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Fleet Capabilities Based Assessment (CBA)

ABSTRACT

Several recent Analyses of Alternatives (AOAs) have demonstrated issues with the AOA process that have limited the NAVY in the pre-Milestone A process. The eventual selection of an AOA preferred alternative that balances mission needs, total ownership cost, and acquisition cost was based on a limited trade space. This paper proposes an improved pre-AOA process to better define a fiscally constrained set of fleet requirements that are allocated to the different ships, aircraft and systems comprising the battle force over a forty year time span. The proposed process extends the Capabilities Based Assessment (CBA) defined in the Joint Capabilities Integration and Development System (JCIDS) to apply to the entire Fleet Design instead of each capability area. In this way, fleet requirements derived from the National Security Strategy and the DOD Strategic Guidance are allocated to different warfare platforms. The required analysis combines physics based modeling of the individual war fighting units, realistic cost engineering/estimation, and rigorous operations analysis via the Navy SYSCOMs. The fleet planning is done over three time horizons: Long Range Planning of 15 to 40 years in the future to guide S&T development; Mid Range planning from the end of the Future Year Defense Plan (FYDP) to 15 years to establish architectures, guide technology transition as well as derive from the fleet level CBA the platform level CBAs for the individual programs; and Near Term planning within the FYDP where the concerns are reacting to emerging threats, meeting affordability goals, and maintaining the industrial base. The resulting fleet level analyss directly supports force level assessments as part of the Quadrennial Defense Review (QDR).

INTRODUCTION

During the past few years, Analyses of Alternatives (AOAs) for several ship acquisition programs (including LHA(R), MPFF, and CG(X)) have not produced results that could enable the selection of a preferred alternative that properly balances mission needs, total ownership cost, and acquisition cost and allow an orderly entry into the acquisition process. For LHA(R) and MPFF, the final acquisition alternative implemented (after much delay) was not part of the recommended solution set coming out of the AOA (Warner 2005, 2006). For CG(X) the final acquisition alternative has not been selected almost a year after the originally scheduled completion of the AOA. (O'Rourke 2008) All of these AOAs suffered from the lack of a well defined fleet architecture where the role and needed capabilities of these individual ships were clearly articulated and prioritized within the context of total fleet affordability. The Navy needs an improved pre-AOA process to better define a fiscally constrained set of fleet requirements that are allocated to the different ships, aircraft and systems comprising the battle force and those planned for procurement in the thirty year shipbuilding plan. The current acquisition process as described by DoD 5000.02 (DOD 2008) and implemented by the Navy is reactionary in that material solutions are not studied or explored in any level of detail until a capabilities gap is identified as part of the JCIDS process. Material solutions are developed to specifically address each individual capabilities gap independent of other gaps or consideration of overall fleet or systems architectures. The fleet is currently designed one acquisition program at a time – without a complete understanding of the inter-relationships and trade-offs between the different elements of fleet design, strategy and tactics. What is done today are uncoordinated studies requested by the Office of the Chief of Naval Operations (OPNAV), Deputy Assistant Secretaries of the Navy (DASNs), Commander, Naval Sea Systems Command (COMNAVSEA), etc. and performed by various organizations both within and outside the Government. It is not clear that these studies take advantage of the tremendous knowledge of appropriate experts within the Navy to ensure the results are valid and integrated across the Navy. The current process also does not provide timely, actionable guidance to the developers of technology and systems to support future acquisitions.

