaration, and are compliant with current DoD information assurance directives and policies, and supports the SoS Interoperability requirements identified in the SPD.

The SoS SE IPT shall also collaborate with each of the portfolio acquisition programs to assure that each program adheres to the Navy integration and interoperability management process.[22] The Capability SoS Interoperability Assessment Report noted above is a key input to this process.

6.2. Naval Capability Development Process (NCDP) Interactions

The Naval Capability Development Process is OPNAV's capability-based approach to define, develop, and deliver technologically sound, sustainable, and affordable military capability within the Naval Force Development System (see Appendix A). The SoS SE IPT must interact with this process in order to align the Capability Evolution Plan with OPNAV's acquisition priorities and to support the resourcing of the plan so that the portfolio of acquisition programs are properly funded to achieve the planned capability objectives.

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[19] CJCSI 3170.01E, Joint Capabilities Integration and Development System, 11 May 2005
[20] Ibid
[21] CJCSI 6212.01D, Interoperability and Supportability of Information Technology and National Security Systems, 8 March 2006
[22] Naval SeaPower 21 Integration and Interoperability Management Plan (Draft), 1 May 2006

6.2.1. Submit the Capability Evolution Plan for Approval and Resourcing

The SoS SE IPT must approve the Capability Evolution Plan and submit it to ASN RDA for endorsement. Once endorsed, ASN RDA should submit it to OPNAV for appropriate resourcing considerations. The SoS SE IPT should interact with ASN RDA during the CEP staffing and approval and support the OPNAV organizations as they align the plan with their resourcing and acquisition priorities.

6.2.2. Submit the System Performance Document (SPD) for Approval and Resourcing

The SOS SE IPT must approve the System Performance Document (SPD) and submit it to ASN RDA for endorsement. Once endorsed, ASN RDA should submit it to OPNAV for appropriate resourcing considerations. The SPD should be accompanied with the Specification Changes Notices (SCNs) necessary to be approved and funded to modify existing acquisition program system requirements.

6.2.3. Submit Capability POM Issues Papers

The SoS SE IPT should prepare an issue paper to ASN RDA when a member of its acquisition portfolio cannot achieve its requirements, or the funding necessary for it to achieve its requirements was impacted by acquisition decisions, or it can not achieve the desired schedule milestones. The issue paper should identify the impact on delivery of the Naval capability, and the requested action to rectify the situation. When approved, ASN RDA should forward the issue paper to OPNAV for concurrence and appropriate resourcing considerations. Acquisition programs should continue to develop their own POM issue papers, to reflect the effects of SoS SE decisions on their individual programs.

6.3. Acquisition System Interactions

The SoS SE IPT must interact with the Acquisition Enterprise (PMs, PEOs, and Syscoms) to continually monitor the progress of the acquisition portfolio, assess risks and interoperability achievement, support portfolio program acquisition milestones, and oversee the SoS Change Control Board (CCB). The SoS SE IPT must provide feedback from the acquisition programs into the Capability Planning (Section 2) and Capability Engineering (Section 3) processes to ensure that the acquisition portfolio can achieve the capability objectives and timeline identified in the CEP (see Section 2.4), and the functional and performance requirements identified in the SPD (see Section 2.3.4).

6.3.1. Prepare a Capability Status Report

The SOS SE IPT must continually monitor the portfolio of acquisition programs to ensure that the fielding plan will satisfy the capability objectives, and to take action when risks arise (see Section 4.1.7.1) or acquisition decisions impact the ability of the acquisition portfolio to achieve the desired capability objectives. A capability status report should be prepared and submitted to ASN RDA and the appropriate Joint Staff Functional Control Board (FCB) to support portfolio acquisition program milestones (see Section 4.3) and the JCIDS review of the related acquisition program Capability Design Document (CDD) and Capability Production Document (CPD). The status report should summarize the results of the assessments identified in the following five subparagraphs.

6.3.1.1. Document the Portfolio Performance Assessment

The portfolio of acquisition programs should be monitored to assess if the desired capability objectives can be satisfied given the level of performance individual programs can achieve. This involves determining if the programs will achieve the necessary level of performance and interoperability to operate as a fully integrated and interoperable joint force (see Section 4.1.3). When performance issues arise, the impact on the ability to field the desired capability should be determined and documented in the Capability Status Report.

6.3.1.2. Document the Portfolio Resource Assessment

The portfolio of acquisition programs should be monitored to assess if the funding profile is adequate to permit the program to achieve their fielding plan and incrementally evolve their performance and interoperability to achieve the capability objectives. When funding reductions affect programs within the portfolio, the impact on the ability to field the desired capability should be determined and documented in the Capability Status Report.

6.3.1.3. Document the Portfolio Schedule Alignment Assessment

The portfolio of acquisition programs should be monitored to assess if the schedule of individual acquisition programs are supportive of the overall capability evolution schedule (see Section 4.2). When schedule changes affect programs within the portfolio, the impact on the ability to field the desired capability should be determined and documented in the Capability Status Report.

6.3.1.4. Perform an SoS Interoperability Assessment

The portfolio of acquisition programs should be monitored to assure adherence to the Navy Integration and Interoperability Management Process and to assess the interoperability of the acquisition programs with each other and the legacy, fielded systems within the Naval Enterprise (see Section 4.1.3.2). When programs within the portfolio report that they cannot achieve their Net-Ready Key Performance Parameters (KPP), the impact on the ability to field the desired capability should be determined and documented in the Capability Status Report.

6.3.1.5. Document the Portfolio Risk Assessment

The portfolio of acquisition programs should be monitored to assess the risks challenging the acquisition programs within the portfolio that would affect the fielding of the desired capability (see Section 4.1.7). Risk mitigation strategies should be identified, and risk reduction recommendations documented in the Capability Status Report.

6.3.2. Conduct the SoS Change Control Board (CCB)

The SoS SE IPT should conduct a Change Control Board to manage changes to the Capability Evolution Plan, Systems Performance Document (SPD), and Capability Interface Matrices. The SoS SE IPT CCB should meet quarterly to review the Capability Status Report, and acquisition program submitted change proposals. The CCB must take action to approve, defer, or reject change proposals submitted by individual acquisition programs when the change is not in the best interest of the warfighter. Alternatives to rejected change proposals must be identified, and socialized within the acquisition community to identify a solution that satisfies the intent of the proposed change.

6.3.3. Assess Portfolio Program Capability Alignment

The SoS SE IPT must continually assess the schedules of acquisition programs within the acquisition portfolio to ensure that they remain aligned with the capability fielding plan identified within the Capability Evolution Plan (see Section 4.2). When acquisition programs schedules deviate from the capability fielding plan the impact on the delivery of the capability must be identified, and cause of the deviation identified, and alternatives to realignment explored. Recommended actions should be forwarded to ASN RDA and OPNAV in the form of a POM Issue Paper (see 6.2.3)

6.3.4. Support Portfolio Program Acquisition Milestones

The SoS SE IPT should provide a capability status report to the acquisition program's Milestone Decision Authority in support of each milestone (see Section 4.3). The status report should identify the funding, schedule, performance, or interoperability risks associated with the acquisition program, and the impact of the risks to the capability fielding plan. Representatives of the SoS SE IPT should participate in the acquisition program Milestone to ensure that the program is understood in terms of how it contributes to delivering the desired capability to the warfighter.

Appendix A. Naval Force Development System (NFDS)

The Naval Force Development System (NFDS) is a term used within this document to describe the Navy and Marine Corps' implementation of capabilities-based planning and acquisition through the Naval Capabilities Development Process (NCDP), the Expeditionary Force Development System (EFDS), and the Department of the Navy execution of the DoD 5000 acquisition process. The NFDS consists of four phases:

- Concept Development
- Capability Analysis
- Capability Prioritization and Resourcing
- Capability Acquisition, Fielding, and Transition

A.1. NCDP and EFDS Overview

The Department of the Navy (DON) uses a capability-based approach to define, develop, and deliver technologically sound, sustainable, and affordable military capability. This approach is implemented in the Marine Corps by the Expeditionary Force Development System (EFDS) and in the Navy via the Naval Capability Development Process (NCDP).

EFDS was established under MCO 3900.15A dated 26 November 2002. It is a systematic, concept-based approach for the development of future Marine Corps capabilities and provides a standardized methodology for translating future needs into fielded integrated capabilities. The initiating directive established the process, products, supporting products, duties and responsibilities by billet, and organizational relationships. Advocates who represent the major elements of a Marine Air–Ground Task Force (MAGTF): a Command Element (CE), a Ground Combat Element (GCE), an Aviation Combat Element (ACE), and Combat Service Support Element (CSSE) and advocates for supporting installations and recruiting run EFDS. EFDS products such as Advocates Campaign Plans, the Expeditionary Capabilities List, and the S&T Campaign Plan are either produced by the advocates or produced in support of the advocates. EFDS is self-sustaining and operates on a two-year cycle tied to the budget cycle.

OPNAVINST 3050.23 of 5 November 2001 modified the Navy's Programming, Planning and Budgeting System (PPBS) to focus on capability-driven warfighting requirements. These modifications included increasing the emphasis on capabilities required for delivery at a Battle Force vice platform level and enhancing the ability to better communicate a long-term warfighting vision. The Battle Force Capability Assessment and Planning Process (BCAPP) was identified as the means to accomplish these actions. Within BCAPP, programs are defined in terms of application to mission capabilities and grouped into associated Mission Capability Packages (MCPs). Each MCP is assigned a capability sponsor as an advocate. Analysis and integration of the MCPs lead to the development of a fiscally constrained Integrated Strategic Capabilities Capability Plan (ISCP) that serves as the Navy's warfare investment strategy for programming operational capabilities. The ISCP is then used as the basis for development of an Integrated Sponsor Program Plan Proposal (ISPP) – the end-point of the process. The instruction designates Deputy Chief of Naval Operations for Warfare Requirements and Programs, N7, as the executive agent and lead for implementation of BCAPP but does not define the process.

NCDP replaced BCAPP following the release of Sea Power 21. Sea Power 21 created four operational concepts: FORCEnet, Sea Strike, Sea Shield, and Sea Basing. Within NCDP, these concepts were designated as Naval Capability Pillars and the MCPs were allocated among the pillars. Integration across the NCPs leads to the development of the ISCP which remains the basis of the ISPP.

A.2. NFDS Phase I (Concept Development)

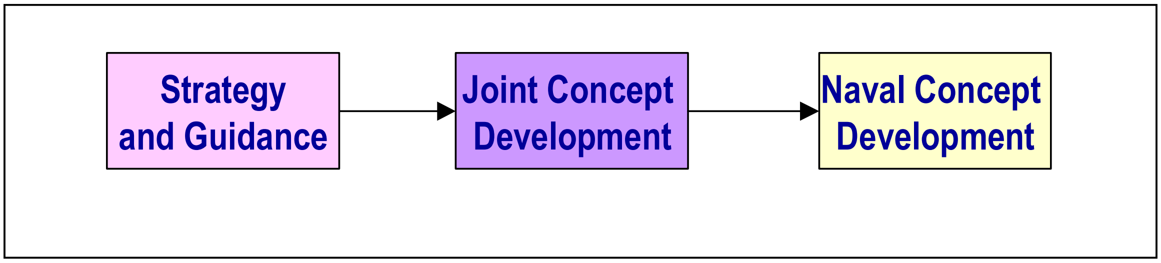

Figure A-1: NFDS Phase I

Phase I is the Concept Development phase of NFDS as depicted above. Within this phase, national strategies and guidance that are the basis for Joint and service-level concepts are examined. Joint concept development translates these overarching documents into the Family of Joint Concepts that identity future warfighting capabilities and attributes of the joint force. Naval concept development details how the Navy and Marine Corps will organize, equip, and deploy to contribute to and provide needed capabilities to the joint force. The significance of developing future naval warfighting concepts is profound. The capabilities articulated in these concepts when linked to the future warfighting capabilities contained in the Family of Joint Concepts are the basis for future acquisitions. Processes and process owners for joint and service-unique concepts are identified and assessed.

A.2.1. Strategy and Guidance

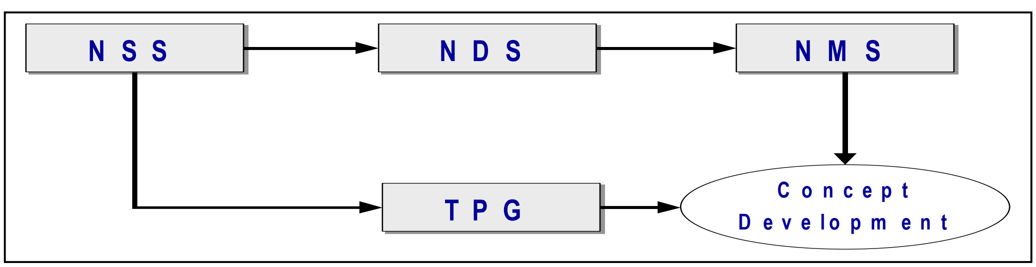

Figure A-2: Relationship of National Strategies to Concept Development

The National Security Strategy (NSS), National Defense Strategy (NDS), and the National Military Strategy (NMS) provide the basis for the development of future warfighting concepts that form the underpinning for the military's capabilities-based planning process. Transformation Planning Guidance (TPG) establishes the schedule and assigns responsibility for the development of concepts. The relationship of these documents is shown in Figure A-2.

The **National Security Strategy** is an annual report given by the President to Congress. The current NSS, signed 17 September 2002, outlines the President's national security goals for political and economic freedom; peaceful relationships with other states; and respect for human dignity.

The **National Defense Strategy** is prepared by the Under Secretary of Defense for Policy (USD(Policy)) and signed by the Secretary of Defense (SECDEF). The NDS implements the National Security Strategy for the Department of Defense (DoD). It provides defense policy goals, general direction, and broad priorities for the Services, Combatant Commands (COCOMs), and support services. It also serves as the foundation for detailed strategy development in the near, mid, and far term.

The **National Military Strategy** is prepared by J5, Strategy, Plans and Policy Office and issued by the Chairman of the Joint Chiefs of Staff. It operationalizes the broad strategic guidance contained in the National Security Strategy and the National Defense Strategy for the services and for the combatant commanders. The NMS provides focus for military activities by defining a set of interrelated military objectives and joint operating concepts from which the Service Chiefs and combatant commanders identify desired capabilities and against which the Chairman of the Joint Chiefs of Staff assesses risk. These objectives are:

- Protect the United States
- Prevent conflict and surprise attacks
- Prevail against adversaries

To achieve these objectives, the NMS states that connected joint operating concepts (JOCs) are required to provide direction on how the joint force will operate and provide a foundation for defining military capabilities. The JOCs support each objective and link specific tasks to programmatic actions as well as guide the development of plans and the execution of operations. These joint operating concepts are

- Homeland Security
- Stability Operations
- Strategic Deterrence
- Major Combat Operations

The **TPG Transformation Planning Guidance** was prepared by USD(Policy) in coordination with CJCS, Joint Forces Command (JFCOM), and Director, Office of Force Transformation (OFT) and was released in April 2003.. It is SECDEF's response to direction given in the NSS to transform the military to focus more on how an adversary might fight rather than where and when a war might occur. It identifies the critical elements of transformation, assigns roles and responsibilities for promoting transformation, and describes how the DoD will organize to implement transformational capabilities. It also states the outcome to be achieved: fundamentally joint, network-centric, distributed forces capable of rapid decision superiority and massed effects across the battlespace. This transformation strategy, in part, is designed to link with the acquisition process through the Joint Capabilities Integration and Development System

(JCIDS). JCIDS is and DoD's capabilities-based process that identifies, evaluates, and prioritizes capabilities needed to implement the joint concepts (discussed in Phase II).

The TPG calls for a family of joint concepts made up of, which includes an overarching vision and interrelated operating, functional, and integrating concepts. (JOCs specified in the NMS are the set of operating concepts required by TPG.)

A.2.2. Joint Concept Development

A joint concept is a visualization of future operations that describes how a commander, using military art and science, might employ capabilities to achieve desired effects and objectives. It need not be limited by current or programmed capabilities. A joint concept describes a particular military problem and proposes a solution that can be supported by logic and investigated through experimentation.

