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Portfolio Management Structures: System, Capability, and Mission Portfolios

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Abstract

Since 2008, ongoing attempts by the DoD to support decision-making across capability portfolio management have been unsuccessful. Proposed is a multidimensional portfolio structure schema, which utilizes ANSI Standard for Portfolio Management and is informed by ISO Standard for Building Information Modeling (BIM)s. The schema creates a non-hierarchical structure of three portfolio types across component PEOs representing product/platforms, component operational units representing capabilities, and combatant and supporting commander Operations Plans (OpsPlan) representing missions. The multidimensional nature of the structure allows for enhanced management insight and decision-making using structured performance management across the DoD Decision Support Systems (D2S2). Observations and challenges discussed range from the misalignment of Joint Capability Assessment (JCA) with the field use of Universal Joint Task List (UJTL) to not capturing cost estimate's quantitative risk data. The path forward outlines building a notional multidimensional programmatics model, which demonstrates how key data can be aligned with Mission Engineering and Systems Engineering models, allowing for full utilization of evolving Artificial Intelligence (AI) and Natural Language Processing (NLP) techniques to enhance management insight and decision-making across the enterprise.

Introduction

The University of Maryland, Project Management Center of Excellence, conducted research in support of Capability, Mission, and PEO (CMP) Portfolio Performance Analysis and Visualization task.[1] This research paper focuses on portfolio performance analyses and visualization across platforms, capabilities, and missions managed across DoD PEO portfolios. The research supports the National Defense Authorization Act (NDAA) Sec. 913 (FY18 NDAA) and Sec. 801 and 836 (FY22 NDAA), by identifying data-driven approaches to analytic insight at the program and portfolio levels.

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This research, cognitive of the significant change in the defense acquisition environment over the past decade, looked at recent DoD attempts for portfolio performance analyses and visualization across PEO portfolios of systems and also capability and/or mission portfolios. Recent changes to support capability portfolio management, such as the Integrated Acquisition Portfolio Review (IAPR) efforts, are struggling to produce actionable advice for senior leaders. The "capability" structure utilized is loosely aligned with CJCS Joint Capability Assessment (JCA) structure. The newly created Chief Data and Artificial Intelligence Office (CDAO) has been gathering data with the Advance Analytics (ADVANA) systems started by the OSD Comptroller.[2] We observed a general frustration in attempts to use the classic program-centric acquisition structure and metrics along with decision tools, such as Spruill Charts, in a program or portfolio aggregate, whether at product/platform, capability, or mission views. Using the existing structure was not providing clarity to the ever-increasing complicated and complex[3] nature of the underlying SoS product/platforms and SoS decisions support management structure used to make decisions to achieve joint warfighter capabilities.

The Government Accountability Office (GAO) identified in 2015 that the Department of Defense (DOD) was not effectively using portfolio management to optimize its weapon system investments, as evidenced by affordability challenges in areas such as shipbuilding and potential duplication among some of its programs. Best practices recommend assessing investments collectively from an enterprise-wide perspective and integrating requirements, acquisition, and budget information, but several factors inhibit DOD's ability to do so. (GAO, 2015b)

In 2019, the Section 809 Panel wrote extensively on how the DoD should move to a more industry-standard[4] approach for portfolio management for the PEO collection of product/platforms. Many of those recommendations have not been implemented; thus poor portfolio management structures and practices persist.

Many parts of the D2S2 have their own portfolio approach. The Chairman of the Joint Chiefs of Staff (CJCS) has Capability Portfolio Management Reviews based on JCAs as part of the requirements systems known as JCIDS.[5] The reviews are conducted by Functional Capability Boards (FCB), which also align with JCAs. USD(R&E) holds Technology Portfolio Management Review (TPMR) for 14 technology areas. USD(A&S) conducts Integrated Acquisition Portfolio Review (IAPR) based on an organizational structure poorly aligned to JCAs. The Cost Assessment and Program Evaluation office holds Strategic Portfolio Reviews (SPRs). There does not appear to be any alignment across these various portfolio reviews, making it difficult if not impossible to aggregate across the enterprise.[6]

Each part of the D2S2 is a decision system that takes a unique hierarchical approach. The use of a hierarchical portfolio structure method for integration and trade-

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[2] The ADVANA effort was described to the research team by some OSD staff as a data mesh quickly turning into a data swamp.

[3] We separate the complicated from the complex as defined in Cynefin Framework by Dave Snowden.

[4] Project Management Institute (PMI) publishes an ANSI Standard for Portfolio Management. There is also an ISO standard in the 21500 series for project, program, and portfolio management.

[5] JCIDS is the Joint Capabilities Integrated and Development Systems, CJCSI 5123.01I.

[6] Technology portfolios would flow directly into systems/platform portfolios.

offs can work, but not if the various structures cannot be aligned. The migration to network structure was recommended shortly after the department moved to the capability-based planning approach driven by the 2001 Quadrennial Defense Review and the subsequent Aldridge Study in 2003. At the time, it was recognized the complicated nature and the need for non-hierarchical approaches. The allocation of resources is

> not only at a given level and within a given concept of operations, but also across levels and configurations. Anyone who imagines that analysts can readily compute the relative worth of an additional fighter aircraft, missile launcher, or company of tanks probably has a simplistic and rigid notion of military operations and a correspondingly simple-minded way of comparing worth (e.g., by their relative lethality in a duck-shooting contest). It is better to adopt the spirit of portfolio analysis and recognize the role of multidimensional trade-offs and subjective judgments. This view may be heretical to operations researchers, but it is true nonetheless. (Davis, 2002)

The architecture/civil engineering/building industry has created an "Organization and digitization of information about building and civil engineering works, including building information modeling (BIM)" international standard, known as ISO 19650. A framework for pulling programmatic, engineering, and sustainment information together. The defense department has built the DoD Architecture Framework (DODAF), a structure "designed to meet the specific business and operational needs of the DOD." It might be useful, but unlike the WBS structure in weapons acquisitions, it has not taken hold across products/platforms even as the network-centric approach has permeated throughout products/platforms. The DODAF structure is not used in any of the D2S2 systems.

The challenge at the enterprise level is no robust integrating structures across the various organizations within OSD and its components.[7] The DoD operates with an incomplete, diverse D2S2 across six or more decision systems, creating a complex framework for making decisions. A decade ago, it was noted, "It is arguably time for the strategic level of analysis to be revisited" (Davis et al., 2008). It is not going to be simple, but like any wicked set of problems, they need to break down into manageable challenges, which is what the three aligned portfolio structures can provide.