The 2 Pass 6 Gate review process was initially defined by the Secretary of the Navy (SECNAV) in SECNAVNOTE 5000, (SECNAV 2008) and subsequently codified in SECNAVINST 5000.2D (SECNAV 2008a). This process, as shown in Figure 3, begins with a Capabilities Based Assessment (CBA) followed by the development of an ICD. of the products of the CBA are a Functional Area Analysis (FAA), Functional Needs Analysis (FNA) and a Functional Solutions Analysis (FSA). The problem with this process is that each mission area has its own CBA, yet ships and aircraft are inherently multi-mission. The integration of all the mission areas allocated to the Navy from the National Military Strategy into a coherent fleet architecture is not aligned with the multiple independently conducted CBAs. Furthermore, the current process does not facilitate cost-performance trade-offs at the fleet and force architecture level. In a fiscally constrained environment, affordability is an important constraint in establishing the level of capability that can be provided across the multiple missions assigned to the Navy. Understanding the threat environment and the relationship between cost and performance across the elements of the fleet architecture (and how the threat enviornment and relationships change over time) are key to producing the optimal fleet design. In 2006-2007, the Naval Sea Systems Command (NAVSEA) demonstrated many of the analytical tools necessary to perfrom such a fleet level design in the Affordable Future Fleet Study. These tools and the results of their analysis are detailed in Goddard et al. (2007) and Koenig et al. (2008).

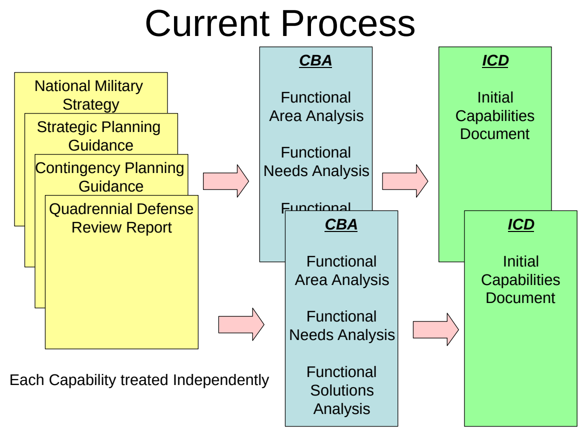

Figure 1: Current Pre-AoA Process

Ideally, the fleet architecture over a forty year time horizon would be established within a standing and funded CBA Integrated Product Team (IPT) with participation from organizations with specific needed expertise (see Table 1). As shown in Figure 2, this CBA IPT would create an integrated set of CBAs for all the naval missions that together comprise the fleet architecture. Missions and capabilities would be allocated to individual ships/aircraft/systems in the form of Initial Capabilities Documents (ICDs) for programs that are entering the acquisition process, or draft-ICDs for programs that will begin the acquisition process in the future. Unlike the recent AOAs, the allocation of requirements to individual ships / aircraft / systems would be based on total fleet mission effectiveness as well as total fleet affordability. These decisions would be based on physics based models and response surfaces [1] developed by the Navy systems commands and incorporated into an ever expanding library of concepts that are certified by the appropriate technical authorities (including cost). This library of concepts is anticipated to be produced in a collaborative environment including the ship designers, systems experts, fleet designers, and fleet operaters. Another paper in this conference details how such a Continuing Collaborative

[1] For more information on Response Surfaces and Response Surface Methodology, see Carley et al. (2004) Grier et al. (1997) describe the application of RSM to link force structure to campaign objectives.

Concept Formulation (C3F) process would function.

The draft-ICDs via this pre-AoA process should provide the basis for Science and Technnology (S&T), and Research and Development (R&D) planning, tools development, design methodology development, workforce shaping, and technology roadmap development for future Material Solution Programs of Record. Because the evolution of the threat, world events, and technology advancements are impossible to predict over a forty year horizon, analytical methods addressing uncertainty such as those that incorporate alternate futures (such as Future Force Formulation (Rice 2005) and methods that evaluate the value of flexibility and robustness (such as Real Options Analysis (Gregor 2003)) should be employed in this analysis.

Table 1: Organizational Contributions to CBA

- Operational Expertise
  - Office of the Chief of Naval Operations (OPNAV)
  - Fleet Representatives
  - Naval Warfare Development Command (NWDC)
  - Military Sealift Command (MSC)
- System Cost and Performance
  - Naval Sea Systems Command (NAVSEA)
  - Naval Air Systems Command (NAVAIR)
  - Naval Facilities Command (NAVFAC)
  - Space & Naval Warfare Systems Command (SPAWAR)
  - Naval Surface Warfare Center (NSWC)
  - Naval Undersea Warfare Center (NUWC)
  - Navy Center for Cost Analysis (NCCA)
- Operational Analysis
  - OPNAV N81,
  - Navy QDR Office
  - Naval Postgraduate School (NPS)
  - Naval War College (NWC)
  - Center for Naval Analysis (CNA)
  - Applied Physics Laboratory (APL)
- Technology Development
  - Office of Naval Research (ONR)
  - Naval Research Laboratory (NRL)
  - Naval Surface Warfare Center (NSWC)
  - Naval Undersea Warfare Center (NUWC)
  - DARPA
  - UARCS