As shown in Figure A-3, the **Joint Operations Concept (JOpsC)** heads the family of joint concepts. These concepts consist of the Joint Operating Concepts (JOCs), Joint Functional Concepts (JFCs), and Joint Integrating Concepts (JICs).

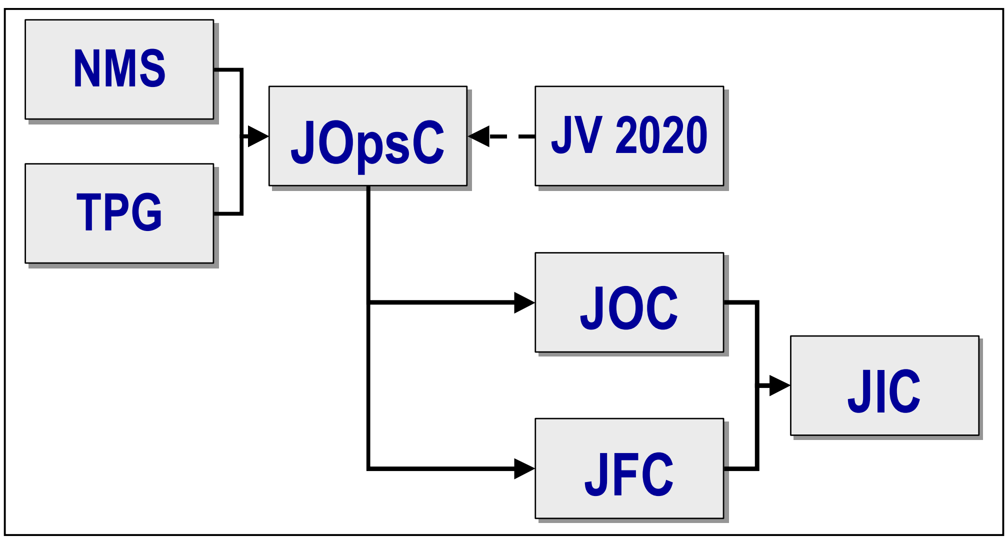

Figure A-3: Family of Joint Concepts

The **JOpsC** is an overarching description of how the future joint force will operate 10-20ten to twenty years in the future in all domains across the range of military operations within a multi-lateral environment in collaboration with interagency and multinational partners. It guides the development of future joint concepts and joint force capabilities by establishing the unifying framework for the family of operational, functional, and integrating concepts.

A **Joint Operating Concept (JOC)** is an operational-level description of how a Joint Force Commander 10-20 ten to twenty years in the future will accomplish a strategic objective through the conduct of operations within a military campaign. This campaign links end state, objectives, and desired effects necessary for success.

A **Joint Functional Concept (JFC)** is a description of how the future joint force will perform a particular military function across the full range of military operations 10ten to twenty-20_years in the future. JFCs support the JOpsC and JOCs and draw operational context from them. JFCs identify required capabilities and attributes, inform JOCs, and provide functional context for joint integrating concept development and joint experimentation. Within the context of a JFC, capabilities emphasize the means to perform a set of tasks.

Functional Capability Boards (FCBs) develop and maintain JFCs and assist in the development of attributes, assumptions, measures of effectiveness and standards that support JCIDS. JFCs are approved by CJCS. Joint Warfighting Capability Assessment (JWCA) teams were incorporated into the FCBs. There are eight JFCs and corresponding FCBs:

- Battlespace Awareness
- NetCentric
- Force Management
- Training
- Command and Control
- Force Application
- Focused Logistics
- Protection

A **Joint Integrating Concept (JIC)** is a description of how a Joint Force Commander ten to twenty 10-20 years in the future will integrate capabilities to generate effects and achieve an objective. A JIC includes an illustrative concept of operations (CONOPS) for a specific scenario and a set of distinguishing principles applicable to a range of scenarios. JICs have the narrowest focus of all concepts and distill JOC and JFC-derived capabilities into the fundamental tasks, conditions and standards required to conduct a capabilities-based assessment (CBA) for identification of capability gaps and excesses. The relationship between the family of Joint Concepts is shown in Figure A-4.

Seven JICs are currently under development:

- Joint Undersea Superiority
- Joint Forcible Entry Operations
- Global Strike
- Integrated Air & Missile Defense
- Seabasing
- Joint Logistics
- Joint Command and Control

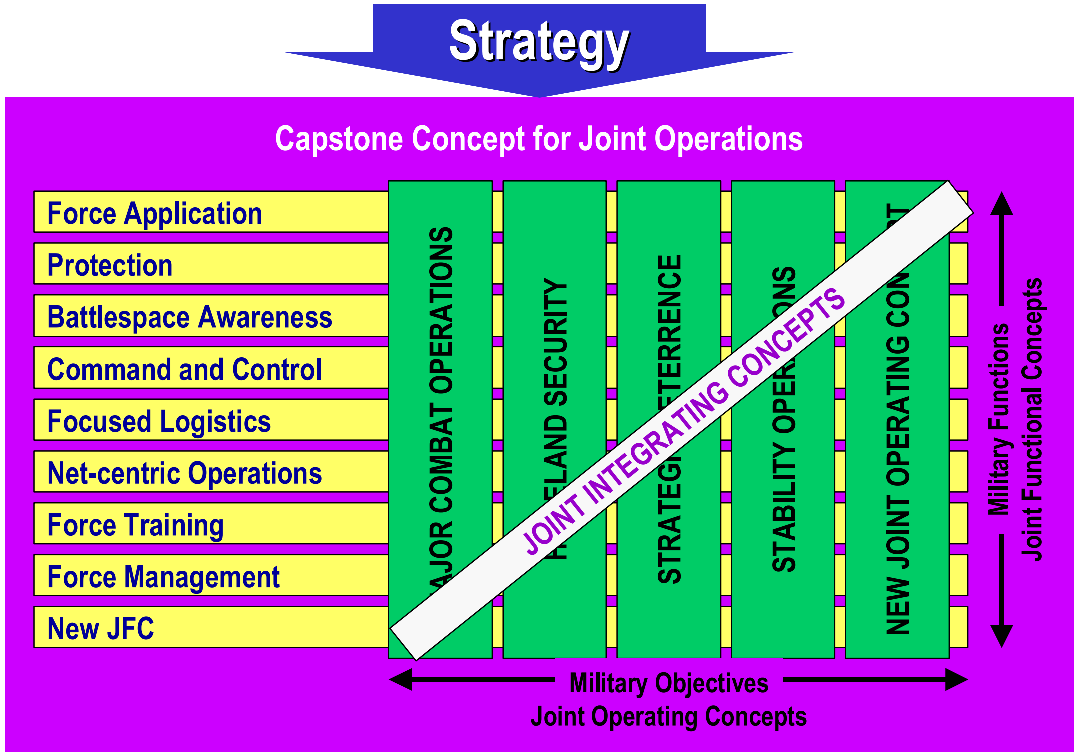

Figure A-4: Relationship between JOCs, JFCs, and JICs

OPNAV N3/N5 is Navy's interface to the joint concept development process and coordinates staff assignments for joint concept development with the exception of JFCs. Typically, the Navy representative to the lead FCB for a JFC is responsible for staffing the concept. The Joint Concepts Branch of EWDC provides Marine Corps staffing.

A.2.3. Naval Concept Development

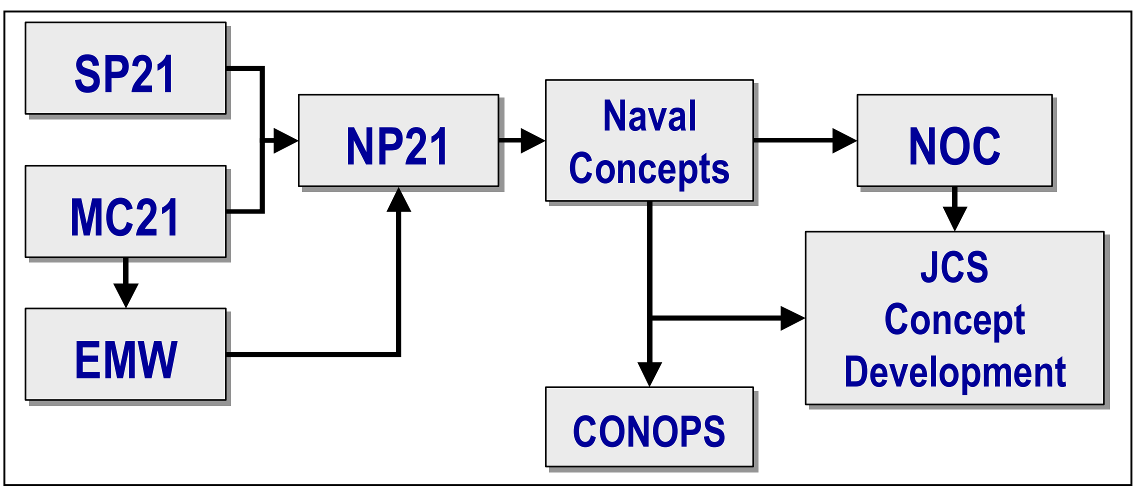

Figure A-5: Relationship of Naval concept development to JCS concept development

Service visions –Marine Corps Strategy 21 (MC21) and Sea Power 21 (SP21) – spearhead naval concept development, although the concept development approach and philosophy employed by the services vary greatly. Figure A-5 details the relationship of various documents to naval concept development and the relationship of naval concepts to joint concept development.

MC21, dated 3 November 2000, provides the vision, goals, and aims of the Marine Corps to support the development of future combat capabilities. It establishes core values, core competencies, and signature characteristics of the Marine Corps. MC21 also details how the Marine Corps is operationally organized, how it deploys, the range of operations it undertakes, and how the Marine Corps fits in to the larger joint force.

Expeditionary Maneuver Warfare (EMW), the Marine Corps capstone concept dated 10 November 2001 operationalizes MC21 and provides the foundation for Marine Corps operational concept development. Three operational concepts are identified in EMW – Operational Maneuver From the Sea (OMFTS), Sustained Operations Ashore (SOA), and Other Expeditionary Operations (OEO).

SP21 serves as both the Navy's vision document and capstone concept document. SP21 is unique in that it was published as an article in the October 2002 edition of the U. S. Naval Institute's *Proceedings*, but was never republished and promulgated under a separate cover as a stand-alone document. SP21 provides overviews for three operational concepts – Sea Shield, Sea Strike, and Sea Basing – that form the basis for future naval operations. These operational concepts are enabled by ForceNet and implemented by the Global Concept of Operations, also described in SP21. SP21 also contains three organizational processes – Sea Trial, Sea Warrior, and Sea Enterprise – which that are intended to align and accelerate the development of enhanced warfighting capabilities.

Naval Power 21 … A Naval Vision was signed by CMC, CNO, and SECNAV in October 2002. Lastly, NP21 incorporates MC21, EMW, and SP21 as the services' strategies and capstone concepts for future force development. NP21 provides naval visions based upon three pillars:

- *We assure access*. Assuring seabased access worldwide for military operations, diplomatic interaction, and humanitarian relief efforts. Our nation counts on us to do this.
- *We fight and win*. Projecting power to influence events at sea and ashore both at home and overseas. We project both offensive power and defensive capability. It defines who we are.
- *We are continually transforming to improve.* Transforming concepts, organizations, doctrine, technology, networks, sensors, platforms, weapon systems, training, education, and our approach to people. The ability to continuously transform is at the heart of America's competitive advantage and a *foundation* of our strength.

The vision describes four fundamental qualities of naval forces – decisiveness, sustainability, responsiveness, and agility. Seven focus areas are identified:

- People: The heart of the team

- Homeland Security
- Projecting power and influence: Winning at sea and beyond
- Future naval capabilities: Transformational by design
- Sea Enterprise: Capturing business efficiencies
- The future: An expanded naval force
- Organizing by force: A Naval Operational Concept

The Naval Operating Concept for Joint Operations (NOC) was signed by CMC and CNO in November 2004. The NOC is a capstone concept and provides the overarching guidance for the development of future capabilities and forces, and for the further alignment of naval concepts within a greater joint context. It describes in broad terms how the Navy and Marine Corps Team will operate across the full range of military operations in the near, mid, and far terms through 2020 and links Navy and Marine Corps visions and concepts with emerging Army, Air Force, and joint operational concepts. It amplifies the naval vision and provides a more detailed foundation for force structure planning and follow on naval concept development. The NOC operationalizes Naval Power 21 and complements the Naval Transformation Roadmap (developed in Phase III).

SECDEF's ***Defense Planning Guidance For Fiscal Years 2003-2007*** directed all services to develop transformation roadmaps. These roadmaps are intended to demonstrate how the services and JFCOM are building the capabilities necessary for executing the joint operating concepts. As such, the roadmaps provide a link from Phase III of NFDS, Prioritization and Resourcing, to Phase I, Capability Analysis.

A.3. NFDS Phase II (Capability Analysis)

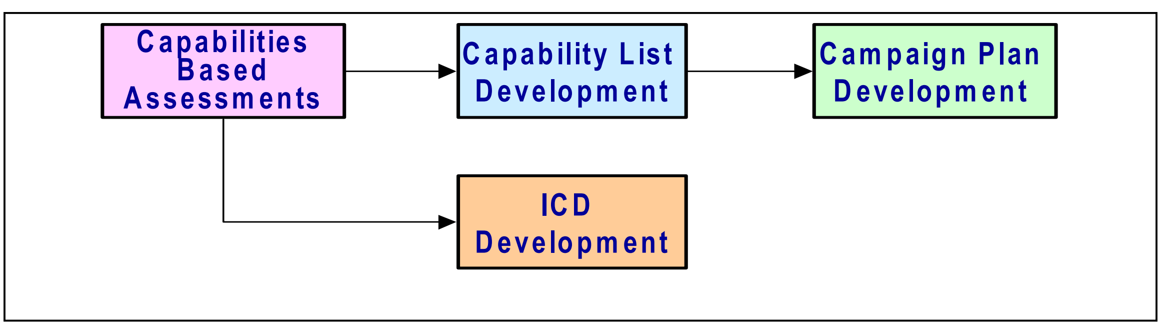

Figure A-6: NFDS Capability Analysis

Phase II of NDFS deals with capability analysis. This phase, shown in Figure A-6, commences with Capabilities Based Assessments (CBA) of future capabilities identified in Joint and Naval concepts to determine if capability gaps or overlaps exist in current and projected warfighting capabilities. Should a capability gap exist, potential materiel and non-materiel alternatives to resolving the gap are identified. The results of these analyses are captured in two distinct ways.

First, potential materiel solutions are submitted to the Joint Staff for approval via submission of an Initial Capabilities Document (ICD). Second, analyses are compiled to form a Capabilities List. The Capabilities List is a prioritized list comprised of all applicable projected warfighting capabilities identified in Joint and Naval concepts and capability gaps associated with those future needs. The Capabilities List serves as the basis for developing a Campaign Plan that details the Service's course of action to attain needed future warfighting capabilities and establishes time-phased acquisition priorities.

A.3.1. Capabilities Based Assessments

The Capabilities Based Assessment process, shown below in Figure A-7, is governed by JCIDS. It is a structured, four-step methodology that defines capability gaps, capability needs and approaches to provide those capabilities. The four steps include a Functional Area Analysis (FAA), a Functional Needs Analysis (FNA), a Functional Solution Analysis (FSA), and a Post Independent Analysis (PIA). Combatant commanders, FCBs, defense agencies, or the services may initiate a CBA but only defense agencies and the services may conduct a FSA. Services must collaborate with the combatant commands and FCBs to ensure capabilities are defined from a joint perspective. The analysis is based on the Family of Joint Future Concepts and forms the foundation for integrated architectures that are developed to structure solutions to capability needs.