Background

The Acquisition Innovation Research Center (AIRC) was created by the Secretary of Defense in September 2020 in response to 10 U.S.C. 2361(a) utilizing the DoD's Systems Engineering Research Center (SERC) University-Affiliated Research Center (UARC).[8] Among the research tasks was an emphasis on portfolios/missions with a *Data-driven capability portfolio management pilot* to prototype capability to enhance data-driven decision-making regarding acquisition and support programs (UARC, 2021) Working from a previous effort to create a Model-Based Portfolio Analysis Capability for the Joint PEO for Chemical, Biological, Radiological and Nuclear Defense (JPEO-CMRND; WRT, 2020), Dr. Daniel DeLaurentis with his Purdue research team and other university partners

[7] DoD components include OSD, CJCS, DoD Inspector General, Military Departments, DoD field activities, the Combatant Commanders, and some other minor organizations.

[8] University of Maryland is a member of UARC.

adapted a previously developed systems-of-systems analytic workbench (SoS-AWB) of analytic tools to create a decision-support prototype, effective for informing decisions in Integrated Acquisition Portfolio Reviews (IAPRs). These advanced prototypes provide a broader range of insights (e.g., resource trade-offs, cost-sensitivity analysis, etc.) for stakeholder decision making.

The report notes under a portfolio-centric approach:

> The Department of Defense (DoD) has an increasing focus on Mission Engineering (ME) analysis and architecture development for modernization decisions, including investments and prioritization related to requirement development and selection of capabilities to support various concepts of employment and technological improvements. Typically, however, systems engineering tools focus on the system itself. That is, the tools may not translate the complexities of mission engineering analysis into the configuration in a way that is both (a) meaningful to the requirements within the trade space of capabilities and (b) flexible, scalable, and configurable to integrate with other analyses. To this end, recommendations from an advisory panel suggested that the DoD approach should take a more holistic and portfolio-centric method for acquisitions rather than the current program-centric approach. In our prototype, systems and technologies are evaluated within an overall portfolio, exposing how each component plays a role in the realized capability while connecting the mission needs of warfighters with acquisition decisions. Continued development along these lines will eventually pave the way for the establishment of Acquisition Integration and Interoperability (AII), which should be based on mission and digital engineering, using data-driven methods (AIRC, 2022).

Though the concepts are solid, they have not evolved into usable tools for OSD decision-makers within the DoD Decision Support Systems (D2S2), which has evolved over the past 60 years, but is fundamentally the same structure of interfaced, but not aligned, decision systems. If it was a weapon system of systems, it would be considered poorly integrated and not interoperable. During the past 60 years, the underlying weapon and other products/platforms have grown more integrated and interoperable. As Vice Admiral Arthur Cebrowski noted at the end of the last millennium,

> Network-centric warfare and all of its associated revolutions in military affairs grow out of and draw their power from the fundamental changes in American society. These changes have been dominated by the co-evolution of economics, information technology, and business processes and organizations, and they are linked by three themes:
>
> - The shift in focus from the platform to the network.
> - The shift from viewing actors as independent to viewing them as part of a continuously adapting ecosystem.
> - The importance of making strategic choices to adapt or even survive in such changing ecosystem.

As the OSD and other DoD components explore portfolio management, which industry standards is also evolving, the DoD cannot ignore that it is fundamentally still in a major platform-centric management structure. As Admiral Cebrowski notes at the end of the article, as

B. H. Liddell Hart said, “The only thing harder than getting a new idea into the military mind is getting an old one out” (Cebrowski & Garstka, 1998). The DoD should move toward a network of portfolios when managing product.

Much has been written on the need for the DoD to effectively use portfolio management, both for improving the DoD’s acquisition outcomes (GAO, 2007) as well as at an enterprise level to integrate DoD Decision Support Systems (D2S2; GAO, 2015a).

> DOD attempted to standardize portfolios in the 2006 to 2008 time period. However, a former senior official who was involved in that effort said the mapping was “impossible” and that there was organizational resistance because the portfolios did not align with many decision makers’ areas of responsibility. Many of the enterprise- and service-level officials we interviewed said using a wide variety of constructs is necessary and sometimes beneficial given the different roles and perspectives of the organizations involved. However, when they want to analyze their portfolios from another perspective—for example, examining funding associated with joint capabilities areas—they have to go through extensive mapping exercises. (GAO, 2015a)

For programs, the Program Executive Officer has the requirement to balance risk, cost, schedule, performance interoperability, sustainability, and affordability of a portfolio of acquisition programs (GAO, 2007). The Section 809 Panel report provides almost a hundred pages on how PEOs could be more effective as empowered Portfolio Acquisition Executives (PAE) with a half dozen portfolio-specific recommendations (DTIC, 2019). The 809 Panel recommended a transition from the program-centric execution model to a portfolio model with an increased enterprise view, which meant various portfolio views led within the requirements structure. The panel also recommended implementing best practices for portfolio management. The effectiveness of D2S2 “must be assessed in terms of developing, delivering, and supporting defense systems that enable US dominance. … For more than 50 years, the fundamental structure and focus of acquisition have been on MDAPs,[9] but the nature of capabilities has changed” (Ahern & Driessnack, 2019).

In 2008, the DoD published the Directive on Capability Portfolio Management, DoDD 7045.20. It establishes the policy to use capability portfolios following the “existing joint capability areas (JCA) structure.” The directive called for “Capability Portfolio Strategic Plans” and creating co-leads with “no independent decision-making authority.” The directive was not well implemented, nor has it been effective in using the Deputy’s Management Action Group (DMAG) or “ensuring alignment to strategic priorities and capability demands” (DOD, 2019).

The latest DoDD 5000.01[10] calls for “Capability portfolio management, mission engineering, and integration analysis using an effects/kill chain framework will be employed to assess the integration and interoperability of the SoS required to execute critical mission requirements.” Recently USD(A&S) has reorganized into so-called[11] Capability Portfolios whose “mission is to use Capability Portfolio Management to analyze, manage, and inform acquisition and resourcing decisions in platform and weapon portfolios” (DOD, 2023). Last year an Integrated Acquisition Portfolio Review (IAPR) was established but has also not been

[9] MDAP is a Major Defense Acquisition Program.

[10] DoD acquisition directive and instructions were significantly revamped from 2020 to 2022.

[11] We use the term “so-called” because the structure does not align with the CJCS JCA structure.

successful. As a result, in late January 2023, an Acquisition Integration and Interoperability (AI2) concept was outlined to be established within OSD(A&S) to:

- "Enable the delivery of integrated defense capabilities
- Drive adoption of threat-based mission thread analysis …
- Acquisition portfolio reviews to drive resourcing and enterprise decision …IAPR
- Establishes an OSD entity to align service-specific systems acquisition programs, prototypes, and S&T projects to deliver joint integrated capabilities.
- In partnership with key stakeholders across OSD, the Joint Staff, and the Military Departments and Military Services, AI2 will deliver dedicated analysis, planning, resource recommendations, and portfolio management necessary to deliver joint capabilities across the Department."