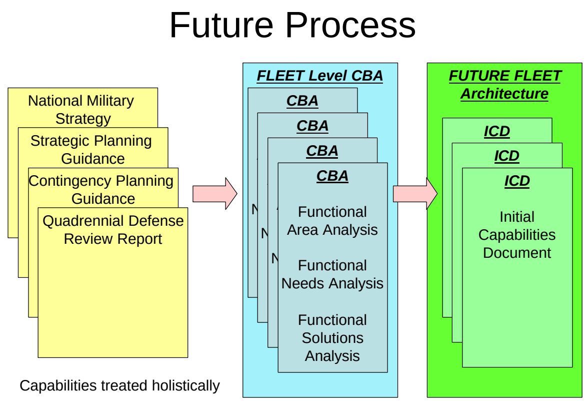

Figure 2: Proposed Pre-AoA Process

The proposed process has the advantage of directly linking the CBA process defined in the Joint Capabilities Integration and Development System (JCIDS) with Fleet Architecture Development using the full expertise of OPNAV, Naval Warfare Development Command (NWDC), and the Technical Authorities within the System Commands. By designing the fleet through trading off cost versus capability at the fleet level using physics/engineering based models, the Navy can optimize the performance of the fleet within fiscal and risk constraints.

Another advantage is that by developing focused ICDs for each ship / aircraft / system, the AOA and post-AOA trade-studies / feasibility studies / Concept of Operations (CONOPS) development leading to an approved Capability Development Document (CDD) at Gate 3 greatly improve the requirements stability, cost confidence to support PPBE and architecture development at the start of the Technology Development phase (Preliminary Design for ship acquisition programs) following Milestone A at the beginning of Pass 2. Figure 4 shows the proposed relationship between the Fleet Level CBA and the acquisition process for each specific acquisition program (assuming program initiation at Milestone A).

