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Leveraging Digital Transformation for Resourcing Investments

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Abstract

Resourcing in the DoD is a challenging endeavor. A program must navigate various appropriations that align to both their strategic goals and tactical needs, all the while external factors such as skill set availability and congressional winds may delay or derail well-thought-out plans. A program must also leverage a myriad of subject matter experts to design, develop, field, and sustain its complex weapon systems and when resourcing constraints arise, knowing what products and services provide the best business value is not always clear. Lastly, the lack of feedback mechanism for a specific product or service are not always well understood or even measured. This can lead to questions regarding resourcing needs and impact to secure resources at a future state. This vicious cycle remains unchanged and requires an innovative approach for resourcing priorities in support of program and mission needs. Previous attention in this area has focused on restructuring the PPBE process or purely mathematical models that rarely capture the complex dynamics of the ecosystem. This research supports this thirst for innovation by leveraging digital transformation to identify the relationships in a systems-of-systems approach and provides analytical methods analysis to achieve that end-state.

Introduction

Making resourcing and investment decisions in the Department of Defense (DoD) is challenging. The DoD has many customers, stakeholders, appropriations, and priorities that must be weighed before a budget can be finalized and funding promulgated and initiatives staffed. The procurement process is the backbone for developing and sustaining military capability and is comprised of the Joint Capability Integration Development System (JCIDS), Acquisition Process, and the Planning, Programming, Budgeting, and Execution (PPBE) process (Figure 1; DAU, 2023).

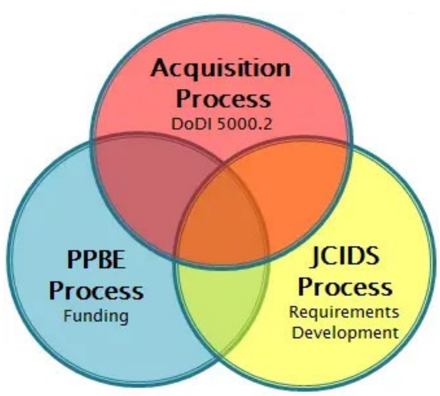

Figure 1. Defense Acquisition System

The JCIDS process is what provides the documentation and baseline of validated capability needs. The PPBE process is used to determine funding requirements across the various defense appropriations and allocate resources to provide the capabilities deemed necessary to accomplish the Department's mission. PPBE is the DoD system for allocating resources among the armed services, defense agencies, and other components, and is the primary mechanism in which program offices or command teams document and request funding to execute their programs (McGarry, 2022). Although well-ingrained, the process has received additional scrutiny over the past few years due to a perception of obsolescence and the need to make adjustments in funding acquisitions given the pace or technology availability and evolving threat baselines (Hale & Lord, 2024). The acquisition process is the overarching approach programs and support teams procure and acquire capabilities directly related to or in support of military weapon systems design and support. The approach, or pathway, to procurement has been modernized in the past few years to allow for different types of systems and needs to be acquired in a manner that more aligns with industry and development timelines (Figure 2).