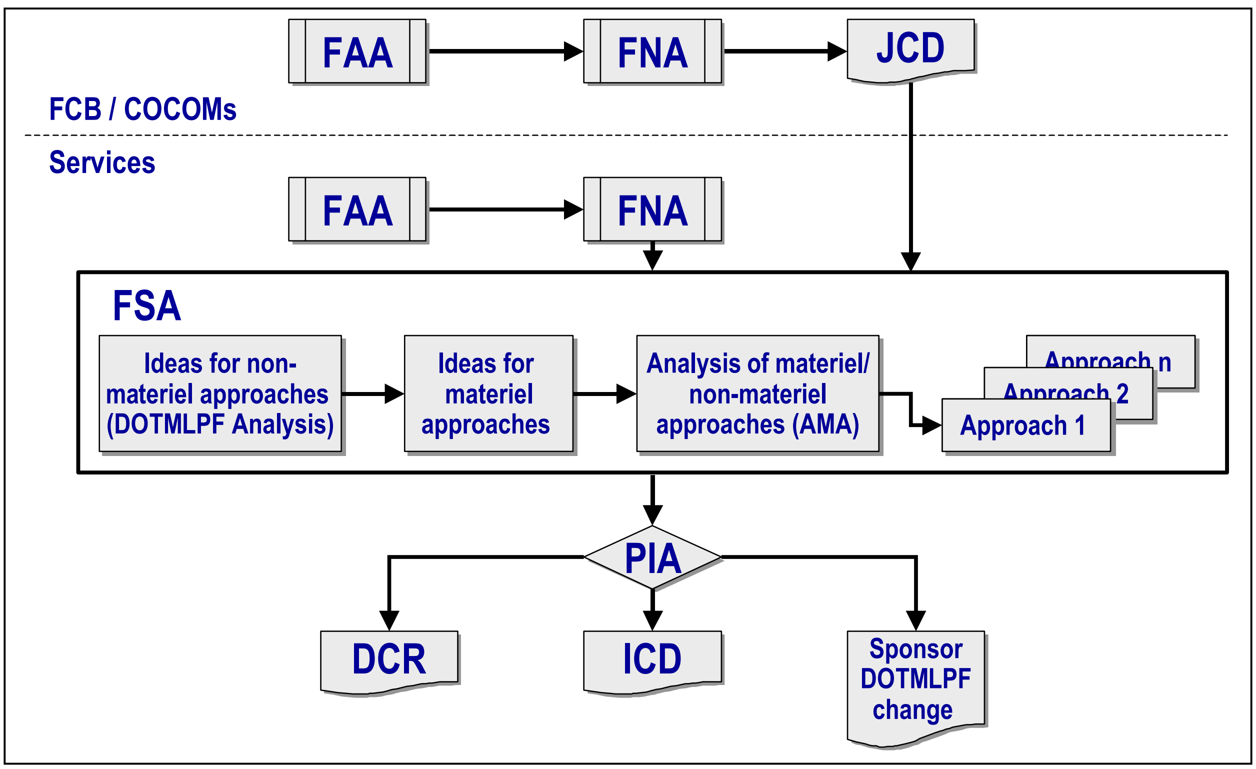

Figure A-7: CBA Process

An FAA is the first step in a CBA. The FAA is based upon an approved concept of operations (CONOPS), such as a JIC, and identifies the operational tasks, conditions and standards needed to achieve the desired outcomes for the military objectives. The output of the FAA is a list of capabilities and their associated tasks and attributes.

The second part of a CBA is an FNA. The FNA assesses the ability of current and programmed joint capabilities to accomplish the tasks that the FAA identified and serves to further define and refine integrated architectures. Using the tasks identified in the FAA as primary input, the FNA produces a list of capability gaps that require solutions, and indicates the time frame in which those solutions are needed. Combatant commands and FCBs document the results of their analysis in a Joint Capabilities Document (JCD) at the conclusion of the FAA and FNA. Services may also elect to submit a JCD to the JROC for validation and approval prior to proceeding into the functional solution analysis (FSA) if the capabilities described impact on joint warfighting.

The third step in a CBA is the FSA. An FSA is an operationally based joint assessment of potential DOTMLPF and policy approaches to solve or mitigate one or more of the capability gaps identified in the FNA. Services lead FSAs with support from combatant commands and oversight by the FCBs. The gaps identified in the FNA serve as inputs to the FSA. An analysis of non-materiel approaches determines whether a non-materiel or integrated DOTMLPF and/or policy approach can fill the capability gaps. The FSA also identifies joint materiel approaches that can provide required capabilities. These approaches may include family of systems (FoS) or system of systems (SoS) solutions. The process should leverage the expertise of all government agencies, as well as industry, in identifying possible materiel approaches. An analysis of materiel/non-materiel approaches (AMA) determines which approach or combination of approaches may provide the desired capability or capabilities. The FSA output identifies potential approaches to resolve identified capability gaps and should include the broadest possible range of joint and independent possibilities for solving the capability gap. Results of the FSA influence the future direction of integrated architectures and provide input to capability roadmaps.

The final step in the CBA is the PIA. A PIA assesses the compiled information and analysis results of the FSA (non-materiel and materiel approaches) to ensure the list of approaches with the potential to deliver the capability identified in the FAA and FNA is complete. Individuals who were not involved in the FSA conduct the PIA. This information will be compiled into an appropriate recommendation and documented in an Initial Capabilities Document (ICD) or joint DOTMLPF Change Recommendation (DCR).

Within the Marine Corps, the Materiel Capabilities Division of the Expeditionary Force Development Center (EFDC) is responsible for conducting CBA's. FAAs and FNAs are routinely conducted for Marine Corps future warfighting capabilities. Upon competition of an FAA and FNA, the Capabilities Officer reviews the results with the appropriate advocate and a decision to initiate an ICD is made. The Capabilities Officer leads the IPT that oversees the FSA and development of an ICD or DCR. After internal staffing and review, the completed ICD is forwarded to Deputy MCCDC for endorsement and ACMC for approval before forwarding to the Joint Staff.

The Navy does not have an organization dedicated to capability assessments. Resource sponsors conduct CBAs as a part of ICD development. While ICD teams typically include representation from one or more PEO program offices, the resource sponsor determines which PEO and program offices participate. Similarly, representation by ONR, OPTEVFOR, and naval warfare centers are at the discretion of the resource sponsor.

A.3.2. Initial Capabilities Document Development

An ICD documents the need to resolve a specific capability gap, or set of capability gaps, identified through a CBA. Submission and approval of the ICD is governed by JCIDS and follows the process depicted in Figure A-8. The ICD supports the concept decision, AoA, technology development strategy, Milestone A acquisition decision, further refinement and/or development of integrated architectures, and subsequent technology development phase activities. ICDs should be non-system specific and non-Service, agency or activity specific to ensure capabilities are being developed in consideration of the joint context. The ICD is based on either an analysis of the Family of Joint Future Concepts and CONOPS or on the results of the analysis used to develop a relevant JCD. The ICD defines the capability gap and identifies the scenarios against which the capabilities and attributes were assessed. The ICD also captures the FSA evaluation of different materiel and non-materiel approaches that are proposed to provide the required capability. The ICD proposes a range of approach(es) that will be further refined and analyzed during an AoA. The analysis that supports the ICD helps to shape and provides input to the AoA that will be used through the life of the system.

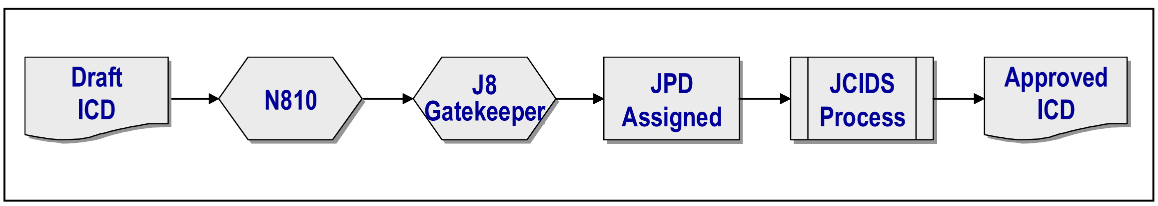

Figure A-8: ICD Approval Process

The draft ICD captures the results of a CBA in the specific format required by JCIDS. Both the Navy and the Marine Corps provide draft ICDs to N810. N810 enters the draft ICD into JCS Knowledge Management / Decision System (KDMS) tool. KDMS is the Joint Staff automated tool for processing, coordination and repository functions for JCIDS documents. Once in KDMS, J-8, the JCIDS Gatekeeper, assigns a joint potential designator (JPD) and designates a lead FCB and supporting FCBs, as required, for the ICD.

The JPD determines the JCIDS review and approval process for the ICD. A JPD of “JROC Interest” is applied if capabilities have a significant impact on joint warfighting or a potential impact across Services. The JROC Interest JPD applies to all ACAT I/IA programs and selected ACAT II and below programs. JROC Interest ICDs are staffed through the JROC for validation and approval. A JPD of Joint Integration is assigned if concepts and/or systems do not significantly affect the joint force but staffing is required for threat validation and applicable certifications (IT and NSS interoperability and supportability, intelligence and/or insensitive munitions). The Joint Integration JPD applies to ACAT II and below programs. The ICD is validated and approved by either the VCNO or ACMC. If the concepts and/or systems do not significantly affect the joint force and no certifications are required, a JPD of Independent is assigned. The Independent JPD applies to ACAT II and below and is returned to the sponsoring component for validation and approval

A.3.3. Capabilities List Development

The most recent change to the JCIDS manual creates the Joint Capabilities Document (JCD). The JCD describes capability gaps that exist in joint warfighting functions, as described in JOCs, JFCs, and JICs. The JCD establishes the linkage between the key characteristics identified in the family of concepts and the capabilities identified through the functional area analysis (FAA). The JCD defines the capability gaps in terms of the functional area, the relevant range of military operations and the timeframe under consideration.

The JCD capture the results of a well framed JCIDS analysis FAA and functional needs analysis (FNA). A JCD will be generated, validated and approved to define and prioritize the capabilities required for joint warfighting. The JCD is used as the basis for one or more functional solution analysis (FSA) and resulting ICDs or joint DOTMLFP Change Recommendations (DCRs). The JCD is informed by and will also be used as a basis for updating the integrated architectures and the capability roadmaps.

Marine Corps advocates, assisted by MCCDC, conduct mission area analyses of operational concepts to determine capabilities and capability gaps. Working collaboratively, the advocates, assisted by MCCDC, produce the EMW Capability List (ECL). The ECL provides execution guidance and direction to achieve the goals and strategy of MC 21 and serves as the key enabler for the remainder of the process. The ECL provides and assessment of capabilities and capability gaps in the near, mid, and far term and the DOTMLPF solution, if know. Capability gaps in the ECL may lead to the generation of material solutions and the development of an ICD, the starting point of NFDS Phase II.

The Navy has not produced a list of capability and capability gaps associated with SP 21. The capabilities list produced by NCDP is similar to the EFDS MAGTF Capabilities List (MRL) produced in Phase III. This list contains material solutions recommended for resourcing.

A.3.4. Campaign Plan Development

Campaign Plans are an integral part of EFDS. The advocates develop them the plan in the first phase of the process and then use it to guide activities performed in later phases. This methodology is consistent with JCIDS in that it places a premium on up-front planning. Marine Corps Campaign Plans are prepared on a two-year cycle synchronized with the budgeting process. They serve to inform other activities that occur within EFDS and are informed by and updated by the products of those activities. In preparing the Campaign Plan, the advocate, assisted by MCCDC, conducts a mission area analyses of operational concepts to determine capabilities and capability gaps within his domain.

The Navy has no formalized process to produce overarching guidance similar to the Campaign Plans generated in EFDS. That is not to say that the Navy does not have Campaign Plans. In those instances where there is close collaboration between the two services, Campaign Plans are frequently used to provide vision and unifying direction. The Mine Warfare Campaign Plan and the draft FORCEnet Campaign Plan are examples.

A.4. NFDS Phase III (Capability Prioritization and Resourcing)

Phase III of the Naval Force Development System is shown by Figure A-9. This phase operates within the DoD Planning, Programming, Budgeting and Execution (PPBE) process. This Section first provides an overview of the Planning, Programming, Budgeting and Execution (PPBE), one of the three main acquisition decision support processes, is first provided. Then the services' processes for prioritizing capabilities and transitioning from planning to programming are examined. POM development for both the Navy and Marine Corps are also explored. Navy and Marine Corps execution of PPBE is examined and PPBE process owners are identified.

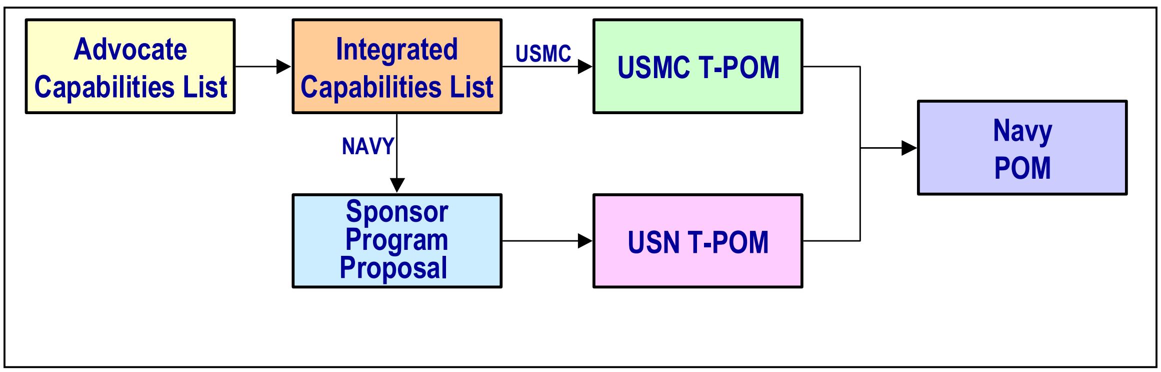

Figure A-9: Capability Prioritization and Resourcing

A.4.1. PPBE Overview

The following Section is based on information taken from the OSD Comptroller's website.

In 2003, Defense Planning Guidance (DPG) tasked the Senior Executive Council to lead a study and identify improvements that could be made to DoD decision-making and budgeting process. Known as the DPG 20 Streamlining Decision Process, the study recommended a process that became known as Planning, Programming, Budgeting, and Execution (PPBE). Concurrent with the new planning, programming, and budgeting processes, PPBE set forth a two-year budget cycle, which allows DoD to formulate two-year budgets and use the Off-Budget year to focus on budget execution and evaluate program performance.

With the introduction of PPBE, a major thrust of DoD moving forward is to increase the effectiveness of the programming and budgeting process and to place significant importance on budget execution. Specific emphasis is on linking any major decision both to the Defense Planning Guide and to program and budget development, and then evaluating the performance results.

The new PPBE process guides DoD in developing strategy; identifying needs for military capabilities; planning programs; estimating, allocating, and acquiring resources; and other decision processes. In addition, the change more closely aligns DoD's internal cycle with external requirements embedded in statutes and administration policy.

PPBE is a continuous process that results in the annual submission of the President's Budget to Congress. It addresses the Future Years Defense Program (FYDP), which looks ahead six years, as well as the current and upcoming budget execution years. While the different phases of PPBE are considered sequential, because of the amount of time required to develop estimates and review resource requirements, there are generally at least two phases of PPBE ongoing at any given time. Each of the phases is described in this Section—Planning, Programming, Budgeting, and Execution.

A.4.1.1. PPBE—Planning

During the Planning phase, DoD analyzes the threat to national security and develops appropriate strategies to prepare for and handle the threat. The Planning phase culminates in the development of the Strategic Planning Guidance (SPG) and initial Defense Fiscal Guidance (DFG) to the services and defense agencies. SPG provides planning assumptions and direction for the Component's program submission, or Program Objectives Memorandum (POM). SPG is not resource constrained and becomes the foundation for many of the subsequent discussions in POM and budget review phases on military requirements.

The focus of the Planning phase is to:

- Define the National Military Strategy (NMS) to support national security and US foreign policy two to seven years in the future
- Plan the military forces to accomplish that strategy
- Ensure the necessary framework exists to manage DoD resources effectively
- Plan and negotiate goals, and revise as necessary and appropriate.

A.4.1.1.2. Joint Capabilities Development

With the move toward the Planning, Programming, Budgeting and Execution process, a major aspect of the Planning phase is the Joint Capabilities Development process. The Joint Capabilities Development is a new approach to defense planning that focuses attention on needed capabilities while providing guidance to fit programs within the resources available to meet the defense goals. The result is fiscally constrained programmatic guidance to accomplish the National Military Strategy and the defense goals in the Quadrennial Defense Review.