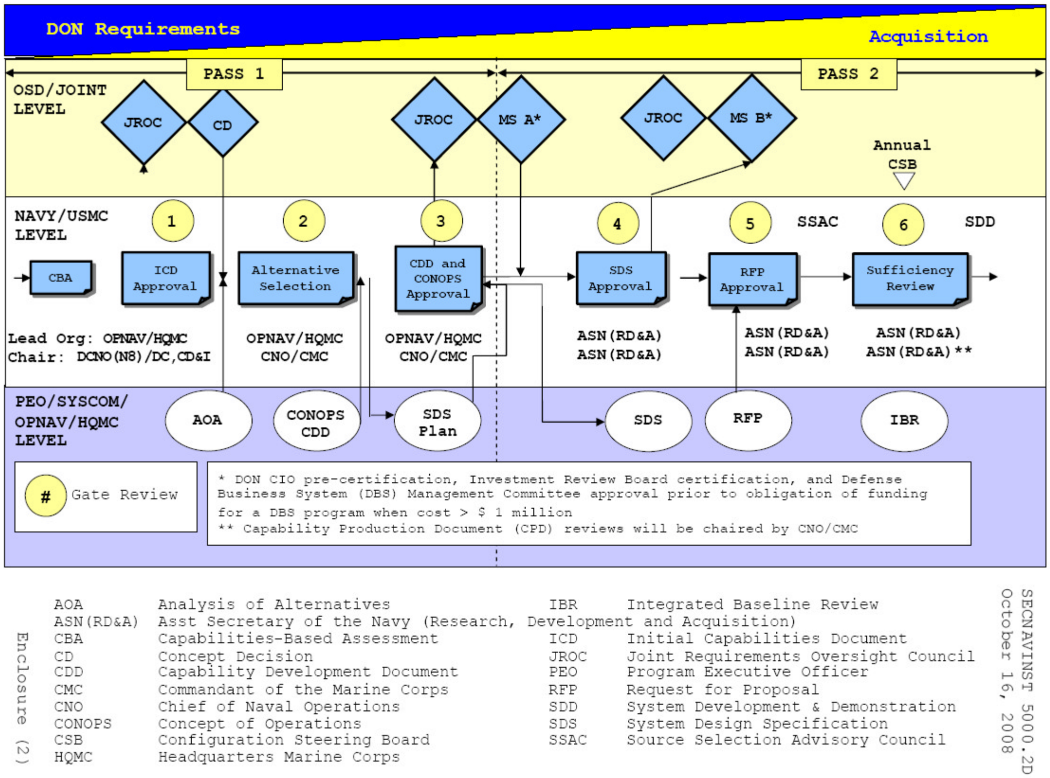

Figure 3: Two Pass, Six Gate Process (SECNAVINST 5000.2D)

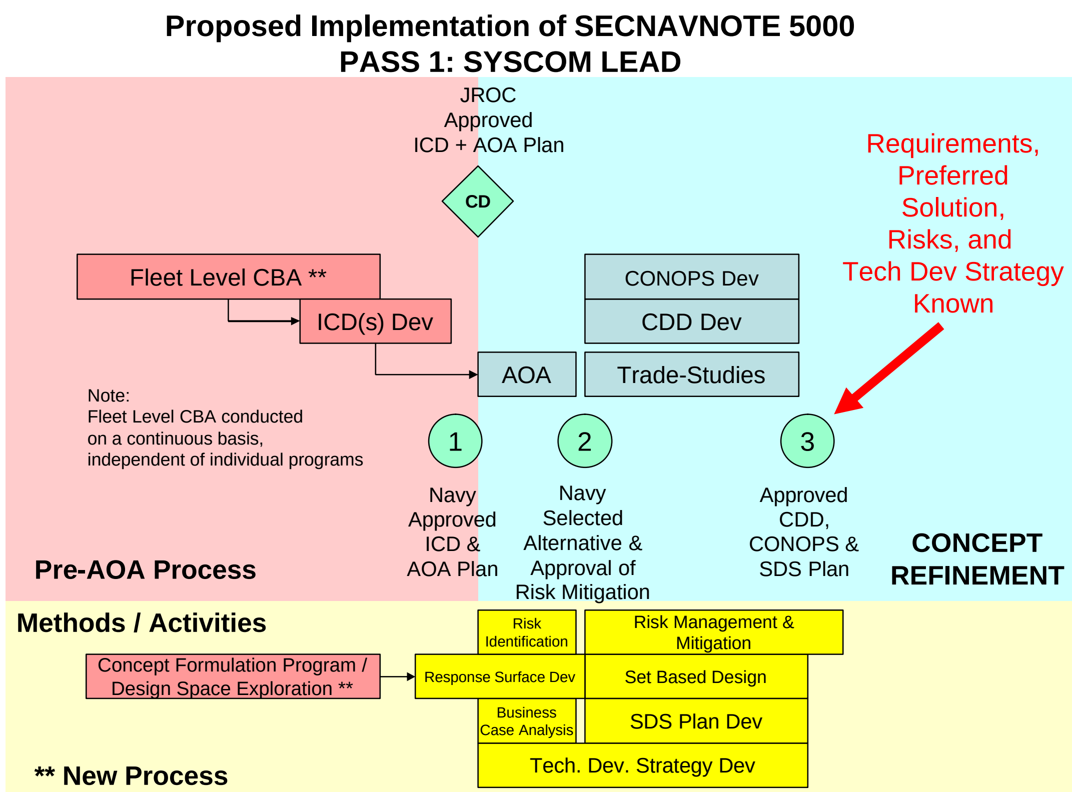

Figure 4: Proposed Implementation of Pre-AoA Process and Pass 1

FLEET LEVEL CBA DESCRIPTION

The Fleet Level CBA consists of analysis in 3 planning horizons:

Long Range Planning:
15 to 40 years in the future

Mid Range:
End of the Future Year Defense Plan (FYDP) to 15 years

Short Range:
During the Future Year Defense Plan (five to six years in the future)

These divisions are based on the need for different levels of uncertainty, constraints and appropriate tools and methods. While the planning activities are likely to be performed somewhat independently of each other, they must be consistent across the boundaries of the planning horizons. For shipbuilding programs, the results of the analysis in all three planning horizons should form the basis of the annual Report to Congress on Annual Long Range Plan for Construction of Naval Vessels.