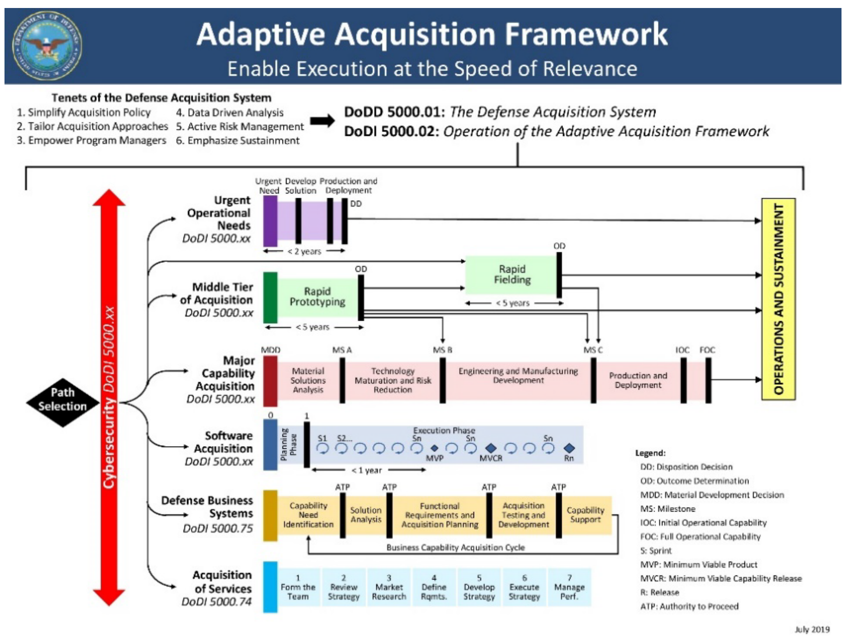

Figure 2. Adaptive Acquisition Framework

It is within each of these independent processes, JCIDS, PPBE, and acquisition, as well as between them, that decisions need to be weighed on what, where, when, why, and how to invest. Fielded weapon systems may need port, facility, or system upgrades to alleviate maintenance, reliability, or production strains. A system command (SYSCOM) or warfare center may want to invest in IT infrastructure for analytical capabilities or to sundown legacy systems. New science and technology opportunities may arise and investments must be planned ahead of time with the right appropriation to incorporate.

With any investment, the key considerations are how much funding is required, when does it need to be paid, and for what? Additionally, any smart investor would want to know who receives the benefit, how is the benefit measured, and when is the benefit realized? Beyond those initial questions, it's important to consider other factors such as what are the short-term and long-term impacts of choosing one path instead of another, and if one path is chosen, are you prevented or limited in your options in the future? This concept of opportunity costs (or opportunity capabilities, readiness, or another measure) must also be part of the decision space as it aligns to the organizations strategic intent and core values (Fernando, 2024). With precious human capital, financial resources, development time, risk tolerance of global events, insights for investment decisions in the DoD have never been more critically monitored (Beckley & Brands, 2024).

The Funding Process

The yearly PPBE process requires teams to identify their future needs to support their program, the necessary appropriations for the products and services, and the estimates of the funding required. As the PPBE process unfolds, the requested funding becomes authorized and finally appropriated into the year of execution budget. Programs are informed of what they are authorized for and begin the decision process on what to prioritize based on funding received. Planned investments for program offices may include weapon system reliability or maintainability improvements, or training on internal process efficiencies, including analysis and training. Programs must face this challenge each year as part of the budget process and planning for future year's needs. Planned activities, including hiring, may need to be deferred one or more years based on not only funding, but also as a result of events that occur throughout the year. For example, in 2017 the T-45 and F-18 fleets had an increase in physiological episodes that required time, effort, and resources to address what was the number one safety issue in naval aviation (Hudson, 2017). Teams external to program offices, whether it be at the Command level or lower, plan investments for IT capabilities and processing, facility and range improvements, connection nodes between government and industry partner sites, or specific investments to business operations to improve internal process such as new methodologies or training. For non-program teams, it is observed that investments in the DoD tend to be made by aligning to overarching or new strategies, such as a conscious focus to modernize infrastructure or workforce development. The challenges internal to a single program are difficult enough, and are compounded when improvements in one weapon system that are now deferred have a cascading effect to a systems of systems (SoS) capability that will now be delayed. Localized decisions rarely remain contained to a single team, and the result is a constant reactive nature across a program office, capability kill-chain, or a Command.

How a benefit is articulated, conveyed or conceptualized is important. More important is how the needs are defined and understood. A poor understanding of the problem limits the effectiveness or the solution or benefit. Understanding must be the precursor as to whether the solution enabled by the funding request is achievable or dependent on other factors. If a deeper understanding of the needs is not conveyed, the requirement for funding in the POM submission is more likely to be viewed as a "shopping list" of wants. This perception erodes trust between stakeholders at different echelons and further hinders conversations. Furthermore, who asks first, which program is more high profile, or which program is the "flavor of the month" are not sustainable approaches for delivering warfighter advantage at a cost we can afford. Programs have been on a journey to best communicate their needs to those who are not involved in the day-to-day operations of their specific program, receive requests from many programs, have insufficient time to process the requests, and must balance tactical and strategic perspectives.