Overall, the approach does not address the enterprise level; nor does it establish a network structure of portfolio below the enterprise; nor does it adopt portfolio management best practices as recommended in the Section 809 panel and defined by ANSI standards for portfolio management.

Research Tasks

The research effort is currently broken into three phases with a goal to "expand and enhance capability and performance management insights across DoD acquisitions program, including at Mission and Program Executive Officer (PEO) portfolio levels. Two main thrusts (1) focus on portfolio funding profile and (2) development of a portfolio executive dashboard to provide integrated data/views for missions, capability, and product/platform. Each phase expands both thrusts, which are perceived to be synergistic.

The team interfaced with a half dozen current OSD portfolio managers and participated in weekly OSD level meetings on improving data analytics to support and improve insights for the portfolio managers. Two comprehensive reviews were conducted in December 2022 and February 2023 with OSD staff as well as numerous other meetings to clarify observations and insights. The team also met with PEO IWS staff on several occasions as well as Navy and Air Force staff relative to those components data systems, such as the Assistant Secretary of the Navy (Research, Development, and Acquisition) (ASN(RD&A)), Information System (RDAIS), and Army/Air Force/Space Force Project Management Resource Tool (PMRT).

Portfolio Funding Profile (Task 1a)

Portfolio Level Funding and Quantities Chart (see Table 1), commonly known as the "Spruill Chart," named after Dr. Nancy Spruill, has been around for over 20 years (Woolsey, 2018). The chart is explained in detail in the DoD Cost Estimating Guide. The research team was tasked with creating a portfolio version by aggregating all the data for all the programs/systems within the portfolio, whether those portfolios are by PEO of Systems, Capabilities, or Missions. A notional minimum viable product (MVP), a wireframe mockup, using PEO IWS as an example for a portfolio-level dashboard was created and reviewed with OSD portfolio managers (Kenney & Kwapong, 2023b). The concept was to move beyond "charts" to more visually integrated data graphics. Further work was suspended due to data quality and access restrictions.

Table 1 The Program Funding and Quantities Chart

Program Funding & Quantities			Acquisition to O&S Cost Ratio					(BY 2019)	Curr Est	Δ Current	Δ Original
			Total Required Acq (BY$M):			$14,782	32%	PAUC:	581.9M	+4.6%	+10.2%
			Total Required O&S (BY$M):			$31,245	68%	APUC:	740.1M	-3.2%	+60.2%
($ in Millions / Then Year)	Prior	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY21-25	To Comp	Prog Total
RDT&E	BLIs:										
Prior $ (PB 20)		416.5	1,718.1	1,092.7	1,005.0	220.9	16.0	0.0	2,334.6	0.0	4,469.1
Current $ (POM 21)		**447.8**	**1,652.0**	**1,256.0**	**995.0**	**235.0**	**0.0**	**0.0**	**2,486.0**	**0.0**	**4,585.8**
Delta $ (Current - Prior)		31.3	(66.1)	163.3	(10.0)	14.1	(16.0)	-	151.4	-	116.7
Required[1] $		**488.1**	**1,635.5**	**1,205.8**	**985.1**	**251.5**	**0.0**	**0.0**	**2,442.3**		**4,565.8**
Delta $ (Current - Required)		**(40.3)**	**16.5**	**50.2**	**10.0**	**(16.5)**	-	-	**43.7**	-	**20.0**
PROCUREMENT	BLIs:										
Prior $ (PB 20)		0.0	0.0	522.7	1,999.6	2,313.5	2,650.6	2,346.3	9,832.5	1,872.2	11,704.8
Current $ (POM 21)		**0.0**	**0.0**	**562.0**	**1,754.0**	**2,385.0**	**3,012.0**	**2,133.0**	**9,846.0**	**2,152.0**	**11,998.0**
Delta $ (Current - Prior)		-	-	39.3	(245.6)	71.6	361.4	(213.3)	13.5	279.8	293.2
Required[1] $		**0.0**	**0.0**	**562.0**	**1,859.2**	**2,385.0**	**2,861.4**	**2,026.4**	**9,694.0**	**1,974.1**	**11,668.1**
Delta $ (Current - Required)		-	-	-	**(105.2)**	-	**150.6**	**106.7**	**152.0**	**177.9**	**329.9**
MILCON	BLIs:										
Prior $ (PB 20)		0.0	1.5	1.7	0.0	1.7	16.0	2.9	22.3	15.3	39.1
Current $ (POM 21)		**0.0**	**1.4**	**1.7**	**0.0**	**2.0**	**2.1**	**3.0**	**8.8**	**12.6**	**22.8**
Delta $ (Current - Prior)		-	(0.1)	(0.0)	-	0.3	(13.9)	0.1	(13.5)	(2.7)	(16.3)
Required[1] $		**0.0**	**1.5**	**1.8**	**0.0**	**2.0**	**2.2**	**3.3**	**9.3**	**12.6**	**23.4**
Delta $ (Current - Required)		-	(0.1)	(0.1)	-	-	(0.1)	(0.3)	(0.5)	-	(0.6)
SYSTEM O&M[2]	BLIs:										
Prior $ (PB 20)		0.0	0.0	0.0	0.0	141.3	16.0	1,230.0	1,387.2	37,051.0	38,438.2
Current $ (POM 21)		**0.0**	**0.0**	**0.0**	**0.0**	**125.0**	**359.0**	**1,268.0**	**1,752.0**	**37,051.0**	**38,803.0**
Delta $ (Current - Prior)		-	-	-	-	(16.3)	343.0	38.0	364.8	-	364.8
Required[1] $		**0.0**	**0.0**	**0.0**	**0.0**	**118.8**	**362.6**	**1,318.7**	**1,800.1**	**35,198.5**	**36,998.5**
Delta $ (Current - Required)		-	-	-	-	6.3	(3.6)	(50.7)	(48.1)	**1,852.6**	**1,804.5**
TOTAL											
Prior $ (PB 20)		416.5	1,719.6	1,617.1	3,004.5	2,677.3	2,698.6	3,579.1	13,576.6	38,938.5	54,651.2
Current $ (POM 21)		**447.8**	**1,653.4**	**1,819.7**	**2,749.0**	**2,747.0**	**3,373.1**	**3,404.0**	**14,092.8**	**39,215.6**	**55,409.6**
Delta $ (Current - Prior)		31.3	(66.2)	202.6	(255.5)	69.7	674.5	(175.1)	516.2	277.1	758.4
Required[1] $		**488.1**	**1,637.0**	**1,769.6**	**2,844.3**	**2,757.2**	**3,226.2**	**3,348.4**	**13,945.6**	**37,185.1**	**53,255.8**
Delta $ (Current - Required)		**(40.3)**	**16.5**	**50.1**	**(95.3)**	**(10.2)**	**146.9**	**55.6**	**147.2**	**2,030.5**	**2,153.8**
QUANTITIES											
Prior (PB 20)		0	2	1	2	4	6	2	15	3	20
Current (POM 21)		**0**	**2**	**1**	**2**	**4**	**6**	**2**	**15**	**3**	**20**
Delta Qty (Current - Prior)		0	0	0	0	0	0	0	0	0	0
Required Qty[3]		**0**	**2**	**1**	**2**	**4**	**6**	**2**	**15**	**3**	**20**
Delta Qty (Current - Required)		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