Long Range Planning – Future Force Formulation

Long-range force planners must contend with the difficulty of predicting future threats, fiscal and political environments, and technical advances twenty to forty years in the future. Extrapolating current trends can suffice for less than twenty years, but uncertainties in the future dominate long-range predictions. One technique for addressing this difficulty is Future Force Formulation (Rice 2005, Moreland 2008).

As shown in Figure 5, Future Force Formulation postulates multiple possible futures and possible force designs. The general steps for defining an alternate future and a corresponding fleet force structure is shown in Figure 6. The multiple force designs produced are then analyzed to develop

- Science and Technology (S&T) needs to guide S&T investments. While the S&T Community currently derives its guidance from perceived holes in DoD capabilities, these holes are not always supported by analysis.
- Far-Term (15 to 30 years out) input to the Long Range Naval Vessel Construction Plan.
- Draft ICDs and associated CONOPS for new ship classes, aircraft, and major systems introduced in the Far Term (15 to 40 years out)
- Recommendations for modernization and service life extension of systems in the Far Term.
- Appropriate Operational and Systems views of the alternate fleet architectures using the DoD Architectural Framework (DoDAF). See Figure 7 for an example of a DoDAF architectural product. (DoD 2007)

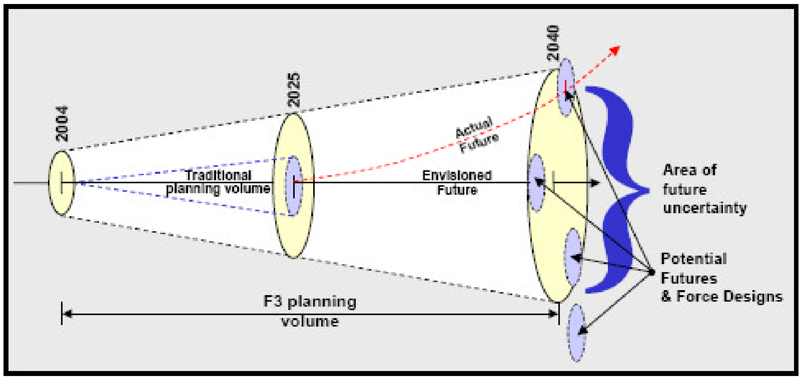

Figure 5: Future Force Formulation alternate futures (Rice 2005)