The three elements in the Joint Capabilities Development process are:

- Strategic Planning Guidance—issued early in the Planning process to provide overall policy and strategy guidance to be used in developing the defense program.

- Major Issue Analysis—a combined OSD/JCS examination of major issues and performance metrics for measuring success in achieving the programmatic goals.
- Joint Programming Guidance—final document of the Planning process. JPG is issued in On-Budget (even-numbered) years by OSD, and contains fiscally constrained programmatic guidance and performance measures. JPG drives the development of the Program Objective Memoranda (POM) and Budget Estimate Submissions (BES).

A.4.1.2. PPBE—Programming

The Programming phase is the period when planning decisions, programming guidance, and congressional guidance is converted into a detailed allocation of resources. The services and defense agencies match their available resources against their requirements and submit program proposals. These proposals are reviewed and alternatives are presented to the Deputy Secretary of Defense to address significant programmatic issues, such as airlift capacity, readiness, or modernization issues.

The Program Objective Memorandum (POM) is the primary document used by the services to submit programming proposals. The Program Objective Memorandum includes an analysis of missions, objectives, alternative methods to accomplish objectives, and allocation of resources. With the implementation of a two-year budget cycle, a new document—the Program Change Proposal (PCP)—was introduced into the budgeting process to address urgent matters that need action during the Off-Budget year.

The Program Decision Memorandum formally documents the directives from the Secretary and Deputy Secretary of Defense to the Defense Components on issues raised during POM review. The issuance of the Program Decision Memorandum to DoD Components, the Chairman, Joint Chiefs of Staff, and OMB completes the Programming process.

The four principle documents developed in the Programming phase are:

- Program Objectives Memorandum (POM)—issued during the even-numbered On-Budget years, contains recommended programming and resource allocations.
- Program Change Proposals (PCP)—issued during odd-numbered Off-Budget years to request program changes to the baseline.
- Issue Books—single page narratives prepared by OSD staff, DoD Components, and OMB.
- Program Decision Memorandum (PDM)—final document of the Programming process; contains decisions of the Secretary of Defense regarding programs and resources.

A.4.1.3. PPBE—Budgeting

The Budgeting phase (formulation and justification) provides a platform for a detailed review of a program's pricing, phasing, and overall capability to be executed on time and within budget. The budgeting process addresses the years to be justified in the President's Budget (including the current and upcoming execution years) and provides a forum to develop the Secretary's budget position.

The Budget Estimate Submission (BES) is the primary document used by the services and defense agencies to submit budget estimates. Each budget estimate is based on the programs and fiscal guidance contained in the Program Objectives Memorandum (POM); and includes the prior, current, and two budget fiscal years. For example, the FY06 Budget Submission includes data from FY04, FY05, FY06, and FY07. The FY07 Budget Submission will include data from FY05, FY06, FY07, and FY08.

Data for the four years beyond the budget year is derived from the Future Years Defense Program (FYDP). With the implementation of a two-year budget cycle, the Budget Change Proposal (BCP) document was introduced into the budgeting process to address fact-of-life changes and urgent matters that need action during the odd-numbered Off-Budget year.

A detailed OSD budget review supports the development of resource alternatives that are articulated in a series of Program Budget Decisions (PBD). Program Budget Decisions are coordinated with all of the stakeholders on a particular issue. Through this review process, all perspectives—including those of the Chairman of the Joint Staff, Under Secretaries of Defense, Service Secretaries, and OMB—are considered as an integral part of the decision-making process. In his deliberations, the Deputy Secretary of Defense considers PBD and also the responses prepared by all interested parties.

The final output of PPBE is the submission of the DoD budget to the President for approval and to Congress for authorization and appropriation. The DoD budget now becomes part of the President's budget.

A.4.1.4. PPBE—Budget Execution

Current year budget execution begins on October 1, around the same time that the Planning phase begins for the following year. During execution, funds are allocated, obligated, and expended to accomplish DoD's plan. In addition, execution entails the rigorous monitoring and reporting of actual results to budgeted, anticipated results, along with causes of variances and planned corrective actions, if necessary.

The Budget Execution phase begins when the President signs the appropriations bill. Appropriations—the most common means of providing budget authority—allow federal agencies to incur obligations and make payments from the Treasury for specified purposes. The major DoD appropriations categories are:

- Research, Development, and Test and Evaluation (RDT&E)
- Procurement
- Shipbuilding and Conversion (SCN)
- Operation and Maintenance (O&M)
- Military Personnel (MILPERS)
- Military Construction (MILCON)
- Defense Working Capital Fund (DWCF).

Budget execution and performance reviews allow DoD to assess the allocation of resources and determine whether the Department is achieving its planned performance goals against budget estimates. Throughout the Execution phase—but at least quarterly—OUSD(C) and the Director, Program Analysis and Evaluation (DPA&E) review program performance using metrics that were integrated into the budget during the Programming and Budgeting phases. To the extent that a program fails to meet performance goals, recommendations may be made either to replace the program or to adjust funding as appropriate. As a result, programs are adjusted throughout the year to meet emerging conditions. At mid-year, comprehensive reviews of all performance indicators are conducted throughout DoD and programs are adjusted as required.

A.4.2. Advocate's Capability List

Service advocates are responsible for developing and maintaining capability campaign plans and a list of capability gaps within their respective domains. The Advocate's Capability List (ACL) is a prioritized list of capability gaps and associated warfighting programs and R&D efforts that the advocate desires to have considered during the POM development process. In preparing the ACL, the advocate must consider the requirements of current strategic and joint planning guidance as well as evaluating the sufficiency of the existing program of record currently funded. ACL development and preparation is coordinated with the operating forces, the S&T community, the R&D community, PEOs, program offices, and other supporting commands.

Within the Marine Corps, the ACL is the vehicle by which capability priorities are conveyed to the programmers and resourcing official. The ACL serves as the interface between EDFS and the POM development process.

Navy does not produce an ACL. Annual sufficiency analysis within focus areas of each MCP domain produces a prioritized list of capability gaps for consideration and integration within the overarching Naval Capability Pillar (NCP) analysis which serves as a Front End Assessment for the POM development process.

A.4.3. Integrated Capabilities List

The Integrated Capabilities List (ICL) is a service specific compilation of key crosscutting issues and capabilities derived from the Marine Corps' Advocate Capabilities Lists and from the NCP analysis for the Navy's investment and R&D accounts. The Navy also produces ICLs that provides context to the services' planning guidance for POM development. While both the Navy and Marine Corps produce ICLs, the process for their development and value-added to the POM development process vary.

Marine Corps' ICL is the MAGTF Capabilities List (MCL). The MCL is developed by the Command Element Advocate (CG, MCCDC) in conjunction with the other advocates and MARFORs. The MCL is typically an alphabetized listing of key capabilities for consideration in the POM, although a prioritized listing has been developed in past years. As with the ACLs, the MCL is an input to POM development and is not in competition with that process's prioritization and resourcing procedures.

Navy produces no fewer that four ICLs referred to as Integrated Strategic Capability Plans (ISCPs), although PR-07 guidance refers to ISCPs as Integrated Sponsor Capability Programs. The ISCPs detail the level of funding required to support minimum Navy requirements in the respective domains, plus plans for additional levels of support that could be provided if additional dollars were made available.

The ISCP produced by N7 for warfighting capabilities is more contentious than other ISCPs because it impacts over 60% of the Navy Total Obligation Authority. Drawing upon the NCP analyses, the N7 ISCP outlines an investment strategy to produce capabilities that ultimately is used to provide programming guidance the resource sponsors. The ISCP is produced in coordination with CFFC and results in a prioritized list of capabilities. Typically, the prioritized list is not a rank and file listing of all Navy programs within the POM, but is a short list of new start programs and existing programs that are of a high priority.

A.4.4. USMC POM Development Process

The Programming Phase of the PPBE cycle translates the concepts and capabilities developed during the Planning Phase into programmatic language. Using external guidance, the POM is built by way of "Top-down" guidance, yet is built "Bottom up," as described below. The basic steps, detailed below, are: Core and Initiative construction, Initiative prioritization, Program merge, and Funding.

Central to the process is the work of the various working groups, formed by DC, P&R, and comprised of members from throughout Headquarters Marine Corps and Fleet Commands. The Program is built through the use of three action groups: the Program Evaluation Groups (PEG), the Program Working Group (PWG), and Program Review Group (PRG). Each group considers requests for funding of specific programs in order to neck down the total unconstrained list of programs to a balanced POM recommendation to CMC.

DC, P&R controls the program process via the publication of period POM Serials, describing either the overall or schedule specific policies for that specific POM cycle. The process elements are:

- **<u>Core Construction</u>**. The Marine Corps builds the program starting with a clean slate. However, recognizing that certain past decisions must be honored and that some of the program is slated towards the "cost of doing business" within the Corps, DC, P&R identifies which individual programs should be earmarked for funding without having to submit them through the development process. Those identified programs constitute what is termed the POM Core and are articulated in the "Program Cores" POM Serial. The portion of those programs that is identified as "Core" does not compete through the rest of the process and is therefore considered "in" the POM under development.

- **<u>Initiative Construction</u>**. Those program requests that are not placed in Core then compete for remaining funds throughout the FYDP. Field Commands and

Headquarters Departments are then queried for program requests for funding across all disciplines in the Marine Corps.

- **Program Evaluation Group (PEG)**. DC, P&R convenes six PEGs to start the POM construction process: The Investment, Operations and Maintenance, Blue-in-Support of Green, Military Construction, Family Housing, and Manpower PEGs. Each PEG is comprised of action officers that are considered "duty experts" in each specific appropriation category.

- **Initiative Prioritization**. The PEG scrutinizes each initiative for relevance to requirements and required operational and support capabilities and compares the request to all other initiatives submitted to that PEG. Through discussion, statistical decision support, and majority vote, the PEG produces a prioritized list of initiatives in descending order of importance to the Corps.

- **Program Working Group (PWG)**. The PWG is an eleven-member committee which is chaired by the Programming Development Officer at P&R (Code RPD), and consists of representatives from the major Departments at HQMC, MCCDC, and MARCORSYSCOM. The PWG's mandate is to construct the draft POM for CMC approval.

- **Program Merge**. The PWG links all forwarded initiatives to all required capabilities listed in the Marine Corps Master Plan (MCMP), considering the assigned priorities within the MCMP and merges all PEG lists into one prioritized list, including individual benefit of each initiative to the Marine Corps, as a whole.

- **Funding**. During PWG deliberations, OSD publishes Fiscal Guidance to the Department of the Navy (DoN), assigning the Top Line fiscal controls by Fiscal Year throughout the FYDP. The Marine Corps and Navy have a Memorandum of Understanding (MOU) on file which defines how to calculate that portion of the DoN assigned resources that are to be assigned to the Marine Corps for program planning purposes. The percent of the DoN guidance that transfers to the Marine Corps is termed as the "Blue-Green Split." The PWG then assigns funding levels to specific programs on their prioritized list. It is the responsibility of the PWG to balance the sum of funding of all programs within the draft POM with the results of the Blue-Green split. The resultant draft POM, termed the Tentative POM or "T-POM" is forwarded to the Program Review Group (PRG) for endorsement and to CMC for approval.

- **Program Review Group (PRG)**. The PRG is a flag level committee, chaired by DC, P&R, and comprised of CG, MCCDC, Deputy Chiefs of Staff throughout HQMC, and COMMARCORSYSCOM. The PRG reviews the T-POM, amending it as necessary prior to forwarding to Executive Steering Group (ESG).

- **Executive Steering Group (ESG)**. The ESG has the final chop on the T-POM prior to submission to CMC for approval. The ESG is chaired by the ACMC and consists of the top executive level leadership within the Marine Corps.

- **POM Submission**. Once CMC approves the T-POM, sponsors are tasked, by DC, P&R, to convey the T-POM through the OSD accepted format for submission. OSD publishes the accepted formats through a POM Preparation Instruction (PPI). Ultimately, the Department of the Navy submits one POM, which consists of the Navy and Marine individual Programs. DC, P&R is responsible to CMC for submission of the Marine Corps portion of the DoN POM in approved PPI format.

A.4.5. USN POM Development Process

Navy's POM development process is dynamic and is governed year to year by POM or PR Assessment serials promulgated by N8. As such, the process changes annually. Nonetheless, the Navy's POM development typically follows a general pattern, albeit undocumented.

POM development commences with the identification of issues to be considered during the process. Similar in nature to the Marine Corps initiative construction, issues generally reflect under-funded programs or new emerging capabilities that are required by the operating forces. Resource sponsors, SYSCOMS, PEOs, and the Fleet submit issues that form the underpinning for preliminary focus area assessments. The resource sponsors and mission capability package leads conduct focus area assessments. These assessments are then presented at the 3-star level for review. The results of these assessments then lead to the development and issuance of the CNO's investment strategy.

The CNO investment strategy, developed by N81, provides general guidance to resource and capability sponsors for developing a balanced program within respective capabilities areas and for incorporating key issues identified by the initial focus area assessments. This guidance leads to the development of capability plans and mission capability plans by the resource and capability sponsors. The plans almost always include:

- Integrated Strategic Capabilities Plan by N6/7 covering the Navy's investment accounts and RDT&E
- SCN and APN Plans by N6/7 addressing shipbuilding and aircraft needs
- Integrated Readiness Capabilities Assessment by N4 evaluating operating and support funding
- Manpower Review by N1 assessing the adequacy of manpower and personnel funding

Following capability plan briefings at the 3-star level, N8 issues Fiscal and Programming Guidance to the resource sponsors for development of the Sponsor Program Proposal (SPP) and, to N7 for development of the Integrated Sponsor Program Proposal (SPP). Fiscal and Programming Guidance is directive in nature. It apportions the Navy's total obligational authority (TOA) among the resource sponsors and directs that resource sponsors remain within year-to-year top line controls. Historically, approximately 65% of Navy's TOA is placed in the investment and RDT&E accounts controlled by N6/N7. 25% of TOA is for operating and support costs. Manpower and personnel accounts for approximately 5% of TOA. The remaining 5% is divided between all other resource sponsors.

Fiscal and Programming Guidance also directs resource sponsors to include major initiative that were developed during the initial focus area assessments and capability plans in respective Sponsor Program Proposals. Once submitted and vetted at the 3-star level, the SPPs and ISPP are integrated by N80 to form Navy's Tentative POM (T-POM). N80 reviews the T-POM for compliance with Fiscal and Programming Guidance. N81 review the T-POM to ensure the objectives of the CNO Investment Strategy have been met.

In a process know as "the end game", the Navy staff reviews the T-POM through the CNO Executive Board, chaired by CNO. At this review, CNO is presented with staff versions of the SPPs and with recommendations from the overall POM reviewers, who are striving for balance and coherence across all the SPPs. On the basis of this final review, the Navy POM is assembled for presentation to SECNAV for review and approval.

A.5. NFDS Phase IV (Capability Acquisition, Fielding, and Transition)

Phase IV of the Naval Force Development System, shown in Figure A-10, follows the DoD 5000 series five-phase process for Defense acquisition. Within Phase IV acquisition related milestones, reviews and documents, test and evaluation events, and certification processes, including Strike Force certification, are described and process owners are identified.

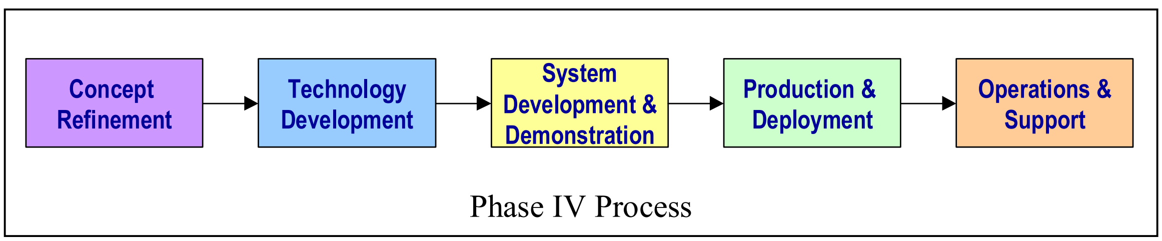

Figure A-10: Capability Acquisition, Fielding and Transition

Phase IV of NFDS is the culmination of DoN's capability-based approach to define, develop, and deliver military capability and is dependent upon the products and processes of the previous phases. Three characteristics distinguish this phase from the first three phases of NFDS.