We had three significant observations with this task. The first observation was with the required line and the point cost estimate nature of that line not representing the confidence level of the proposed required funding line. The second observation was simply understanding what products/platforms were within the portfolio, whether that was a PEO portfolio, a capability portfolio, or a mission portfolio. Finally, the concept of aggregating the individual program funding within appropriations would likely not be very useful as the movement of funds across programs is restricted by reprogramming rules.

Capability/Mission Thread Portfolio Schedule/roadmap on PEO-IWS (Task 2a)

Under the concept of the OSD level Integrated Acquisition Portfolio Review (IAPR), a particular capability portfolio, made up of the product/platforms which provide the particular capability would be reviewed together, both individually and as an aggregate. Also, the capabilities used within selected mission threads would be reviewed to determine if end-user mission capabilities were being improved. As a result, the research team was tasked with developing a capability portfolio view that looked across systems/platforms within the capability.

Through a UMD partnership with Catalyst Campus for Innovation and Technology, located within the University Campus Research Park, the research team worked with PEO IWS leadership and the Forge software factory to identify a use case for capability portfolio system/platform data. The complicated nature of the PEOs portfolio (Figure 1) helped quickly identify challenges in the assumptions of the research.

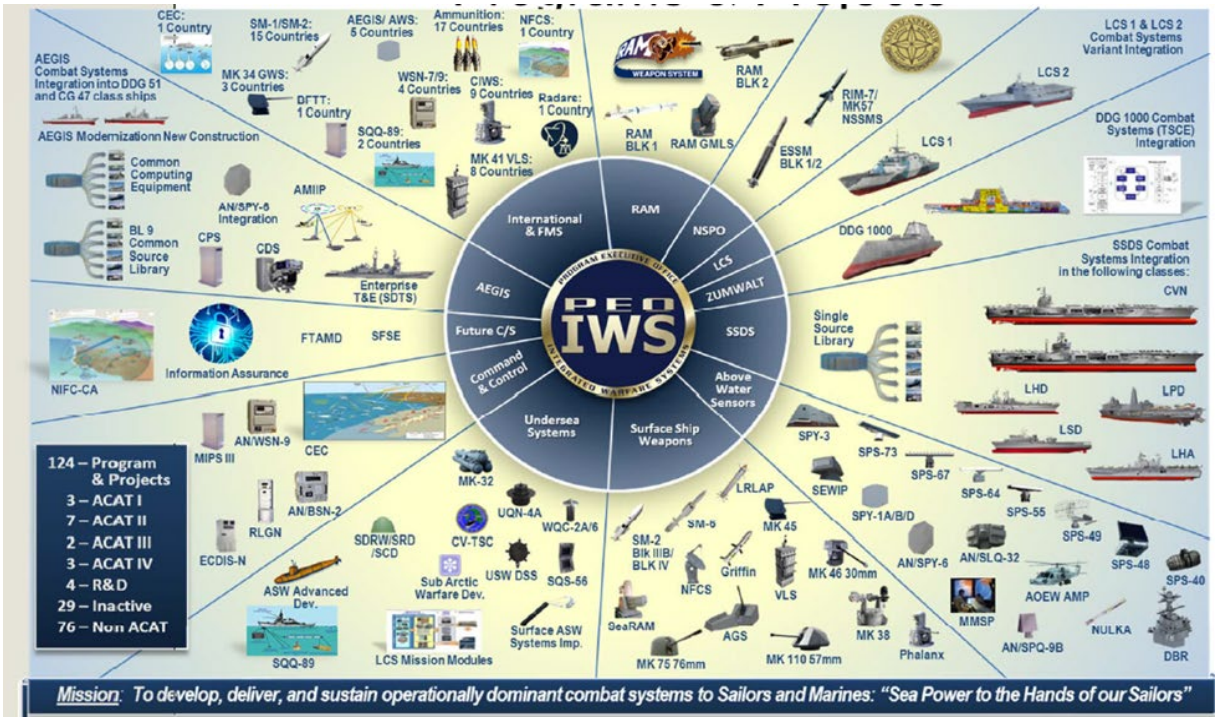


Figure 1 PEO IWS overview slide 2015

Working with the OSD capability portfolio managers, several systems across the PEO IWS structure were selected. Quickly, it was identified that obtaining any relative data for capabilities or missions would be classified. Looking at Task 1a on the funding profile for the systems, it became clear there was no standardized way to identify which Budget/POM lines across the appropriations were funding the programs. As we further looked into the scenarios across other PEOs and services, we ran into situations in which consistency in how the funding of new capabilities, especially with modification, increased the complicated nature of the Budget/POM lines. A platform could be funding its modification completely on its own or systems/subsystems could be funded outside the platform with no apparent rule to drive consistency.

When it came to schedules, the team looked at Budget/POM exhibits (RDT&E and Procurement), which have schedule formats for contract actions and overall program schedules. The team compared documents for selected programs from 2015 to 2021. Observations confirmed the impressions of many of the OSD portfolio managers that these documents were "useless" relative to their needs to assess the status of the efforts or to provide insight on funding. The portfolio managers found the data out of date and at such a summary level that it provided little value. The research team observed that across the various budget submittals, there was often no alignment of the text/schedule portions from year to year, thus greatly limiting the usability of the data. In reviewing the availability of the data in ADVANA, the team found key program descriptions, explanations of accomplishments, and the schedules themselves, mainly because they were picture pasted onto the form; the data was not captured

in any standardized format that was traceable from year to year. Below the PE project code on the RDT&E document, the use of project code, there was no standardized structure on how descriptions, accomplishments, and plans were characterized. In many cases, project codes were not used. The use of AI/ML/NLP type techniques would not be productive to pursue at this time without some improvement in how the efforts were described in a more standardized approach to the project level.