Digital Transformation

Digital Transformation (DX) is the adoption and integration of digital technologies to improve efficiency and streamline business operations across all sectors of a business, fundamentally altering how value is brought to customers (Gebayew et al., 2018; Hanelt et al., 2021; Libert et al., 2016). Examples of DX technologies are artificial intelligence (AI), cloud computing, autonomy, and advanced model and simulation (M&S; Waugh, 2022). Developing and leveraging advanced M&S, teams at various echelons can run scenarios for what are the best use of their resources, for a given outcome, at a specific point in time. Integrating cloud computing allows for better accessibility, resilience, and processing power for specific improvements and investments under consideration. AI can highlight indicators of good returns on investment and the environmental factors that strengthen or reduce the benefit.

Despite these well-known axioms, many organizations have continued to struggle with implementing these for resourcing investments in the most optimal way. There remains a lack of understanding in how resources are prioritized and aligned in support of programs. The lack of feedback mechanisms for the funded products and services and their impact on mission outcomes remains unclear in many cases. This paper looks at a novel approach to connect DX with investment decisions with the needed development of robust architectures and heuristics that will provide the right insights when they're needed and to whom. By understanding, planning and embracing the right technologies for the right purpose at the right time, DX offers the opportunity to approach how investment decisions are understood, measured, and made that most optimally achieves an organizations tactical and strategic goals.

Quantifying Investment Impacts

Get Real

The desire to know what initiative or investment is going to have the most impact on affordability, availability, or other metric given limited resources is an ever-present endeavor. With competing priorities, resource volatility, and the POM process requiring confident forecasting of not only funding amount, but also appropriation type, establishing known returns on the investments can feel like an effort in futility or at least a significant handicap when asked to defend budget requests. This reality has only been exacerbated over time with an aging inventory requiring more resources in sustainment accounts. One funding account has seen a four-fold increase in an eight-year span (Figure3).

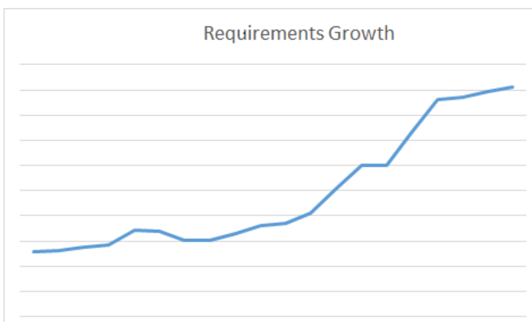

Figure 3. Requirements Increase

A program must be its own best advocate. The saying goes, "you won't know until you ask," and requesting additional funding is the responsibility of each program. In fact, additional funding was the reason why weapons systems can achieve their availability targets (Abott, 2019). While no one would dispute that more funding is needed to meet operational demands, it is also fair to ask if the resources were allocated in the most efficient way, and what was sacrificed in the process.