First, acquisition, fielding, and transition are discrete events that occur sequentially. Each has its own governing process. In most cases, governance is determined by the nature of the capability being acquired and the platform on which the capability will be installed.

Second, processes external to NFDS govern acquisition and fielding. Linkage of these external processes to the other phases of NFDS is established by the ICD and campaign plans developed in Phase II and the POM submission that is developed in Phase III.

Lastly, acquisition, fielding, and transition do not adhere to a specified timeline. These activities can and will span multiple cycles of other NFDS phases. As such, NFDS must continuously review the capabilities being acquired for relevancy and ensure stable funding is provided to ensure timely realization of new warfighting capabilities.

A.5.1. Defense Acquisition System Overview

The Defense Acquisition System (DAS) is the management process by which DoD provides effective, affordable, and timely systems to the users. DoD Directive 5000.1 defines this process. DoD Instruction 5000.2 implements the DAS management process. This process, integrates both statutory and regulatory requirements for acquisition programs and is divided into five distinct phases as shown in Figure A-11. These phases are: Concept Refinement; Technology Development; System Development and Demonstration; Production and Deployment; and Sustainment. A detailed examination and explanation of this process can be found at http://akss.dau.mil/ifc/index.htm.

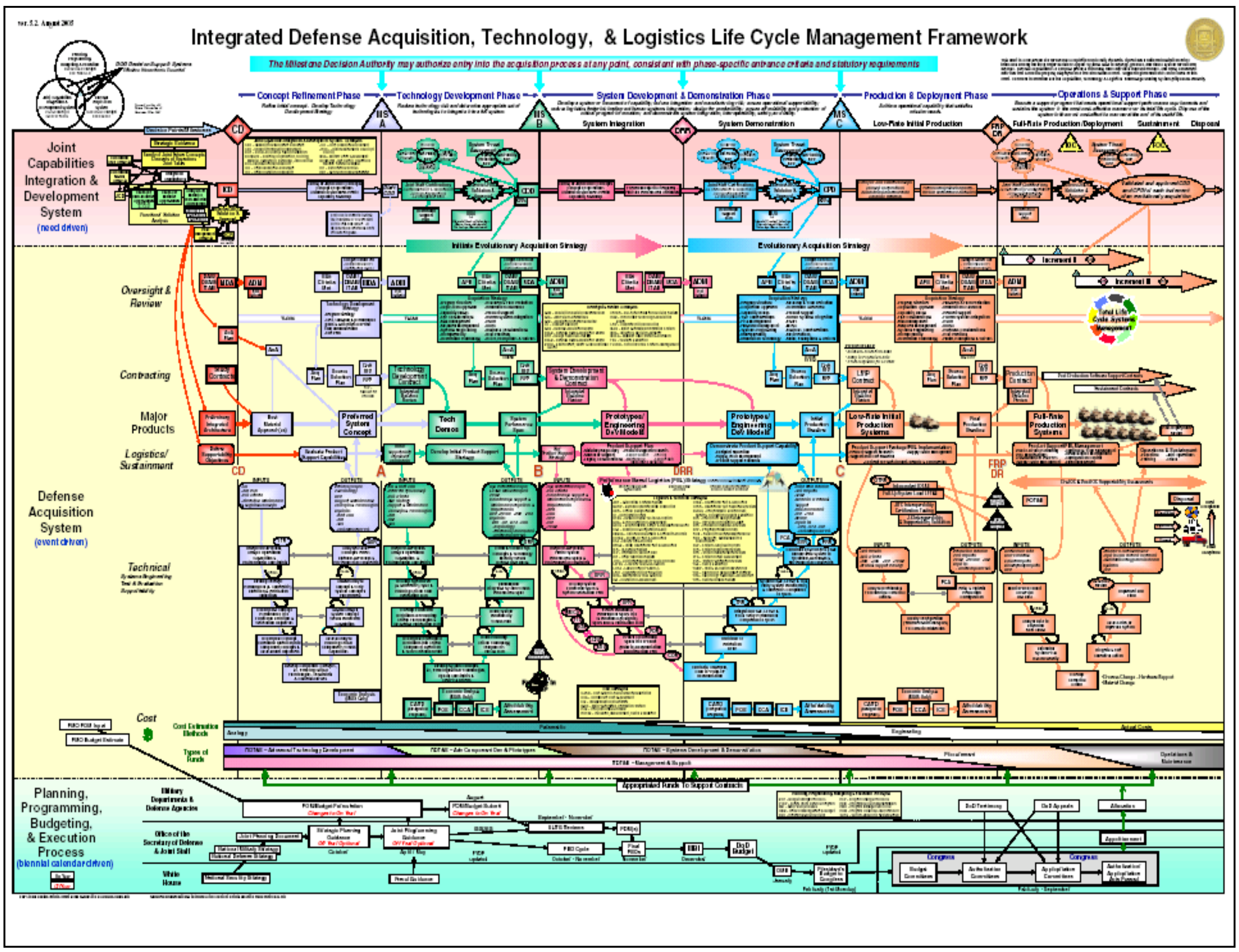

Figure A-11: The Defense Acquisition System

Operation of the DAS by the services is the responsibility of the Component Acquisition Executive (CAE), also known as the Service Acquisition Executive (SAE). The CAE for the Navy and Marine Corps is the Assistant Secretary of the Navy for Research, Development and Acquisition (ASN (RDA)). ASN(RDA) implements and further refines the DAS in SECNAVINST 5000.2.

By defining the interfaces of the first three phases of NFDS with DAS and simplifying the overall process, the scope of Phase IV is established as shown in Figure A-12. The interfaces are shown as occurring at major decision points within the acquisition process.

For ACAT ID and ACAT IM programs the Milestone Decision Authority (MDA) resides at the OSD level with USD(AT&L) and ASD(NII), respectively. For all other Navy and Marine Corps ACAT I and II programs, ASN(RDA) is the MDA unless delegated. The MDA for ACAT III and IV programs can be a SYSCOM, Program Executive Officer (PEO), or Direct Reporting Program Manager (DRPM) as delegated by ASN(RDA).

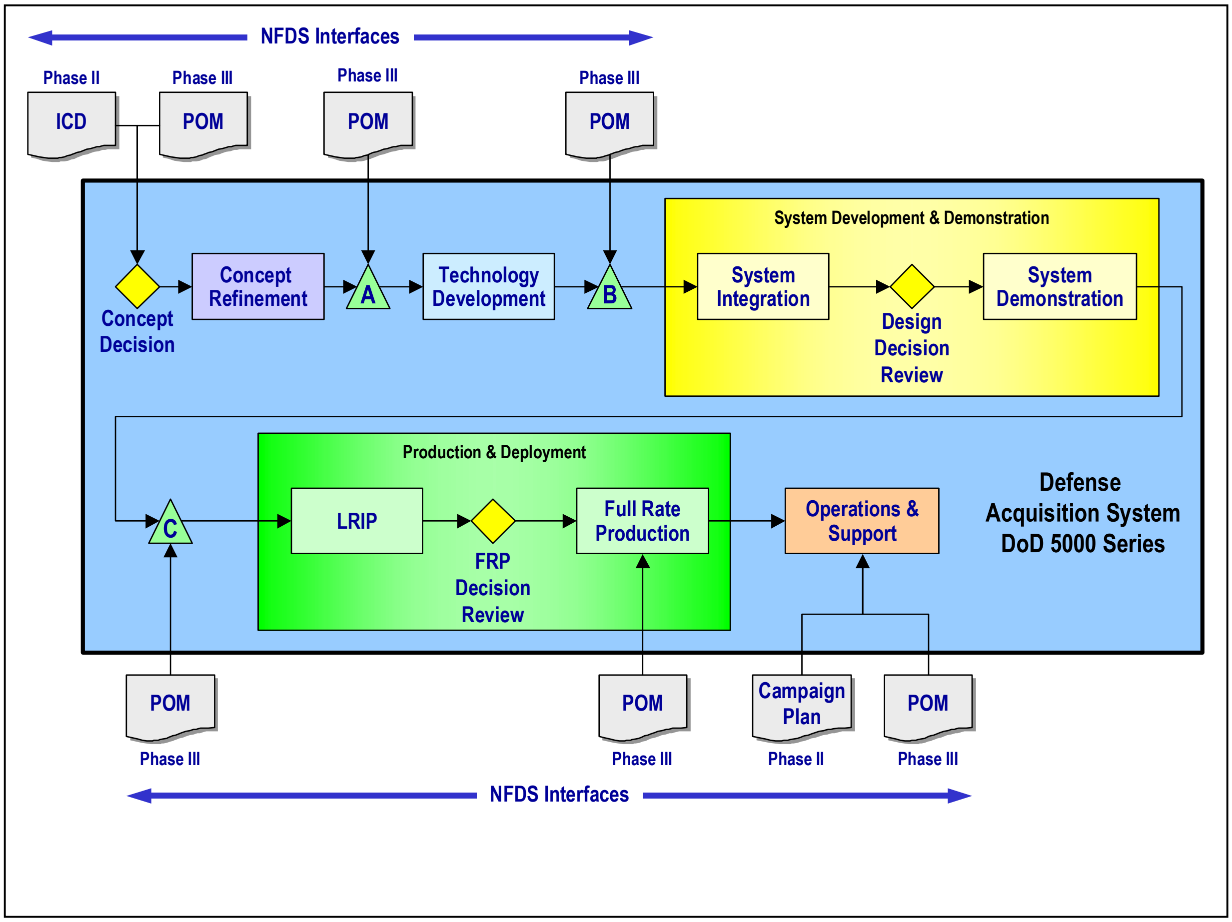

Figure A-12: NFDS Interfaces to the DAS

It is important to understand the major milestone, reviews, assessments, and documentation that occur within DAS and the potential influences NFDS may have on capability acquisition, transition, and fielding. These milestones, reviews, assessments, and documents as they occur with the overall DAS process are shown in Figure A-13.

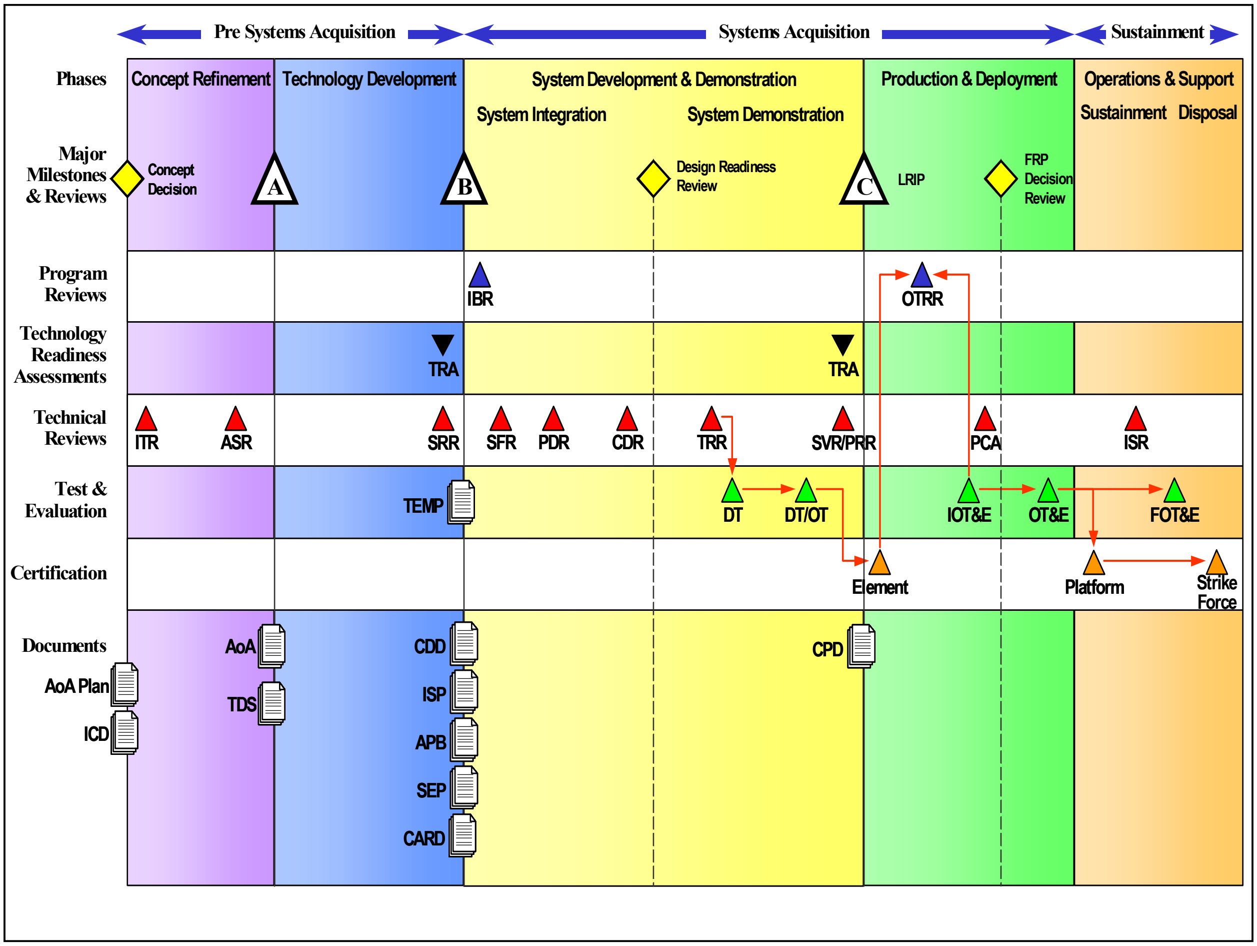

Figure A-13: DAS Major Milestones and Reviews

A.5.2. Concept Refinement Phase

Concept Refinement begins with the Concept Decision. The purpose of this phase is to refine the initial concept and develop a Technology Development Strategy (TDS). Entrance into this phase is dependent upon an approved ICD developed in NFDS Phase II and an Analysis of Alternatives (AoA) plan. This effort is normally funded only for the concept refinement work. The MDA designates the lead DOD Component(s) to refine the initial concept, approves the AoA plan, and establishes a date for a Milestone A review. The MDA decision is then documented in an Acquisition Decision Memorandum (ADM).

The ICD and the AoA plan guide Concept Refinement. The focus of the AoA is to refine the selected concept documented in the approved ICD. The AoA assesses the critical technologies associated with these concepts, including technology maturity, technical risk, and, if necessary, technology maturation and demonstration needs. To achieve the best possible system solution, emphasis is placed on innovation and competition. The results of the AoA provides the basis for the TDS that is approved by the MDA at Milestone A for potential ACAT I and IA programs.

The TDS documents the rationale for adopting an evolutionary or a single-step-to-full-capability strategy. For an evolutionary acquisition, either spiral or incremental, the TDS also includes a preliminary description of how the program will be divided into technology spirals and development increment. Additionally, the TDS details:

- The program strategy, including overall cost, schedule, and performance goals for the total research and development program
- Specific cost, schedule, and performance goals, including exit criteria, for the first technology spiral demonstration
- A test plan to ensure that the goals and exit criteria for the first technology spiral demonstration are met.

Two technical reviews occur during Concept Refinement. The Initial Technical Review (ITR) is conducted to support the program's initial POM (Program Objective Memorandum) submission. The Alternative Systems Review (ASR) is conducted to ensure that the resulting set of requirements agrees with the customers' needs and expectations and that the system under review can proceed into the Technology Development phase.

Concept Refinement ends when the MDA approves the preferred solution resulting from the AoA and approves the associated TDS.

A.5.3. Technology Development Phase

The Technology Development Phase commences at Milestone A when the MDA approves the TDS. This effort normally is funded only for the advanced development work and does not mean that a new program has been initiated. The exception to this is shipbuilding programs. New construction ships are initiated at the beginning of Technology Development. The purpose of this phase is to reduce technology risk and to determine the appropriate set of technologies to be integrated into a full system.

Technology Development is a continuous technology discovery and development process that requires close collaboration between the S&T community, the user, and the system developer. It is an iterative process designed to assess the viability of technologies while simultaneously refining user requirements. The ICD and the TDS guide Technology Development. Multiple technology development demonstrations may be necessary before the user and developer agree that a proposed technology solution is affordable, militarily useful, and based on mature technology.