The budget documents are structured for reporting, not for management of the program; thus, not characterized by a meaningful management structure, but rather for justification of dollars. In some cases, project # could present billions of dollars while other project # presented millions. There was no alignment with approved program WBS, nor capability, such as a JCA or UJTL item, nor a mission thread.

Overall, data management across a multidimensional portfolio will be a data challenge. To address portfolio data management, a review of NoSQL approaches, including key value pairs, is being explored to model not just programmatic data, but operational capabilities and missions (Kenney & Driessnack, 2023a). Traditional SQL approaches, in use today by most data systems within the DoD, require rigid, structured, relational databases. This approach is limited at scale for enterprise portfolios because it requires strict data formats which can be difficult to modify and prone to user error. As a result, data can be “lost” within these systems, making it difficult for portfolio managers to see the full picture. NoSQL approaches that interact with non-relational databases, such as column-oriented, document-oriented, key-value pairs, and graph databases, can be used for many-to-many relationships, such as multiple systems supporting multiple capabilities and missions.

Phases 2 and 3 Plan

Phases 2 and 3 will expand to program performance management metrics, such as earned value, agile, and classic qualitative and quantitative risk metrics expanded to include constraints, assumptions, issues, risks, and opportunities (CAIRO). The collection of CAIRO data is known as challenge management. The team will also explore the use of artificial intelligence (AI) and machine learning (ML) along with use natural language processing (NLP) on written assessments.

Portfolio performance management metrics for capabilities and missions are not readily available. One OSD capability manager provided their own set of metrics utilized to assess the portfolio of programs with many being proxies, such as looking at program obligation and expenditure rates as an indication of portfolio health. The availability of program-level data below the MDAP was reported as almost impossible for the portfolio managers to obtain. The more the portfolio manager had subsystems, components, or modifications within their portfolio, the less visible the data. The team will review existing data in use, as well as propose a data and metrics framework to support the multidimensional portfolio reporting needed for capabilities and missions.

It is generally accepted that risk management, and explicitly quantitative risk management, is key to managing forward with data. Risk Management is looking into the future, understanding the CAIRO that provides an understanding of how the leadership/management should focus to make decisions today that affect not just the future plan, but the confidence of that plan. The DoD does this type of work within cost and schedule estimating and required contractors on higher cost-plus contracts to incorporate risks in estimates to complete. The challenge is that the data does not make it into any of the OSD or other DoD component management systems except at level 1 of the WBS.

Given the finding in Phase 1, the team has made recommendations for specific changes

to the approach in the future, which are discussed below in the Path Forward section.

Challenges

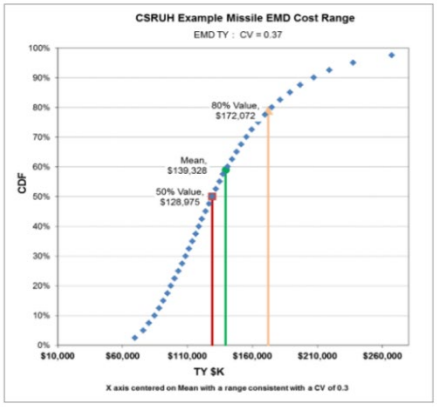
Table 1 shows funding and quantities for prior vis current vis required for the Execution/Budget/POM years with the deltas (current—prior as well as current—required) across each type of appropriation. The chart provides a complete picture of the funding for a particular product/platform. It does not show changes from the prior couple of years or changes in requirements or changes in estimates.

Cost Estimate Range and Risk Drivers Challenge:

All but one of the lines shown in Table 1 are available within the OSD Comptrollers data systems and ADVANA. The exception is the required lines. As outlined in the DoD Cost Guide, these lines represent the "Latest estimate of funds required to successfully execute a program, e.g., support the Warfighter and note simple math available budget TOAs. Typically, this would reflect the Will Cost estimate, CCP, or POE[12] that has not yet been validated by a component cost agency or the CAPE." These estimates are not recorded in any database within OSD, nor the DoD components. The line typically represents to the management team, whether a program, MDA, or Service position, the funding requirements based on one of the cost estimates noted. A cost estimate by its nature would not be a point estimate by fiscal year. Plus, the cost estimate would go through phasing, in which the cost estimate is allocated across the fiscal years to ensure adequate budget authority. Depending on the appropriation, the phasing would be different, which RDT&E incrementally funded, and procurement fully funded. How sensitivity analysis and risks or opportunities, and uncertainty were addressed could also affect phasing. The research team held discussions with several current OSD portfolio managers across several capabilities. The common goal was to "assure the component was robustly funding the program." This is hard to do when the level of confidence in cost and schedule are not documented in a manner that the data is readily available.

The data that characterized the estimate is critical to understanding the uncertainty in the program. "Without a risk and uncertainty analysis, the program estimate will not reflect the degree of uncertainty, and a level of confidence cannot be given about the estimate. Unless a range of costs is provided, decision-makers will lack information on cost, schedule, and technical risks, and will not have insight into the likelihood of executing the program within the cost estimate." It goes on to note that "without an S curve, decision-makers will lack insight of what the likelihood of different funding alternative imply about program success" (GAO, 2020). The DoD Cost Guide provides a suggested S-Curve (Figure 2), as well as other formats for characterizing range. These practices are industry best practices, documented in both ANSI and ISO standards with clear characterizations of both qualitative and quantitative risks along with the designation of contingent and management reserves (PMI, 2021).

[12] CCP is component cost positions; POE is program office estimate.



Probability	TY K$
90%	$207,255
80%	$172,072
70%	$155,334
60%	$140,795
50%	$128,975
40%	$118,768
30%	$108,375
20%	$97,122
10%	$84,554

Cost Uncertainty Drivers
- SW Months
- Design Cost/Mth
- SW labor Rate
- EMD Duration

Figure 2. S-Curve example (notional)

The DoD Capability Portfolio Management goal is stated “to optimize capability investments across the defense enterprise (both materiel and non-materiel) and minimize risk in meeting the Department’s capability needs in support of strategy” (DOD, 2017). It is not possible to achieve with the Spruill Chart and the limited availability of data that characterizes the challenges at the program level and the aggregate at the portfolio levels.

Network Schedule Challenge?

The second challenge is the lack of program or PEO level network schedules, or Integrated Master Schedules. Scheduling information, which includes dates for objectives and thresholds on key milestones, is usually submitted in PDF Gantt chart form with budget documentation or briefing slides attached to PMRT or other reporting tools. However, it typically does not include network schedules that model the program.

The DoD requires very detailed contractor schedules on programs implementing Earned Value Management, with data being submitted per data items descriptions (DID). However, our cursory review and discussion with OSD Portfolio Managers did not expose any network schedule models. One OSD portfolio manager understanding the value of such models was producing a network schedule gathering data from various sources on their own.