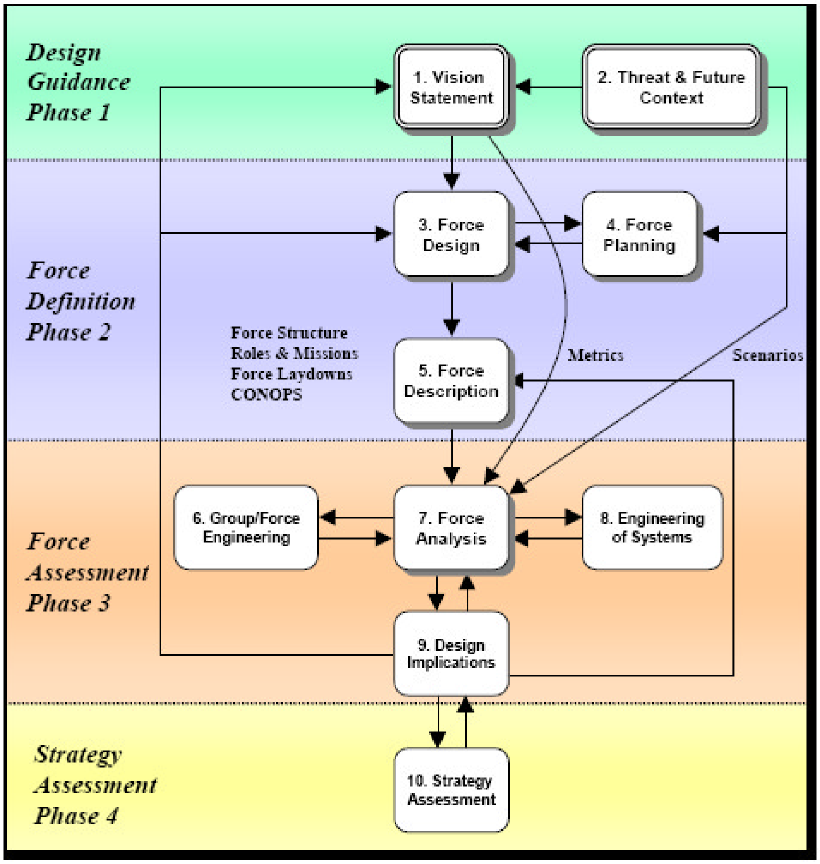

Figure 6: Future Force Formulation Process (Rice 2005)

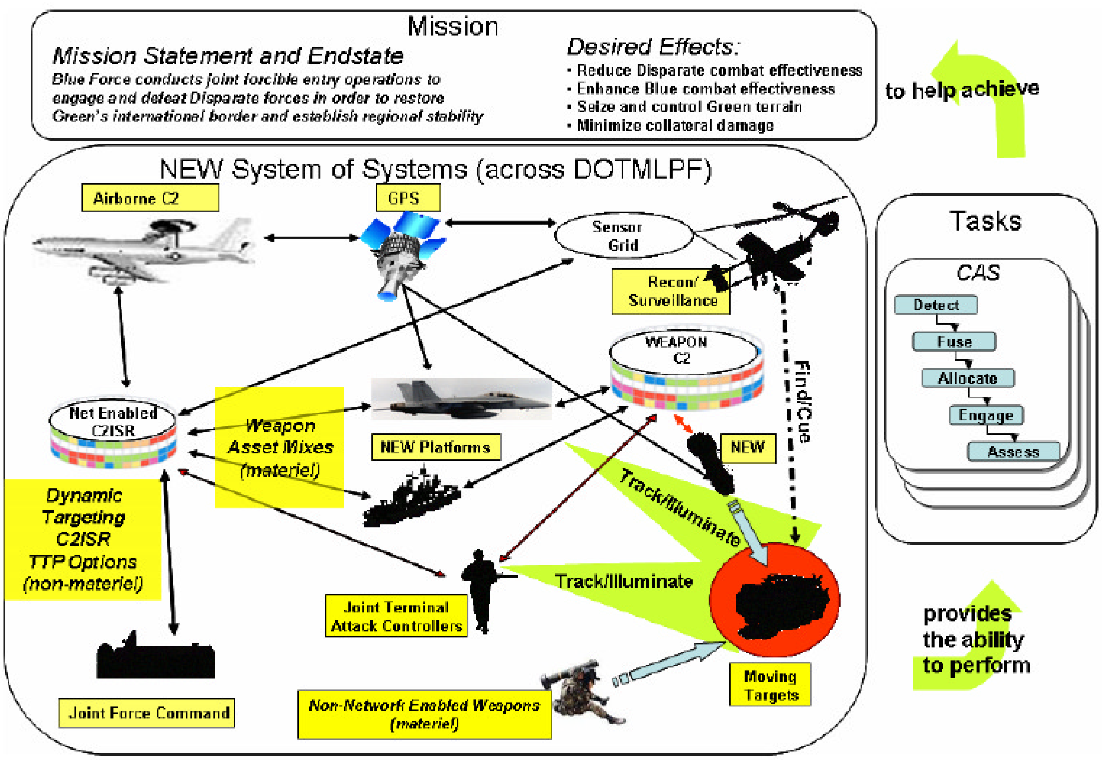

Figure 7: DoDAF Operational View Example (OV-1) Operational Concept Graphic (DoD 2007)