During Technology Development, several key documents are produced that will guide the remainder of the capability development and acquisition process. The Capability Development Document (CDD) builds on the ICD by refining the integrated architecture and providing more detailed operational mission performance parameters necessary to design the proposed system. The CDD is the primary means of defining authoritative, measurable and testable capabilities needed by the warfighters to support the System Development and Demonstration phase. The CDD captures the information necessary to develop the proposed program and outlines an affordable increment of militarily useful, logistically supportable and technically mature capability. The CDD is a JCIDS document and is approved by the same process as the ICD.

As the CDD is being developed to support Milestone B, and program initiation, a more comprehensive T&E Strategy is documented in the Test and Evaluation Master Plan (TEMP). The TEMP, produced by the Program Manager, is a master plan that describes the total T&E planning from component development through operational T&E into production and acceptance. All programs on the OSD T&E Oversight List are required to submit a TEMP for OSD approval. Otherwise, the TEMP is approved by the components independent test and evaluation agency – Commander Operational Test and Evaluation Force (COMOPTEVFOR) for Navy and Marine Corps Operational Test and Evaluation Agency (MCOTEA) for the Marine Corps.

The APB is a statutory requirement that requires every program manager to document program goals prior to program initiation. The program manager derives the APB from the users' performance requirements, schedule requirements, and best estimates of total program cost consistent with projected funding. The CDD provides a threshold and an objective value for each attribute that describes an aspect of a system or capability to be developed or acquired. The program manager uses this information to develop an optimal product within the available trade space. APB parameter values represent the program as it is expected to be developed, produced and/or deployed, and funded. It only contains those parameters that, if thresholds are not met, will require the Milestone Decision Authority to re-evaluate the program and consider alternative program concepts or design approaches.

The Information Support Plan (ISP) explores the information-related needs of an acquisition program in support of the operational and functional capabilities the program either contributes to or delivers. The ISP provides a mechanism to identify and resolve implementation issues related to an acquisition program's Information Technology (IT), including National Security Systems (NSS), infrastructure support and IT and NSS interface requirements. It identifies IT needs, dependencies, and interfaces for programs in all acquisition categories, focusing attention on interoperability, supportability, synchronization, sufficiency and net-centricity concerns. This provides the program manager a mechanism to identify information-related dependencies, to manage these dependencies and to influence the evolution of supporting systems to meet the demands of the system as it evolves to meet the warfighter's needs. In the case where a specific supporting system will not be available, the ISP provides the program manager with awareness of this problem in sufficient time to adjust the program in the most cost effective and operationally efficient manner.

The Systems Engineering Plan (SEP) is a detailed formulation of actions that guides all technical aspects of an acquisition program. It describes the program's overall technical approach, including systems engineering processes; resources; and key technical tasks, activities, and events along with their metrics and success criteria. Program managers establish the SEP early in program formulation and update it at each subsequent milestone. It is intended to be a living document, tailored to the program, and a roadmap that supports program management by defining comprehensive systems engineering activities, addressing both government and contractor technical activities and responsibilities. The Milestone Decision Authority is the approval authority for the SEP.

Prior to proceeding to Milestone B, a System Requirements Review (SRR) and a Technology Readiness Assessment (TRA) are conducted, either independently or combined. The program manager conducts an SRR to ensure that the system under review can proceed into the System Development and Demonstration (SD&D) phase. The SRR ensures that all system and performance requirements derived from the Initial Capabilities Document (ICD) or draft Capability Development Document (CDD) are defined and consistent with cost (program budget), schedule (program schedule), risk, and other system constraints.

The TRA is a regulatory information requirement per DoDI 5000.2 performed by either COMOPTEVFOR or MCOTEA. The TRA is a systematic metrics-based process that assesses the maturity of Critical Technology Elements and is a requirement for all acquisition programs. The TRA scores the current readiness level of selected system elements, using defined Technology Readiness Levels, highlighting critical technologies and other potential technology risk areas requiring Program Manager (PM) attention. The TRA is forwarded by ASN(RDA) to DUSD(S&T) for concurrence. If DUSD(S&T) does not concur with the TRA findings, an independent TRA by DDR&E may be initiated.

The project exits Technology Development when an affordable increment of militarily useful capability has been identified, the technology for that increment has been demonstrated, and a system can be developed for production within a short timeframe. Alternatively, the MDA can decide to terminate the effort. Completion of Technology Development leads to a Milestone B decision and potential program initiation.

A.5.4. System Development and Demonstration Phase

The purpose of the System Design and Demonstration (SDD) phase is to:

- Develop a system or an increment of capability
- Reduce integration and manufacturing risk; ensure operational supportability with particular attention to reducing the logistics footprint; implement human systems integration (HSI)
- Design for producibility; ensure affordability and the protection of critical program information by implementing appropriate techniques such as anti-tamper
- Demonstrate system integration, interoperability, safety, and utility

SDD has two major efforts: System Integration and System Demonstration. The entrance point is Milestone B, which is also the initiation of an acquisition program. Each increment of an evolutionary acquisition has its own Milestone B. For Shipbuilding Programs, required program information is updated in support of the Milestone B decision. The lead ship in a class is normally authorized at Milestone B. Technology readiness assessments will consider the risk associated with critical subsystems prior to ship installation. Long lead for follow ships may be initially authorized at Milestone B, with final authorization and follow ship approval by the

MDA dependent on completion of critical subsystem demonstration and an updated assessment of technology maturity.

System Integration within SDD is intended to integrate subsystems, complete detailed design, and reduce system-level risk. The program enters System Integration when the PM has a technical solution for the system, but has not yet integrated the subsystems into a complete system. The CDD guides this effort. This effort typically includes the demonstration of prototype articles or engineering development models (EDMs).

The program manager conducts several key reviews during SDD to ensure the system being developed does not contain unacceptable technical risks and remains executable. The Integrated Baseline Review (IBR) is a formal review conducted by the program manager and technical staff, jointly with their contractor counterparts, following contract award to verify the technical content of the performance measurement baseline and the accuracy of the related resource (budgets) and schedules. An IBR is also performed when work on a production option of a development contract begins or, at the discretion of the program manager, when a major modification to an existing contract significantly changes the existing PMB. The intent is for the IBR to be a continuous part of the process of program management by both the government and the contractor.

The System Functional Review (SFR) is conducted to ensure that the system under review can proceed into preliminary design. The SFR ensures that all system requirements and functional performance requirements derived from the Capability Development Document (CDD) are defined and consistent with cost (program budget), schedule (program schedule), risk, and other system constraints. The SFR assesses the system functional requirements as captured in system specifications (functional baseline), and ensures that all required system performance is fully decomposed and defined in the functional baseline.

The Preliminary Design Review (PDR) is conducted to ensure that the system under review can proceed into detailed design, and can meet the stated performance requirements within cost (program budget), schedule (program schedule), risk, and other system constraints. The PDR assesses the system preliminary design as captured in performance specifications for each configuration item in the system (allocated baseline), and ensures that each function in the functional baseline has been allocated to one or more system configuration items.

The Critical Design Review (CDR) is conducted to ensure that the system under review can proceed into system fabrication, demonstration, and test, and can meet the stated performance requirements within cost, schedule, risk, and other system constraints. The CDR 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.

The Design Readiness Review (DRR) during SDD provides an opportunity for mid-phase assessment of design maturity as evidenced by measures such as the number of subsystem and system design reviews successfully completed; the percentage of drawings completed; planned corrective actions to hardware/software deficiencies; adequate development testing; an assessment of environment, safety and occupational health risks; a completed failure modes and effects analysis; the identification of key system characteristics and critical manufacturing processes; an estimate of system reliability based on demonstrated reliability rates; etc. Successful completion of the Design Readiness Review ends System Integration and continues the SDD phase into the System Demonstration effort. Although the program manager chairs the DRR, the MDA may determine the form and content of this review.

System Demonstration is intended to demonstrate the ability of the system to operate in a useful way consistent with the approved KPPs. The program enters System Demonstration when the PM has demonstrated the system in prototypes or EDMs. System Demonstration ends when a system is demonstrated in its intended environment, using the selected prototype; meets approved requirements; industrial capabilities are reasonably available; and the system meets or exceeds exit criteria and Milestone C entrance requirements. Successful development test and evaluation to assess technical progress against critical technical parameters, early operational assessments, and, where proven capabilities exist, the use of modeling and simulation to demonstrate system integration are critical during this effort. The completion of this phase is dependent on a decision by the MDA to commit to the program at Milestone C or a decision to end this effort.

The Test Readiness Review (TRR) occurs after subsystems have undergone developmental testing and evaluation (DT&E) by the contractor and is conducted to ensure that the subsystem or system under review is ready to proceed into formal testing. The TRR assesses test objectives, test methods and procedures, scope of tests, and determines if required test resources have been properly identified and coordinated to support planned tests. Depending on the program, additional reviews, such as a Flight Readiness Review in the case of aircraft, are included in the Systems Engineering Plan. Upon successful completion of the TRR, the program commences formal DT&E.

DT&E integrates the subsystems into the defined system and demonstrates the integrated system under its operational environment constraints. This verifies that the system meets performance and functionality requirements, and validates the use of the system in its intended environment. This phase of testing also includes any live fire test and evaluation (LFT&E) and operational assessments of the integrated system. All integration and interface issues must be resolve prior to proceeding to combined DT&E and operational testing and evaluation (OT&E).

Combined DT&E and OT&E verifies and validates the integrated system against the specified operational requirements within the required operational environment to ensure the system can satisfy operational expectations. The developmental and operational test environments and scenarios must be defined, and cost, schedule, and performance considerations must be continually addressed. This involves interoperability and interfaces for the system within any system of systems in which it operates. Interface and interoperability issues for the system must be resolved for the system to achieve its interoperability certification in the next phase. Operational supportability is also confirmed at this time. In preparation for the Production Readiness Review (PRR), Combined DT&E and OT&E confirms that the manufacturing processes are under control and that there are no significant manufacturing risks.

The PRR is convened by the program manager to determine if the design is ready for production and the producer has accomplished adequate production planning without incurring unacceptable risks that will breach thresholds of schedule, performance, cost, or other established criteria. The program manager typically conducts a System Verification Review (SVR) and the PRR by the same group and at the same location.

The SVR is conducted to ensure that the system under review can proceed into Low Rate Initial Production (LRIP) and Full Rate Production (FRP) within cost (program budget), schedule, risk, and other system constraints. The SVR is an audit trail from the CDR and assesses that the system final product, as evidenced in its production configuration, meets the functional requirements as derived from the CDD and draft Capability Production Document (CPD) to the functional, allocated, and product baselines.

The final step in System Development and Demonstration is the development of the CPD that is due at Milestone C. The CPD captures the refined, desired operational capabilities and expected system performance and is used to update the TEMP for the Milestone C decision and for subsequent updates later in Production and Deployment, such as the full rate production decision review.

A.5.5. Production and Deployment

Milestone C approves entry into the Production and Deployment Phase and authorizes low rate initial production (LRIP). At Milestone C, technical testing begins to focus on production testing to demonstrate performance of the production system in accordance with the contract. Operational testing focuses on evaluating the system's operational effectiveness, suitability, and survivability.

Prior to commencing initial operational test and evaluation (IOT&E), an Operational Test Readiness Review (OTRR) is conducted to ensure that the production configuration system can proceed into testing with a high probability of success. The OTRR is complete when the CAE favorably evaluates and determines that the system is ready to commence IOT&E.

IOT&E is conducted on production or production representative articles to determine whether the systems are operationally effective and suitable. IOT&E is performed by DOT&E for items on the OSD Test and Evaluation Oversight List. COMOPTEVFOR or MCOTEA performs IOT&E for all other Navy and Marine Corps programs, respectively. Favorable completion of IOT&E is used to support the decision to proceed beyond LRIP and into full rate production (FRP).

Prior to the FRP decision, the program manager performs a Physical configuration Audit (PCA). The PCA examines the actual configuration of the system being produced in order to verify that the related design documentation matches the item as specified in the contract. In addition, the PCA confirms that the manufacturing processes, quality control system, measurement and test equipment, and training are adequately planned, tracked and controlled.

At the FRP Decision Review, the MDA approves full rate production and issues an acquisition decision memorandum. Additionally, the acquisition strategy and APB are updated and exit criteria are established if required. Provisions for evaluation of post-deployment performance are also established.

After deployment, In-Service Reviews (ISRs) are periodically conducted to ensure that the system under review is operationally employed with well-understood and managed risk. The ISR is intended to characterize the in-service technical and operational health of the deployed system by providing an assessment of risk, readiness, technical status, and trends in a measurable form that will substantiate in-service budget problems.

A.5.6. Operations and Support

The Operations and Support Phase of the Defense Acquisition System overlaps with the Full-Rate Production and Deployment Phase. Operations and Support is divided into two sub-phases; sustainment and disposal. This phase establishes and provides a support program that meets the operational support requirements and sustains the system in the most cost effective manner over its total life cycle. At the end of the system's useful or operationally relevant life, this phase provides for the most cost-effective disposal.

Sustainment starts immediately upon fielding or deployment of a new system. The purpose of this phase is to maintain readiness and operational capability of deployed systems and to conduct modification and upgrades to hardware and software.

Navy's fielding and deployment of new systems is accomplished at the platform level with aircraft, ships, and submarines each having unique processes directly tied to Fleet modernization and support Navy's deployment strategy – the Fleet Response Plan. While variations exist between the modernization programs, each is intended to reduce cost and minimize the numbers of system variants deployed in the Fleet.

NAVRIPP, the Naval Aviation Readiness Integrated Improvement Program, commenced in August 2001 when the CNO tasked Commander, Naval Air Forces Pacific with the responsibility of overseeing all of Naval Aviation. This tasking included implementing a comprehensive program to make fundamental process changes in the way the Navy provides manpower, equipment, and training to stateside Naval Aviation commands between deployments. NAVRIIP defines and executes changes that sustain near and long term aviation readiness goals with the primary goal being to balance and align interactions among operational level maintenance, intermediate level maintenance and the logistics infrastructure that support them to achieve cost-wise readiness.

Most submarine modernization is accomplished through the execution of requirements contained in the Joint Fleet Maintenance Manual. SUBMOD, however, is aimed at selected systems on 688/688I, SEAWOLF, Trident, SSGM, and Virginia class submarines. SUBMOD provides the submarine fleet a common, integrated Submarine Warfare System (SWS) through the use of commercial-off-the-shelf hardware and open architecture to the maximum extent possible. The technical approach to the SWS modernization process is to provide the over-arching system engineering discipline required to successfully acquire, integrate, test, install, and field a modernized "system of systems" for submarine platforms. By achieving commonality across all platforms, SUBMOD will reduce hardware, software, logistics, and training costs for the fleet.

Ship modernization for surface combatants, aircraft carriers, and amphibious ships is accomplished through SHIPMAIN and the C4I and Combat Systems Modernization Process (C5IMP). SHIPMAIN and C5IMP are complimentary processes, each of which is managed by CFFC.

SHIPMAIN is a Navy-wide initiative to create a surface ship maintenance and modernization program that supports the vision of Sea Power 21 and its "culture of readiness." It replaces the hierarchy of over forty different types of alterations, modifications, and field changes with a single streamlined process and establishes funding stability. The overarching vision of SHIPMAIN is for all modernization is approved for funding is installed within three years. The flag officer management team for SHIPMAIN includes Fleet, OPNAV, SYSCOM, and PEO representation.

C5IMP is aligned with SHIPMAIN and is intended to improve Fleet interoperability by the reduction in the number of warfare system variants. It is applicable to all C5I hardware, software and firmware installed afloat and ashore including FORCEnet and Sea Trial initiatives, ACTDs and prototypes. Objectives of C5IMP include ensuring that:

- Strike group units receive improved, interoperable & certified war fighting technologies in order to achieve the highest possible degree of war fighting capability and readiness
- Capabilities are provided with the proper training, integrated logistics and support
- All shipboard skills and training requirements are met
- Modernization is completed on or before a unit's target configuration date (TCD) in order to support the units basic training phase and timely achievement for emergency surge status
- Certification policy supports system operability/interoperability as well as a unit's safety, training and readiness
- All alterations are fully funded through integration of alteration planning and approval with the POM process

The recently issued Joint SYSCOM instruction on Naval Warfare System Certification Process (NWSCP) responds to C5IMP certification requirements and is applicable to new and upgraded warfare system installed elements on ships subject to C5IMP base-lining.