Without a schedule model, it is almost impossible to do a comprehensive quantitative risk analysis on schedule. OSD Cost Estimating guide calls for such analysis, but DOD 5000 series of directives and instructions do not specifically require it. This is counter to industry standards and the evolution within the industry. Within the construction and other industries, “Digital twin’ technology and planning and scheduling are integrated to form a planning and scheduling system based on digital twin” (Wang 2020). A similar approach is needed to address the complex scheduling network within DoD portfolios.

What Is in the Portfolio Challenge?

The third challenge is how a particular portfolio is aggregated. Of the three proposed multidimensional portfolios, Products/Platform, Capability, or Mission, none of them have a clear characterization of the portfolio in any reference schema to allow easy aggregation. The programs/platforms portfolio has focused on Major Acquisition Defense Program (MDAP), using a program number (PNO). OSD is in the process of establishing a PNO, which is three-digit alpha-numeric, for all baselined programs at all levels. The PNO number is also used in budget documentation. However, this is not likely to solve the needs within the multidimensional portfolio structure.

An example would be tracking variants with alternative configurations as the PNO

designation is focused on a program, not the product or platform. The PNO designation is focused on how the DoD baselines and funds an effort. An example of this is GCSS Army has five entries, PNO N03, H41, 347, 402, and 501. PNO 501 is the current effort, GCSS-A Increment 2. In order to see the portfolio view of the capability, the capability manager has to look across multiple PNOs. Another example is the B-52. The B-52 is in DoD Acquisitions Visualization Environment (DAVE) over 25 times with numerous PNOs. This is because the platform has been modified via separate programs, meaning baselined with separate funding, numerous times over the decades. This makes data retrieval and analysis prone to error, as the relationships of the PNOs are not easily traceable within the existing data systems.

For capability portfolios, the CJCS Functional Capability Boards (FCB) under JCIDS, which manage the capability portfolios in DoDD 7045.20, poorly align with USD (A&E) capability breakouts. We could not find a Product/Platform to JCA alignment within the DoD data schemas. Missions Threads aggregated into any type of portfolio structure could also not be found. No comprehensive schema to align across the various D2S2 systems exists.

Industry uses projects as subsets of programs or portfolios. This three-tiered structure would be helpful in further breaking down programs within the DOD. The project term is used in budget documents, but that use is not aligned with any formal baselining of projects under the formalized baselined programs. The Portfolio to Program to Project is a governance breakdown structure (GBS), which is different from the Work Breakdown Structure. The DoD product is a system, like a jet engine, and the platform systems, the fighter aircraft. If F-16 is the platform, a system of systems, then the engine as a system was managed in a different program than the F-16, but relative to the F-16 is in the platform WBS. In the F-35, the engine is within the same programs, but the same governance structure.

Within the project/program management profession, a standard work breakdown structure is key for data collection and integration across not just engineering, but also cost, schedule, risks, and overall programmatic data. The DoD has had a standard WBS structure since 1968. MIL-STD-881 at one point was made a handbook in 1998 to reduce military standards. The handbook version moved back to a standard in 2011, as it became clear the flexibility of the handbook was not providing the appropriate level of standardization.[13]

Multidimensional System of Systems Challenge

The only mention of system of systems (SoS) in DoDD 5000.01 is related to capability portfolio management, mission engineering, and integration analysis using an effect/kill chain framework that employs the **integration and interoperability** of the SoS required to execute crucial mission requirements. Integration and interoperability are bolded to remind ourselves of the new OSD initiative on Acquisition Interoperability and Integration (AI2). It is not about platform SoS but mission SoS. It is not mentioned in DoDI 5000.02 or DoDI 5000.88 on Engineering of Defense Systems. But it does show up in the OSD Mission Engineering Guide relative again to warfighter **integration and interoperability** of SoS.

We are using system and SoS in the broad sense. Industry defines SoS as a “Set of systems or system elements that interact to provide a unique capability that none of the constituent systems can accomplish on its own. Note: Systems elements can be necessary to facilitate the interaction of the constituent systems in the system of systems. Constituent systems can be part of one or more SoS. Note: Each constituent is a useful system by itself, having its own development, management goals and resources, but interacts within the SoS to provide the unique capability of the SoS” (Henshaw et al., 2023). The SEBoK noting the seminal work of Dr. Mark Maier (1998) postulated five key characteristics (not criteria) of SoS, noting

[13] Per discussion with Neil Albert, March 16, 2023 with John Driessnack

operational independence and managerial independence as the two principal distinguishing characteristics of SoS.

It should be useful to combine the management implications of portfolio management (PfM) with the technical and capability implications of system of systems (SoS). Understanding in both cases, there can be sub-portfolios within portfolios and sub-systems or system of systems within a system of systems. For our goal of improving enterprise decisions relative to resources at the DMAG level, the complicated structure is broken into three sets of portfolios:

1. **Portfolio of products/platforms for the purpose of life-cycle management of those products/platforms**. This is the traditional System Program Manager (SPM) who works for a PEO. The SPM in many cases has a portfolio of systems that fit within a larger portfolio managed by the PEO. We need a governance breakdown structure (GBS) that manages products/platforms in which we use a work breakdown structure (WBS). The significant interchange between the GBS and WBS as products used in various platforms are managed under various governance schemas, which are not consistent. The schema creates its own system of systems.
2. **Portfolio of operational unit capabilities[14] for the purpose of managing the requirements relative to a family of similar products/platforms**. This is traditionally the component requirements officer who works with an overall military capability planning organization. Products do not have operational capability; this should refer to the military unit, the fighter squadron, not just the fighter platform. Most if not all of DOTmLPF-P structure needs to be considered. In this portfolio, we suggest the structure should follow how the DoD components are structured by operational units.
3. **Portfolio of combatant missions for the purpose of managing the missions within a combatant command's (CCMD) or combat support agency operations plans**. Here, the capable DoD component operational units are placed into a combatant or support unit structure to perform missions under an operational plan. The structure could follow OpsPlan structure.

Operational Unit Capability Structure Challenge

The operational unit capability challenge was identified when it became clear that the capability portfolios within USD(A&S) and those within the CJCS organization did not align. Table 2 describes groupings of related capabilities that support strategic decision-making and capability portfolio management, including joint analyses of capability gaps, excesses, and major trade-off opportunities. The challenge is capability is defined by CJCS as "the ability to complete a task or execute a course of action under specified conditions and level of performance. This can be achieved through a combination of means and ways across doctrine, organization, training, leadership and education, materiel, personnel, facilities, and policy." The keys in this definition are "TASK" and the reference to "DOTmLPF-P."[15] There is not an emphasis on "materiel," but the whole of the DOTmLPF-P. Materiel is defined as "all items necessary to equip, operate, maintain, and support military activities without distinction as to its application for administrative or combat purposes."