Embracing the Red

Analytical models to assist programs with investment decisions have existed for decades. Within the early acquisition and development communities, models have primarily consisted of requirements development and verification to requirements, mission effectiveness, engineering physics-based models for system performance, and integrated test and evaluation, with only recent developments infusing costs predictions (Byron, 2021; DAU, 2021). Within the logistics, operations and support, and sustainment communities, they have typically focused on decisions pertaining to maintenance, supply provisioning, funding account adjustments, operational availability, resourcing-to-readiness, logistics footprint, manpower, impacts of reliability improvements, and life cycle costs estimates (Draham, 2017). While conceptually each had value and remains a needed area of better insights, all had significant limitations and all but one was ultimately cancelled (SPA, 2022). Other investment areas need to be considered as well, such as the Central Test and Evaluation Investment Program (CTEIP), as DoD's corporate investment vehicle for modernizing DoD test infrastructure; Capital Investment Program (CIP), which establishes a capability for reinvestment in the infrastructure of business areas in order to facilitate mid and long term cost reductions in order to improve product and service quality, timeliness, and reduce costs and foster comparable and competitive business operations; and the Naval Innovation Science and Engineering (NISE) program, which provides a way to conduct innovative basic and applied research, transition technologies into operational use, develop the workforce, recruit and retain highly skilled scientists and engineers, and purchase state-of-the-art labs and equipment (DoD Financial Mgmt, 1994; Miller, 2022; Paust, 2016). The author has found no such model that was or in development to assess the impact of command-level or team-level investments that tie to mission outcomes. The author also believes that business case analysis (BCA) is a better measure to assess investments since return-on-investment (ROI) may imply a financial return is the primary reason and driver for an investment. Lastly, there is the potential for investment in one account or area to be duplicative to one in another if a broader understanding and traceability is not well understood.

In additional to analytical or system modeling, several initiatives have emerged over the last 20 years to help program teams and resource sponsors define where the next dollar should be spent. These initiatives have been organically generated at a small team level, at a Systems Command (SYSCOM) level, and even at the Echelon 1 level. These efforts focused on resourcing investments to reduce costs or improve readiness of systems as the primary goal. A sampling of such efforts has included the Cost Wise Readiness Integrated Improvement Process (CWRIIP) as an overarching process for all Type/Model/Series (TMS) to prioritize Ready for Tasking (RFT) aircraft and cost degraders at the system and part level; the Predictive Analytics Modul (PAM), which was billed as a "modeling and simulation (M&S) capability to accurately represent and evaluate future maintenance and supply functions for ship- and land-based naval aviation operations"; enterprise PAM (ePAM), which was a scaled version of PAM; the Root Cause Analysis Model (RCAM), which was the next iteration of PAM when PAM and ePAM were unfunded; the Cost and Readiness Impact Model (CRIM), a suite of interactive analytics programs that uses an extensive data set to take into account all aspects of the operational and sustainment environments through advanced data analysis, machine learning and artificial intelligence for the sustainment enabler account; and the Readiness Decision Impact Model (RDIM), which looks more strategically on balancing short term and long term decisions (Draham, 2017; Jenkins, 2007; Myers, 2022; NAVAIR, 2022). In addition to these organically developed solutions, commercial-off-the-shelf tools have been pursued, but tend to come up short due to the "black box" nature of their construction or the dependence on personal heuristics rather than and understanding of how the various elements interplay with one another and drive outcomes.

Always Learning

In aligning to the Navy's Get Real, Get Better initiative, it is instructive to deep-dive one of these analytical models as a way of self-assessing our approaches to the investment decision problem set so that we may self-correct, learn, and get better (Franchetti, 2024). As part of the Re-Imagine OPNAV initiative, CRIM was developed to link investment dollars from the 1A4N (now Air Systems Support) enabler account to mission outcomes, by measuring high-level availability and affordability metrics. This appropriation is used for technical publication and maintenance plan updates, reliability analysis and improvements, mission system software updates, readiness and condition-based maintenance analysis, policy updates, IT software and license, and many other important products and services to ensure aircraft are available, reliable, safe, and lethal (Figure 4).

Figure 4. Air Systems Support Products

To fully understand the feasibility of such an analytical capability, data from other appropriations and products and services type were used to test the baseline integrated capability of a combination of organic and COTS products. While successful for the initial investigations, and follow on specific and bespoke analysis in support of AirBoards, the underlying model, data capture, and data governance structure were determined to be more limiting. Scalability outside the initial analyses proved to be a challenge and the data captured in various input modules were cumbersome and onerous. Since the focus of CRIM was on the cost and availability metrics, a thorough verification and validation (V&V) effort was required to build credibility with the organization and stakeholders. The V&V was focused on availability with the metric of mission capable aircraft and the affordability calculation. Sample results of two different platforms are shown below for the improvements to mission capable aircraft (Figure 5).