Certification of new systems occurs at three levels. An element level certification occurs prior to installation of the new system. This certification, issued by a PEO, SYSCOM, or DRPM certifies that the system element or elements are ready to proceed to platform-level certification testing. It includes assessments of performance, design, standards, quality, and human systems integration among other things.

Once a system element has been installed, a platform-level certification provides an assessment of the warfare system operational capability. This certification ensures that all warfare systems that interface with the new system element meet minimum mission requirements and exhibit stable and reliable performance. Platform level certification authorities are:

- SEA 05 for shipboard warfare support systems (HM&E)
- SEA 06 for shipboard warfare systems
- SEA 07 for non-strategic submarines
- NAVAIR for aircraft and shipboard aviation systems
- MARCORSYSCOM for MARCOR systems

The third level of system certification is Strike Force Interoperability Certification and is applicable to surface combatants, aircraft carriers, and amphibious ships. Strike Force Interoperability Certification ensures that all warfare systems on a platform provide a unified, coherent, optimized, and stable warfighting capability. This certification also extends to all shipboard embarkables such as aircraft or Marine Expeditionary Units. This process is aligned with SHIPMAIN and is administered by SEA06.

Appendix B: Management Approach

B.1. Management Challenge

Naval Forces are constituted from building blocks of surface ships, submarines, aircraft, land units and the C4ISR infrastructure that integrates them into a cohesive fighting force. Traditionally, both requirements and acquisition communities have organized around these units because each have unique operating environments, engineering challenges, design practices and supporting technologies that require specialized expertise and a community of practitioners that must be sustained. Thus, this management approach typically aligned the organizations responsible for decision making for platforms and the systems to be installed. This platform-centric approach while it is necessary, and must be retained, is not sufficient in the networked system environment envisioned in the future. The new network-centric approach will demand systems installed in various units, and resourced, acquired and operated by multiple communities, to be engineered and operate with each other as a SoS. Capability delivered by a SoS will require a new management approach for making decisions relative to resourcing and acquiring systems.

B.2. Management Approach

The NCEP management approach is to perform systems engineering at the SoS level through the use of system engineering integrated product teams (SE IPT) avoiding the creation of new formal organizations, and to implement a governance process to make the SE IPT effective by using existing processes where possible. Further, the approach retains the platform focus necessary to engineer and deploy systems, and preserves the authority of Program Managers and their relationship to their resource sponsors.

B.2.1. System Engineering Integrated Product Team (SE IPT)

Mission focused SE IPTs aligned to the NCDP, and the EFDS Expeditionary Warfare Capabilities List, will be the basis for execution of the NCEP. SE IPTs will be established by ASN (RDA) for programs entering the acquisition process as part of a SoS. An SE IPT chair will be designated by and report to ASN (RDA). The Chair will be responsible for developing a Systems Engineering Plan that includes formal technical reviews and decision points. The Chair of the SE IPT will organize the team around the key issues and risks identified in the plans and for executing the plans. The organization and membership will vary between Capability Evolution Planning, Capability Engineering and Portfolio Execution processes. Participants will include program office (government and industry), SYSCOM personnel that support the portfolio programs, and the resource sponsors and fleet personnel representing the warfighter.

B.2.1.1. SE IPT Roles

SE IPT members play two roles: first, they perform the work necessary to execute the plans and build the SE IPT products; and second, they represent their organizational interests within the SE IPT. Thus in the case of portfolio program members, they are expected to bring knowledge and expertise to perform engineering and analytical analyses, they are expected to make the SE IPT aware of decisions that may adversely affect their programs, and they are expected to keep their Program Managers aware of the effect of SE IPT actions on their program. In the case of members representing resource sponsors and the fleet, they must assure that the SE IPT analyses are based on current operating doctrine and are consistent with the NCDP guidance.

In the Capability Evolution Planning and Capability Engineering processes, the objective of the SE IPT is to achieve the most value-added fit into a SoS for programs entering acquisition. This objective can only be achieved through collaboration between SoS programs to achieve a balance in capability, cost and risk. The activities necessary to accomplish this balance are primarily pre-Milestone B and serve as the basis to baseline programs entering the acquisition process for execution by the Program Manager.

B.2.1.2. SE IPT Activities and Products

SE IPT activities will specifically focus on executing the NCEP Capability Evolution Planning, Capability Engineering, and Portfolio Execution processes. The conduct of these technical activities will necessitate extensive interaction and coordination across the organizations and programs responsible for acquiring, delivering and supporting the systems within the acquisition portfolio. The SE IPT serves as a forum for vetting and resolving the SoS cross-cutting issues within the portfolio.

Specific products to be generated by the SE IPT include:

- Current, Planned, and Objective Portfolio Architectures
- Capability Evolution Plan
- System Performance Document
- Integrated Architecture Model
- Portfolio Functional Design Model
- Portfolio Physical Design Model
- Integration and Interoperability Test Matrix
- Portfolio Integrated Schedule
- Portfolio Assessments
- Human Systems Integration Plan
- Distance Support Plan

B.2.2. NCEP Governance

The NCEP governance process is consistent with current acquisition policy, i.e., delegate to the lowest level. Three levels of governance are provided: Peer, PEO and Executive Committee.

B.2.2.1. Peer, or SE IPT level

The Peer level is chaired by the SE IPT Chair. The purpose of the Peer review is to vet technical issues and the related impacts on individual program costs and schedule. The Peer level allows Program Managers to challenge technical decisions made by the SE IPT and present recommended alternatives. SE IPT decisions may affect the allocation of functions, performance constraints (e.g., error budgets and time allocations) and interface requirements between portfolio systems that may also affect cost and/or schedule. Program Managers, resource sponsors and fleet stakeholders will participate to advise the SE IPT Chair.

B.2.2.2. PEO Council

The PEO Council is chaired by ASN (RDA) or his designee. Substantive issues that remain unresolved at the Peer level will be elevated to the acquisition executive for decision. The purpose of this level is to make executive decisions that will likely effect a program's structure and potentially require OPNAV staff/Marine Corps Program Advocates or SECNAV approval. These decisions will typically involve two or more programs in the portfolio overseen by two or more PEOs, and will address areas such as technology readiness road maps, acquisition program baseline thresholds, program funding profiles that require reprogramming and the development of issue papers, or capability fielding plans. Preparation will generally be led by and coordinated through the PEO's Office of Systems Engineer, or Technical Director. Affected PEOs, resource sponsors and Fleet stakeholders will participate to advise the Council Chair.

B.2.2.3. Executive Steering Committee

The Executive Steering Committee is co-chaired by ASN (RDA) and the Vice Chief of Naval Operations/Assistant Commandant of the Marine Corps or their Designee. The purpose of this level is to assess progress of portfolio execution and make decisions necessary to re-align resources with acquisition program plans where failure to do so will significantly degrade a capability increment. These issues will typically be responsive to budgeting and programming actions to PEO generated issue papers. Preparation will be consistent with the procedures followed by the existing Executive Steering Committees. Affected PEOs, resource sponsors and Fleet stakeholders will participate to advise the Committee Co-Chairs.

Appendix C: Role of DoDAF Products

C.1. Background

There are several DoD regulations and instruction manuals that impose architecture product generation requirements on program managers. These products must be reported in the DODAF format to support the program's acquisition lifecycle. First, they serve a regulatory function. In this role, a standard set of products is produced so that a program's status and compliance with Federal statutes and the DoD acquisition process can be objectively assessed. Second, these products enable programs to compare engineering data, such as interface requirements, with other programs. This greatly simplifies the generation of ICDs and other similar documents.

Ideally, these required architecture views don't require any additional effort on the part of the PM. When a program is organized correctly, the engineering data needed to generate these required products is already present within one or more engineering data repositories. Generation of DODAF products should be viewed as an iterative process supporting the systems engineering process, and should be updated periodically, as decisions are made that affect the architecture. Generating DODAF products does not alleviate the need to perform engineering analyses and design functions

The CHENG's role in regulatory compliance and normalizing architecture views between programs is located in the SECNAVINST 5000.2C. The CHENG will assist PMs with the translation of concepts into operational and systems architecture views. The CHENG will also help PMs understand joint capability requirements such as anti-tamper requirements and interactions within the DoD anti-tamper community. Additionally, the CHENG has a leading role in resolving interoperability and integration issues between PMs and supporting Joint and Naval SoS working groups in systems integration and interoperability performance compliance.

C.1.1. Specific Regulatory Requirements

CJCSI 3170.01E defines a specific relationship between the JCIDS process and key program acquisition milestones. Understanding these relationships is critical for the PM to ensure successful milestone completion. The JCIDS process begins with the Functional Area Assessment that is developed to assess a Joint Operating Concept produced by Joint Forces Command with the concurrence of the other Combatant Commanders and the Joint Staff.

Capability identification starts with a Functional Area Analysis (FAA), followed by a Functional Needs Analysis (FNA), and finally with a Functional Solution Analysis (FSA). The Integrated Architecture is used to relate capabilities, identify mission gaps and overlaps, and support decision makers each step of the way. In particular, the FSA is charged with conducting an operationally based assessment of all potential DOTMLPF approaches to solving a capability need. The architecture is uniquely suited to support capability trades and allocation to each DOTMLPF issue and support trade-off analysis between potential solutions.

Subsequently, an ICD is used to define the overall capability that is required to support military operations for a Combatant Commander. Eventually one or more systems will be fielded to instantiate the capability, but system representations in the ICD are always notional. To support ICD development one or more OV-1s will be developed. Most capabilities are too broad to be described in one OV-1. For instance, the Joint CBRNE community has 13 overarching capabilities, so they have 13 OV-1s even though the same system may play a role in implementing more than one capability. Likewise the JTAMD community has 7 different OV-1s to describe JTAMD.

Once Milestone A is reached, the Capability Development Document (CDD) is generated. This is the point where the PM becomes most involved. Prior to this point, the Navy Staff, CHENG, and the Naval Systems Commands have done most of the architecture work. Table 1 lists the products required for the CDD. At this point in the process, these architecture views are not very detailed, but should reflect the level of detail available to a PM at the early stages of the SE lifecycle. As the development process continues, these products will become more detailed and serve as the basis for future architecture product deliverables.

At Milestone B, the Capability Production Document (CPD) is produced, and further refined at Milestone C decision. The information in the CPD, which includes the architecture views, is the information the milestone decision authority will use to determine how the program should continue, or if it should be cancelled. At this time, one or more Interface control documents are also produced using the same architecture views, to govern information exchanges between the developing system and other systems. Table 1 lists the products required for CPD's and Interface control documents.

At Milestone C, Net-Ready Key Performance Parameter (NR-KPP) analysis is completed using the information in the CPD and interface control documents. The architecture views used for development of the CDD NR-KPP should be the same ones used for the interface control documents. NR-KPP compliance is also documented in the Information Support Plans (ISP) as required by CJCSI 6212.01C. The ISP will contain sufficient detail to permit an evaluation of the associated interoperability and supportability requirements.

Table 1 provides a list of directives and the descriptive products from the documents. The focus should be on how to generate these products as part of the program's normal SE lifecycle. This ensures that all product generation work is useful for both the program and the regulators, and that any products produced are an accurate reflection of the program's design.

Directives	Products
CJCSI 6212.01E	
CRD Interoperability I-KPP Development	OV-1, OV-3
CRD Interoperability based on NR-KPP	OV-1, OV-5
Initial Capabilities Document	OV-1
CDD Net-Ready Key Performance Parameters	AV-1, OV-1
	OV-2
	OV-4
	OV-5
	OV-6C
	SV-4
	SV-5
	SV-6
	TV-1
CPD Net-Ready Key Performance Parameters	AV-1, OV-1
	OV-2
	OV-4
	OV-5
	OV-6C, OV-7
	SV-2, SV-4
	SV-5
	SV-6, SV-11
	TV-1, TV-2
NCOW Reference Model	AV-1
	AV-2
	OV-1
	OV-2
	OV-3
	OV-5
	SV-1
	SV-2
	SV-3
	SV-4
	SV-5
	TV-1

Table C-1: Architecture Product Requirements

C.1.2. Use of DODAF Products

As part of the JCIDS process, architectures aid in transforming future concepts and desired capabilities into detailed logical and/or physical descriptions that are assessed against the full spectrum of DOTMLPF issues, coordinated between DoD components, and allocated to the optimal material and/or non material solution. Architectures form the foundation for determining material/nonmaterial solution viability, technical and funding feasibility of the solution, and serve as the bridge between joint capability development and DoD's material acquisition process.

For the Navy, the JCIDS process can be used to define the capabilities needed to support warfighting domains, such as AAW, then determine how these capabilities will be met by an optimal mix of Naval systems, doctrine, manning and employment procedures. An overarching or SoS architecture should be used to define what Joint or Naval capability specific systems must be implemented, while the single system architectures, such as the one for SSDS, will describe how that system will implement its portion of the capability.

The DODAF architecture views provide a common format for describing the operational, system, and technical architectures associated with a SoS. This common format is essential for communicating the SoS architecture to the Joint Service community. It is also important to note that any systems architecting effort must be conducted in the context of a well-defined systems engineering process, in order that the artifacts generated can be verified to satisfy the desired capabilities and further, have high utility in the system design, development, and deployment phases. DODAF architecture products that have been found to be particularly useful in the capability acquisition and systems engineering process are:

- OV-2 (Operational Node Connectivity Description): Focuses on current operational elements and their relationships, e.g. a Carrier Battle Group and its relationship to a MEF.
- OV-3 (Operational Information Exchange Matrix): Identifies the information exchanged within each relationship
- OV-4 (Organizational Relationships Chart): Defines current force structure and command relationships
- OV-5 (Operational Activity Model): Defines the set of activities that are performed by current operational elements to implement the capability. These activities should reflect what actually happens in the fleet and be traced to UJTLs and NTAs.
- OV-6a (Operational Rules Model): Describes one or more scenarios that are critical to understating how the current force executes its mission in relation to a capability. Activities and IERs in each scenario are pulled from the OV-3 and 5.
- OV-7 (Logical Data Model): Defines the data elements that make up each current force IER. Information gaps cannot be clearly identified without understanding how data is manipulated and shared within the fleet.
- SV-1 (Systems Interface Description): Focuses on current Naval systems, e.g. a CVN, and their relationship to other systems, such as an LHA. The systems in the SV-1 should map to the operational elements in the OV-2. Each SV-1 system may be part of one or more operational element.

- SV-2 (Systems Communication Description): For each SV-1 relationship, identifies the physical connectivity of that relationship, e.g., LOS RF, SATCOM, etc.
- SV-4 (Systems Functionality Description): For each SV-1 system, identifies the system functions that are relevant to exchanging data between systems and any system unique functionality needed to implement the capability. The functional descriptions should map to actual functionality and be traced to the Common System Function List (CSFL) for a common reference.
- SV-5 (Operational Activity to Systems Function Traceability Matrix): Maps each OV-5 activity to the system functionally that implements it. Note, some OV-5 functions are done by people during the business process and will not map to system functionality.
- SV-6 (Systems Data Exchange Matrix): For each SV-1 relationship, identifies the system data exchanges that take place. There will be a one-to-many relationship with each OV-3 information exchange.
- SV-7 (Systems Performance Parameters Matrix): For each SV-1 system, documents performance metrics that are relevant to the capability in question.
- SV-8 (Systems Evolution Description): Planned incremental steps toward migrating a suite of systems to a more efficient suite, or toward evolving a current system to a future implementation.
- SV-9 (Systems Technology Forecast): Emerging technologies and software/hardware products that are expected to be available in a given set of time frames and that will affect future development of the architecture.
- SV-10a (Systems Rule Model): As needed, captures the business processes that are used in each system, or group of systems, to achieve a capability. Shows human interaction with the system, and the actual time needed to accomplish each step in the process.
- SV-11 (Physical Schema): Focuses on defining the data that is exchanged between each system as defined by the SV-6. Will serve as a baseline to understand the impact of requiring new or modifying old data exchange messages and rules.
- TV-1 (Technical Standards): For each SV-1 system, identifies the technical standards that apply to information exchanges or are relevant to the capability in question.
- TV-2 (Technical Standards Forecast): Provides a technical standards forecast with its impact on the current system views, within a specified timeframe.