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[14] We will use operational capability to distinguish from technical capability of the product.

[15] DOTmLPF-P is defined in CJCSI 5123.01, the Charter of the JROC and Implementation of the JCIDS as Joint Doctrine, Organization, Training, materiel, Leadership and Education, Personnel, Facilities, and Policy (DOTmLPF-P). The instruction defines the Functional Process Owner (FPO) for each of the DOTmLPF-P process. For "materiel," J-8 Force Structure, Resource & Assessment Directorate is the FPO and manages the overall JCIDS process.

Table 2 Tier 1 JCAs POC's

Tier 1 JCA(s)	Organization
Force Integration	FI FCB
Battlespace Awareness (BA)	BA FCB
Force Application (FA)	FA FCB
Logistics (LOG)	LOG FCB
Command and Control	C4/Cyber FCB
Communications and Computers	C4/Cyber FCB
Protection	Protection FCB
Corporate Management and Support	Pending DEPSECDEF Assignment

The CJCS method to track tasks is through the Universal Joint Task List (UJTL), which is the authoritative common language for all approved joint tasks required for planning, readiness reporting, training and exercises, lessons leaner processing, and requirements. "A universal joint task (UJT) is an action or activity assigned to a unit or organization to perform a specific function and/or provide a capability or resource. UJTs are based on extant joint capabilities, and they have a foundation in approved joint doctrine. Specifically, UJTs describe "what" joint organizations must do using common and joint terminology" (CJCS, 2022).

It appears as if the UJTL is to missions as a product-based WBS is to the product/platform. Both track capability, one helps with operational, the other with technical. JCAs are a management structure for the CJCS minimally aligned with the field, similar to the Capability Portfolio structure within OSD minimally aligned with the PEO/SPM structure in the acquisition community. This weak alignment inhibits any reasonable mapping of data from the governance structures to the actual efforts.

A Joint mission-essential task (JMET) is a mission task selected by a joint force commander deemed essential to mission accomplishment and defined using the common language of the Universal Joint Task List in terms of task, condition, and standard. See also condition; Universal Joint Task List. Source: JP 3-33. The UJTL is a key schema that could be used to map the capabilities of operational units with missions (see Figure 3).

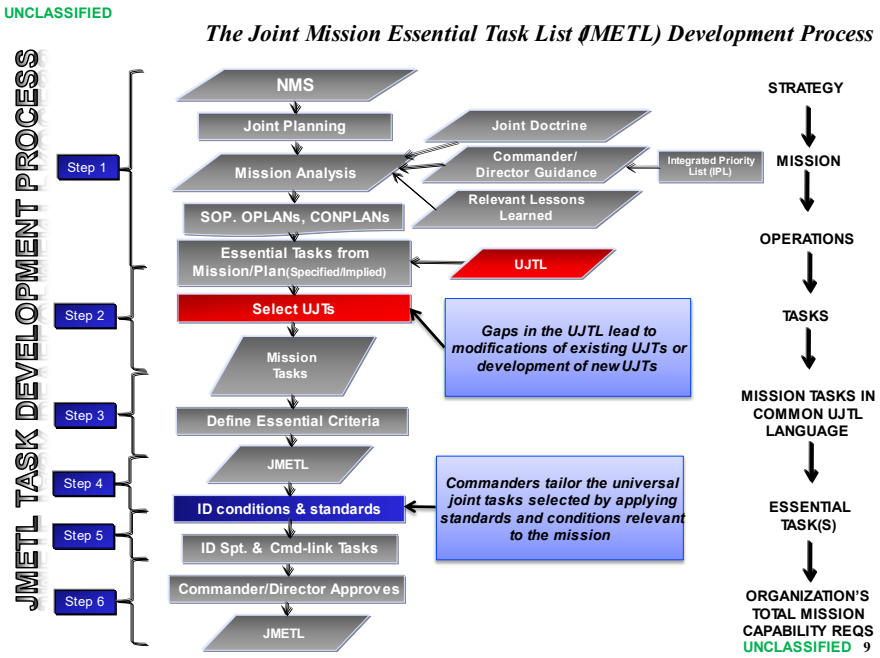

Figure 3 JMETL Development Process

Going back to the F-16 example, in UJTL we could use OP 6.1.4 Conduct Defensive Counterair (DCA). The task is to "conduct defensive measures designed to neutralize or destroy enemy forces attempting to penetrate or attack through friendly airspace. JP 3-01." The UJTL has six defined measures (see Table 3) for which to assess the capability. Within the "mission to readiness" example (see Figure 4), the UJTL sets up the structure not only for the JMETL, but also the training and readiness assessment. The UJTL then forms the structure for the Defense Readiness Reporting Systems (DRRS), which could provide meaningful assessment data.

Table 3 UJTL Capability Assessment Measures

Measures:		
M1	Minutes	To notify friendly counterair forces (to gain intercept position).
M2	Percent	Of joint security area (JSA) and joint operational area (JOA) in which friendly freedom of movement allowed.
M3	Percent	Of enemy air attacks detected early enough to allow engagement.
M4	Percent	Of enemy air defense targets successfully engaged.
M5	Percent	Of enemy aircraft penetrate air defenses.
M6	Percent	Of first-shot kills by friendly fighters in air-to-air combat.

The scope of the Phase 1 research topics helped identify five key challenges, which need to be addressed to complete Phase 1 and continue with Phase 2 and 3. To model across the product/platform we need a structure, like the UJTL, to create a comprehensive architecture for missions. The architecture requirements are to provide an aligned set of structures that will support the individual decision system data systems as well as the enterprise data systems within the D2S2 to enhance effective and efficient decision analytics.