Mid Term Planning

The period covered by Mid Term Planning includes the years after the five to six years of the Future Year Defense Plan (FYDP) up to 15 years in the future. Mid Term Planning is critical because this is where most of the alternate futures of the long term planning are eliminated and focus is placed on a single fleet architecture. Capability Based Assessments (CBA) for all the capabilities assigned to the Navy are integrated to produce a fleet architecture that best fulfills the needs within affordability constraints. Additional DoDAF operational, systems, and technical view artifacts are developed. Platform and System cost estimates as well as performance assessments result from analysis using physics-based models with the proper Verification, Validation and Accreditation (VV&A) credentials. Because the mid-term planning horizon still has uncertainty in the prediction of the future fleet requirements, the value of flexibility and robustness should be evaluated using techniques such as Real Options Analysis (Gregor 2003). The Draft ICDs from the Long Term Planning process are refined into ICDs using the results of the fleet level CBA. These ICDs along with an Analysis of Alternative (AOA) plan are used by each new system to enter the acquisition process at the Concept Decision. Mid Term Planning also informs technology development roadmaps to influence the use of R&D funds for de-risking new technologies and the development of design methods, design tools, and an experienced workforce to ensure successful integration of new technology into acquisition programs that are needed to implement the fleet architecture.

Near Term Planning

The near term consists of the five to six years of the Future Year Defense Plan (FYDP). The force structure of the near term is dominated by the ships, aircraft and systems that are already in the fleet or are under construction. The ability to influence the design of ships and aircraft that are scheduled for procurement in the near-term is constrained. In general, the Near Term Planning concentrates on the number of ships, aircraft and systems to acquire, modernize and retire from service to meet affordability goals while best meeting Navy and Joint Force operational requirements. Force structure requirements are developed and validated through detailed joint campaign and mission level analysis based on evolving fleet Concepts of Operation (such as the Fleet Response Plan (FRP), Sea Swap, forward posturing), and balanced with shipbuilding industrial base requirements.

IMPLEMENTING THE FLEET LEVEL CBA

The Fleet Level CBA outlined above is an exercise of Systems of Systems Engineering. Systems Engineering expertise within the Navy currently resides in the Systems Commands and Warfare Centers. The outputs of the Fleet Level CBA however, are sets of requirements for acquisition programs and the Naval S&T community. Requirements are the responsibility of OPNAV and the fleet; Force analysis is the responsibility of OPNAV; Operational Concepts are the responsibility of NWDC, acquisition is the responsibility of ASN(RDA) and the various PEOs; and S&T is the responsibility of ONR. This diverse set of stakeholders suggests the creation of an Integrated Product Team (IPT) based organization for conducting the Fleet Level CBA. One possible IPT organization is shown in Figure 8.

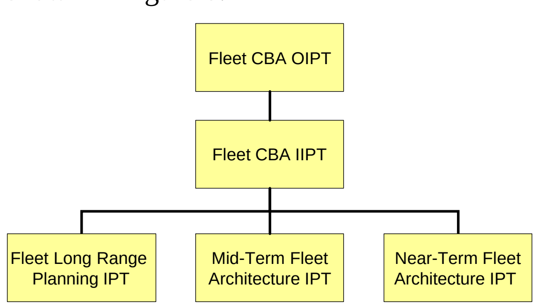

Figure 8: Possible CBA Integrated Product Team (IPT) Structure

Fleet CBA Over-arching Integrated Product Team (OIPT)

The Fleet CBA OIPT consists of senior Navy leadership that provides specific direction in response to the development of the Fleet Level CBA. The Fleet CBA OIPT is anticipated to meet roughly every 6 months.

Fleet CBA Integrating Integrated Product Team (IIPT)

The Fleet CBA IIPT consists of the Study Directors of each of the Architectures. This IIPT meets at least quarterly to ensure the three architectures are aligned. This IIPT also prepares the presentation to the OIPT. The IIPT is also responsible for maintaining a knowledge management system to serve as a repository of analysis and supporting data used to develop the fleet architectures.