Appendix D: System Performance Document Outline

D.1. Background

The System Performance Document (SPD) is identified by SECNAVINST 5000.2C as the basis for program managers to develop or modify individual systems performance specifications under their cognizance. The SPD for a SoS is to be jointly signed by the respective program managers involved. Further, after Milestone B, or Milestone C if this is program initiation, the SPD will be used by ASN (RDA) as a means to maintain alignment of the programs during execution of the acquisition process.

SECNAVINST 5000.2C also establishes systems engineering IPTs, designated by ASN (RDA) for SoS acquisitions, as responsible for deriving, allocating, and describing and documenting system performance among the ACAT programs and modifications that provide SoS mission capability. The SPD is identified to be the document for capturing SoS performance.

D.2. Outline

No description of the desired SPD format is provided by SECNAVINST 5000.2C or the accompanying DoN Acquisition and Capabilities Guidebook. The following is provided as a suggested outline of the SPD contents:

1.0 Scope
- 1.1 Identification
- 1.2 Capability Overview
- 1.3 Document Overview

2.0 Applicable Documents

3.0 Requirements
- 3.1 Required States and Modes
- 3.2 Capability Requirements
- 3.3 Force Package Information Exchange Requirements
- 3.4 Force Package Functional Requirements
- 3.5 Force Package Data Interface Requirements
- 3.6 Computer Resource Requirements
- 3.7 Human Systems Integration Requirements
- 3.8 Environmental Requirements
- 3.9 Safety Requirements
- 3.10 Security and Privacy Requirements
- 3.11 Training Related Requirements
- 3.12 Logistics Related Requirements
- 3.13 Force Package Test Requirements
- 3.14 Other Requirements

4.0 Qualification Provisions

5.0 Requirements Traceability

6.0 Notes

7.0 Appendices

A. Force Package Objective Architecture
B. Functional Interface Design Matrix
C. Physical Interface Design Matrix
D. Integration and Interoperability Text Matrix
E. Integrated Portfolio Schedule

Appendix E: Definitions

Following each term definition, the originating source of the definition is identified in brackets, unless it the term has been originated by this document.

E.1. Terms

Acquisition Portfolio. The subset of the Force Package associated with the military capability identified by the ICD that includes the platforms, facilities. systems, networks, and interfaces which will be acquired, modified, or enhanced.

Analysis of Alternatives. The evaluation of operational effectiveness, operational suitability, and estimated costs of alternative systems to meet a mission capability. (CSCSI 3170.01E)

Analysis of Materiel Approaches. The JCIDS analysis to determine the best materiel approach or combination of approaches to provide the desired capability or capabilities. Though the AMA is similar to an AoA, it occurs earlier in the analytical process. (CJCSI 3170.01E)

Architecture. The structure of components, their relationships and the principles and guidelines governing their design and evolution over time. (JCIDS)

Attribute. A testable or measurable characteristic that describes an aspect of a system or capability. (JCIDS)

Capability (Military). The ability to achieve a specified wartime objective, i.e., win a war or battle or destroy a target set. It includes 4 major components:

(1) force structure: Numbers, size, and composition of the units that comprise defense forces, e.g., divisions, ships, air wings.

(2) modernization: Technical sophistication of forces, units, weapon systems, and equipment.

(3) readiness: The ability of forces, units, weapon systems, or equipment to deliver the outputs for which they were designed (includes the ability to deploy and employ without unacceptable delays).

(4) sustainability: The "staying power" of our forces, units, weapon systems, and equipment, often measured in numbers of days. (JP1.02)

Capability Development Document. A document that captures the information necessary to develop a proposed program(s), normally using an evolutionary acquisition strategy. The CDD outlines an affordable increment of militarily useful, logistically supportable, and technically mature capability. (CJCSI 3170.01E)

Capability Needs. The needs that must be met to ensure a reasonable degree of mission success. (DODAF)

Capability Production Document. A document that addresses the production elements specific to a single increment of an acquisition program. (CJCSI 3170.01E)

Family of Systems. A set or arrangement of systems that provide similar capabilities through different approaches to achieve similar or complementary effects. (CJCSI 3170.01E)

Force Package. An assembly of platforms and facilities (ships, aircraft, submarines, land vehicles, and spacecraft) organized to accomplish specific missions.

Function. A task, action, or activity expressed as a verb-noun combination (e.g., Brake Function: stop vehicle) to achieve a defined outcome. (IEEE 1220)

Functional Architecture. An arrangement of functions and their subfunctions and interfaces (internal and external) which defines the execution sequencing, conditions for control or data-flow, and the performance requirements to satisfy the requirements baseline. (IEEE 1220)

Functional Requirement. A statement which identifies what a product or process must accomplish to produce required behavior and/or results. (IEEE 1220)

Functional Verification. The process of evaluating whether or not the functional architecture satisfies the validated requirements baseline. (IEEE 1220)

Human Systems Integration (HSI). A multi-disciplinary approach to systems engineering and logistics that emphasizes the roles, requirements, provisions, and accommodations of human capabilities and limitations in systems design and development. The aspects of system acquisition that concern humans include: human factors engineering (HFE); manpower, personnel and training (MPT); habitability and quality of life; personnel survivability; and safety and occupational health. (NAVSEA INST 3900.8A)

Initial Capability Document. Documents the need for a materiel approach to a specific capability gap derived from an initial analysis of materiel approaches executed by the operational user and, as required, an independent analysis of material alternatives. (CJCSI 3170.01E)

Information Exchange Requirement. A requirement for information that is exchanged between nodes. (DODAF)

A requirement for information to be passed between and among forces, organizations, or administrative structures concerning ongoing activities. Information exchange requirements identify who exchanges what information with whom, as well as why the information is necessary and how that information will be used. (RDA CHENG)

Interoperability. The ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces and to make use the services, units, or forces and to use the services so exchanged to enable them to operate effectively together. (CJCSI 3170.1E)

Integrated Architecture. An architecture description that has integrated Operational, Systems, and Technical Standards Views with common points of reference linking the Operational Views and the Systems Views, and also linking the Systems Views and Technical Standards Views. An architecture description is defined to be an integrated architecture when products and their constituent architecture data elements are developed such that architecture data elements defined in one view are the same (i.e., same names, definitions, and values) as architecture data elements referenced in another view. (DODAF)

Integrated Data Base. A repository for storing all information pertinent to the systems engineering process to include all data, schema, models, tools, technical management decisions, process analysis information, requirement changes, process and product metrics, and trade-offs. (IEEE 1220)

Joint Capabilities Integrated Development System. Policy and procedures that support the Chairman of the Joint Chiefs of Staff and the Joint Requirements Oversight Council in identifying, assessing, and prioritizing joint military capability needs. (CJCSI 3170.01E)

Key Performance Parameters. Those minimum attributes or characteristics considered most essential for an effective military capability. KPPs are validated by the JROC for JROC interest documents, by the Functional Capabilities Board for Joint Impact documents, and by the DoD Component for Joint Integration or Independent documents. CDD and CPD KPPs are included verbatim in the Acquisition program Baseline. (CJCSI 3170.01E)

Knowledge, skills, and Abilities (KSA) – The human aptitudes (i.e., cognitive, physical, and sensory capabilities) and experience levels that are available in the intended user population and/or are needed to properly (efficiently and effectively) perform job tasks. (NAVSEA INST 3900.8A)

Major Command (MAJCOM) or Major Organizational Element. Denotes major military operational command organizations and other major functional organizations within a DoD Component. (DODINST 7730.64)

Measure of Effectiveness. A qualitative or quantitative measure of a system's performance or a characteristic that indicates the degree to which it performs the task or meets a requirement under specified conditions. MOEs should be established to measure the system's capabilities to produce or accomplish the desired result. (CJCSI 3170.01E)

The metrics by which a customer will measure satisfaction with products produced by the technical effort. (IEEE 1220)

Measure of Performance. A performance measure that provides design requirements which are necessary to satisfy an MOE. There are generally several measures of performance for each measure of effectiveness. (IEEE 1220)

Mode. An operating condition of a function or sub-function or physical element of the system. (IEEE 1220)

Net-Ready Key Performance Parameter. Assesses information needs, information timeliness, information assurance, and net-ready attributes for the technical exchange of information and the end-to-end operational effectiveness of that exchange. (CJCSI 3170.01E)

Node. A representation of an element of architecture that produces, consumes, or processes data. (DODAF)

Objective Architecture. The operational, functional, and physical architecture that incorporates the material solution concept intended to achieve an identified capability.

Operational Activity. A representation of the actions performed in conducting the business of an enterprise. The model is usually hierarchically decomposed into its actions, and usually portrays the flow of information (and sometimes physical objects) between the actions. The activity model portrays operational actions not hardware/software system functions. (DODAF)

Operational Architecture. A representation of the Operational Force, how it is organized, and how it performs its integrated processes/activities to achieve mission objectives. (DODAF)

Operational Model. An executable representation of the operational architecture.

Operational Node. A node that performs a role or mission. (DODAF)

Organizational Element. Functional organization within a military component. (DODINST 7730.64)

Performance Requirement. The measurable criteria that identify a quality attribute of a function, or how well a functional requirement must be accomplished. (IEEE 1220)

Physical Architecture. An arrangement of physical elements that provides the design solution for a consumer product or life-cycle process intended to satisfy the requirements of the functional architecture and the requirements baseline. (IEEE 1220)

Physical Element. A product, subsystem, assembly, component, subcomponent, subassembly, or part of the physical architecture defined by its designs, interfaces (internal and external), and requirements (functional, performance, constraints, and physical characteristics). (IEEE 1220)

Planned Portfolio of Systems. The set of in service and approved/funded platforms and systems in the Fiscal Year Development Plan (FYDP) intended to satisfy an identified military capability.

Portfolio of Systems. The set of platforms and systems necessary to satisfy an identified military capability.

Quality Function Deployment (QFD) Technique. QFD is a technique for deploying the "Voice of the Customer." It provides a fast way to translate customer requirements into specifications and systematically flow-down the requirements to lower levels of design, parts, manufacturing, and production. (INCOSE Handbook, Appendix A)

State. A condition which characterizes the behavior of a function/sub-function or element at a point in time. (IEEE 1220)

System. Any organized assembly of resources and procedures united and regulated by interaction or interdependence to accomplish a set of specific functions. (DODAF)

System Element. A product, subsystem, assembly, component, subcomponent, subassembly, or part of the system breakdown structure which includes the specifications, configuration baseline, budget, schedule, and work tasks. (IEEE 1220)

Systems Engineering. An interdisciplinary collaborative approach to derive, evolve, and verify a life-cycle balanced system solution which satisfies customer expectations and meets public acceptability. (IEEE 1220)

System of Systems. A set or arrangement of systems that results when independent and useful systems are integrated into a larger system that delivers unique capabilities. (OUSD AT&L)

E.2. Acronyms

ACTD	Advanced Concept Technology Demonstration
AoA	Analysis of Alternatives
ASN (RDA)	Assistant Secretary of the Navy, Research Development & Acquisition
CCB	Change Control Board
CDD	Capability Development Document
CEP	Capability Evolution Plan
CFFC	Commander Fleet Forces Command
CHENG	Chief System Engineer (ASN(RDA) CHENG)
CJCSI	Chairman, Joint Chief of Staff Instruction
CPD	Capability Production Document
C^4I	Command, Control, Communications, Computers & Intelligence
DAB	Defense Acquisition Board
DAG	Defense Acquisition Guidebook
DAS	Defense Acquisition System
DASN	Deputy Assistant Secretary of the Navy
DAU	Defense Acquisition University
DODAF	DoD Architecture Framework

DODI	Department of Defense Instruction
DoD	Department of Defense
DoN	Department of the Navy
DOORS	Distributed Object Oriented Requirements System
DOTMLPF	Doctrine, Organization, Training, Material, Leadership and education, Personnel, and Facilities
DSE	Decision Support Environment
EFDS	Expeditionary Force Development System
ESG	1) Executive Steering Group (of the SE IPT) 2) Expeditionary Strike Group
FIOP	Family of Interoperable Pictures
FNC	Future Naval Capabilities
FoS	Family of Systems
GIG	Global Information Grid
HSI	Human Systems Integration
ICD	Initial Capability Document
IDM	Interface Design Matrix
IEE	Integrated Engineering Environment
IEEE	Institute of Electrical and Electronics Engineers
INCOSE	International Council on Systems Engineering
IPR	In-Process Review
IPT	Integrated Product Team
ISP	Information Support Plan
ITM	Interface Test Matrix
I&I	Integration and Interoperability
JCIDS	Joint Capability Integration and Development System
$JBMC^2$	Joint Battle Management Command and Control
JFCOM	Joint Forces Command
KPP	Key Performance Parameter
LSE	Lead Systems Engineer
LSET	Lead Systems Engineering Team
MCP	Mission Capability Package
MNS	Mission Needs Statement
MOE	Measure of Effectiveness
MOP	Measure of Performance
NCDS	Naval Capability Development System
NCEE	Naval Collaborative Engineering Environment
NCEP	Naval Capability Evolution Process
NETWARCOM	Net-Centric Warfare Command
NFDS	Naval Force Development System
NMETL	Naval Mission Essential Task List
NTA	Naval Tasks
ONR	Office of Naval Research
OPNAV	Staff of the Chief of Naval Operations
ORD	Operational Requirements Document
OSD	Office of the Secretary of Defense

PDR	Preliminary Design Review
PEO	Program Executive Office
PEO IWS	Program Executive Office, Integrated Warfare Systems
PM	Program Manager
PPBE	Planning, Programming Budgeting & Execution
PPBES	Planning, Programming Budgeting & Execution System
QFD	Quality Function Deployment
RDT&E	Research, Development, Test, & Evaluation
SE IPT	Systems Engineering Integrated Product Team
SECNAVINST	Secretary of the Navy Instruction
SET	System Engineering Team
SoS	System of Systems
SPD	System Performance Document
SRR	System Requirements Review
TACSITS	Tactical Situations
TEMP	Test & Evaluation Master Plan
T&E	Test and Evaluation
TRR	Test Readiness Review
V&V	Verification and Validation
WG	Working Group

Appendix F: Referenced Documents

F.1. Military Directives & Instructions

CJCSI 3170.1E, Joint Capabilities Integration and Development System, 11 May 2005

CJCS Manual 3170.01B, Operation of the Joint Capabilities Integration and Development System, 11 May 2005

DoD Directive 5000.1, May, 2003

DODI 5000.2, Operation of the Defense Acquisition System, May, 2003

DODI 7730.64, 11 December 04

Marine Corps Order 3900.15A, 26 November 02

NAVSEA INST. 3900.8A, Human Systems Integration policy in Acquisition and Modernization

OPNAVINST 3050.23, 5 November 01

OPNAVINST 5100.24, Navy System Safety Program

SECNAVINST 5000.2C, Implementation and Operation of the Defense Acquisition System and the Joint Capabilities Integration and Development System, January, 2005

F.2. Military Standards & Guidebooks

Department of Defense Acquisition Guidebook, 15 October 04

Department of Defense Architecture Framework, 9 February 04

Department of the Navy Acquisition and Capabilities Guidebook, 17 February 05

MIL-STD-882D, Standard Practice for System Safety

Naval Systems Engineering Guidebook, July, 2004

Software System Safety Guidebook, December 1999

Systems Engineering Fundamentals Guidebook, Defense Acquisition University Press, January, 2001

Systems Engineering Plan for Surface Navy Theater Air Defense (TAD) Volume I: Systems Requirements Engineering, March 1999, NSWCDD/MP-99/11

OUSD (AT&L) Guide to System of Systems (SoS) Engineering: Considerations for Systems Engineering in a SoS Environment (Draft), 25 September 06

Virtual SYSCOM HSI Program Manager's Guide, Vol. I and II

F.3. Industry Standards & Guidebooks

IEEE 1220-1998, Management and Application of the Systems Engineering Process, Institute of Electrical and Electronics Engineers, Inc., September, 1998

Systems Engineering Handbook, International Council on Systems Engineering, June, 2004