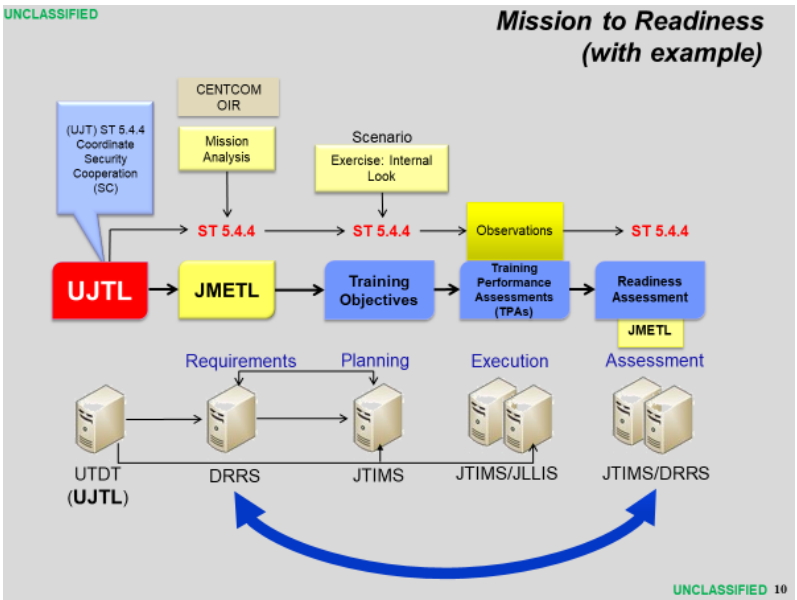

Figure 5 UJTL Common Thread, Mission to Readiness Example

Next, we will create a notional example model of a multidimensional (not multilayers, as it is not a hieratical challenge) structure of portfolios of products/platforms, and operational units, which are assigned to combatant and support commanders. The goal of the structure will be to represent the challenges across the D2S2 by creating a notional data set within each structure. The structure will allow the creation of models with enough standardization to allow useful information to flow from the lowest levels up to the Deputy's Management Action Group (DMAG) level. Additionally, the structures must have enough flexibility to be useful to the various level of managers within the governance structures. While much of the current structure already used within each domain will be considered, the research team anticipates changes will be needed to allow alignment across the portfolios.

Assessment within a Capability or Mission Portfolio will not be possible until the enterprise works off an aligned structure. In phase 2, the use of UJTL will be explored for capability along with a unit organizational structure. Hopefully, it can also be used as a common structure for mission thread assessment. We will need to consider the structure of the regional and functional combatant commanders along with supporting commanders and how Operational Plans are structured under CJCS policy.

The resulting multidimensional portfolio structure could be documented in a revised DoDD 7045.20, renamed the D2S2 Enterprise Portfolio Structure and Management. Today there is no DoD directive or instruction for the overall enterprise DoD Decision Support Systems. As IAPRs focus on Integration and Interoperability, it is not just an acquisition goal but should cut across the enterprise, which should be the value proposition of the Enterprise Portfolio. Under the current structure, the DEPSECDEF supported by the DMAG would be the Enterprise Portfolio Management team.

The Department of the Air Force (DAF) in preparation for the FY24 budget has taken a step in this direction under the Operational Imperatives initiative. The Operational Imperatives, breaking partly from the traditional PEO approach, grouped specific efforts, many of them programs of record, into operational capabilities focused grouping aligned on pacing challenges. The operational imperatives are aligned with the Joint Warfighter Concept, which appears, in some case, to have driven the groups away from traditional PEO buckets. The creation of a structure based on a strategy to achieve specific operational objectives (Figure 5) within and across the seven Operational Imperatives is an example of an enterprise approach (USAF 2023).

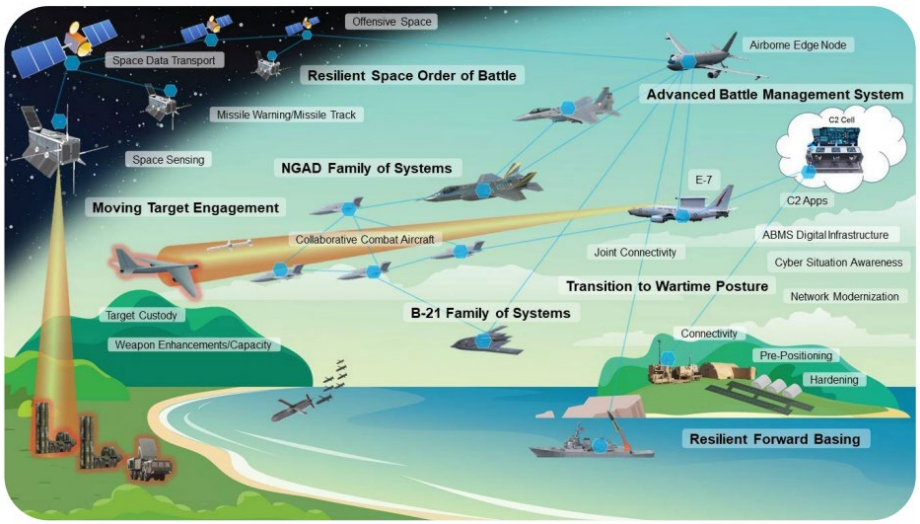

Figure 5 Operational Imperatives

The concept of portfolio management within the department needs to embrace the seven performance domains within the ANSI Standard for Portfolio Management, especially strategic and value management, so clear objectives for these sub-portfolios can be determined, and thus a performance management structure can be established to drive the appropriate measure that will allow data-driven management to those objectives. Moving to a multi (many) dimensions (measure in one direction) view of portfolio management under an enterprise portfolio structure for D2S2 decision-making will allow the DoD organizationally to form a structured network of teams with clear empowerment, which embraces John Kotter's Accelerate concept of a second system within a company that is organized in a network, which has shown a proven approach to accelerate strategic agility and strategic execution in a faster-moving world (Kotter, 2014). This would allow the enterprise to move to a network-centric management approach for decision-making on a network-centric JWC.

Notional Enterprise Decision Support Structure and Models

It might seem unreasonable to do an enterprise-level decision support model. Too complicated with too many stakeholders, thus too complex. But with the creation of the Defense's Chief Digital and Artificial Intelligence Office (CDAO) and the creation of ADVANA, a successful approach is more likely. Key will be conceptually to take enterprise and portfolio level Analysis of Alternatives (AoAs). In defense acquisitions, AoA is an "assessment of potential material solutions to satisfy the capability need to be documented in the approved Initial Capabilities Document (ICD). The AoA focuses on the identification and assessment of potential materiel solutions, key trades between cost and capability, total life-cycle cost, including sustainment, schedule, concepts of operations, and overall risk." AoA typically leverages available data and documents "sufficient quality to support investment and acquisition decisions. … Common or 'wash costs" (DOD, 2022). The key is paying attention to what are the differences in the alternatives.

Enterprise AoAs would take advantage of AoAs that are more focused on the acquisition level or organizational capabilities or combatant missions but would look beyond the individual system's decisions that have been set for a particular requirement and move to a more enterprise view. To accomplish this, a model structure will be needed to look across various PEOs (across DoD components) with various types of system program managers of various materiel/technology solutions (platform, product, sub-product, commercial, software, material/commodity, etc.), which are assigned as assets to component operational units. Those component operational units are assigned to various combatant components (regional, functional, supporting). In Phase 2, the team's goal is to develop an example model using notional data (unclassified) as a tool to demonstrate further possible decision analytics within and across the product/platform, operational capability, or mission portfolios as well as at the enterprise portfolio level.

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