Fleet Long Range Planning Integrated Product Team (IPT)

Led by a study director and supported by an integration manager, the Fleet Long Range Planning IPT would include the study leads from each of the stakeholder organizations. Each of the stakeholder organization study leads would have responsibility for the resources for executing the study tasks assigned to the study lead. The IPT as a whole is responsible for integrating the results into a coherent Long-Term Fleet Architecture. The Fleet Long Range Planning IPT is anticipated to operate on a four year cycle aligned with the Quadrennial Defense Review (QDR). Alternate futures / fleets would be created / updated at least once during the four year cycle. Likewise draft-ICDs would be created / updated at least once during the cycle to reflect changes in the analysis of the alternate futures.

Mid-Term Fleet Architecture IPT

Led by a study director and supported by an integration manager, the Mid-Term Fleet Architecture IPT would include the study leads from each of the stakeholder organizations. Each of the stakeholder organization study leads would have responsibility for the resources for executing the study tasks assigned to the study lead. The IPT as a whole is responsible for updating each of the mission area CBAs and integrating the results into a coherent Mid-Term Fleet Architecture. The Mid-Term Fleet Architecture IPT is anticipated to operate on a biannual cycle to support the two year budgeting cycle.

Near-Term Fleet Architecture IPT

Led by a study director and supported by an integration manager, the Near-Term Fleet Architecture IPT would include the study leads from each of the stakeholder organizations. Each of the stakeholder organization study leads would have responsibility for the resources for executing the study tasks assigned to the study lead. The IPT as a whole is responsible for integrating the results into a coherent Near-Term Fleet Architecture. The IPT also provides feedback to individual programs on the impact of Cost as an Independent Variable (CAIV) trade-offs on the overall fleet capability. The Near-Term Fleet Architecture IPT will likely operate on an annual cycle to support planning, programming, and budgeting.

Successfully implementing the Fleet level CBA requires organizational commitment and dedicated resources for conducting the studies, controlling processes, developing and performing VV&A on tools, managing the knowledge, and training the workforce.

INTERACTIONS WITH INDUSTRY

Conducting the Fleet level CBA can enhance the Navy's interaction with industry in the following ways:

a. Provide a clear and rational indication of the Navy's future. This enables industry to focus internal research and development efforts on technologies that can likely successfully transition to an acquisition program.

b. Provide a better understanding of architecture needs. Specifically, provide an understanding of which aspects of an architecture should be firm, and which should be flexible to account for uncertain requirements. This understanding of architectural needs can also be the basis of incentives in the development of systems.

c. Provide a method to evaluate the impact of reducing specific requirements on the operational effectiveness of the fleet.

RECOMMENDATONS

To implement the Fleet level Capabilities Based Assessment, the following actions are recommended:

a. SECNAV and/or CNO issue a letter requiring a Fleet level Capabilities Based Assessment be used at the basis for developing the ICDs and CONOPS for acquisition programs, for establishing the thirty year shipbuilding program, and for evaluating the impact of reducing system capabilities on overall fleet performance.

b. Establish the IPT structure and fund a pilot Fleet level CBA. This pilot Fleet level CBA would produce the written procedures for conducting the Fleet level CBA, estimated costs for conducting the Fleet level CBA, a list of gaps in tools, processes and knowledge, and the first example fleet architectures. The conduct of the pilot Fleet level CBA would be governed by a Study Guide.

c. Establish a funding line and fund it appropriately to continually execute the Fleet level CBA. Assign appropriate financial oversight to this funding line.

CONCLUSIONS

This paper proposes that the Navy continually conduct a Fleet Level CBA with three planning horizons to provide clear direction to long-term fleet needs to the S&T Community, to allocate warfighting functions among the various ships / aircraft / systems within the fleet over a 40 year span, and to produce the ICD for new acquisition programs.

Implementing the proposed Fleet CBA will require organizational commitment and dedicated funding. Once implemented, this investment will likely repay itself with fewer programmatic redirections and costly requirements changes to ongoing acquisition programs. The Fleet CBA is the first step to an Affordable Future Fleet.

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