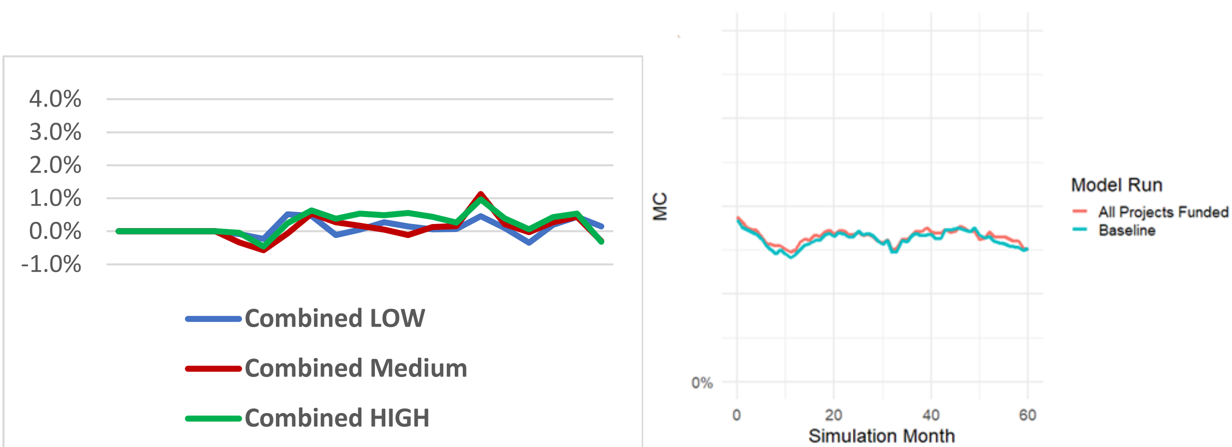

Figure 5. Availability Predictions

The first result shows five initiatives against specific system components with realistic thresholds for low, medium, and high levels of improvements and the simulated change in mission capable aircraft as a result over time. The second platform shows a similar result with more inititaives on specific components of interest selected by the respective program office. This raises a few questions: 1.) is the SIMLOX discrete event simulation accurate, 2.) were the models built right, 3.) why were these system components selected by the programs, and 4.) how comprehensive was the understanding of the impact to the improvements? These results call into question how well the COTS simulation product captures the sustainment ecosystem and actions, products, and services therein, as well as subject matter experts understanding of the connectedness and impacts of certain investments on mission outcomes (Gelsinger, 2022; IBM, 2023). The second part of the V&V effort was on the affordability comparisons. Does CRIM as constructed offer appreciable insights or reduce the burden on programs and allows them to make better decisions, faster? In an analysis conducted in spring of 2022, a comparison between the traditional "back of the napkin" math for cost avoidance for an initiative was compared to the CRIM output. In the simplified approach, the assumption goes something like, "if we double the reliability, we will halve the number of failures, meaning we have a cost avoidance of 50% * unit cost." In the simulated result, multiple Monte Carlo smualtions are run and the number of demands for a component is averaged and then multiplied by the unit price and that results in the cost avoidance. In the 2022 analysis, the results were nearly identical, which would beg the question, is "back of the napkin good enough if it's cheaper and I don't need specific training on a more complicated simulation?"

Furthermore, as of October 2022, none of the Air Systems Support investments could be assessed for their "quantitative effect" for "readiness either with SIMLOX models or with bespoke analysis" (Gelsinger, 2022). SIMLOX is regularly used for ready based sparing (RBS) analysis and provisioning within supportability analysis. It is also the foundation for the Navy Common Readiness Model (NCRM) and the Model-Based Product Support (MBPS) effort (Sashegyi, 2020). OPNAV has directed that "all maritime programs and systems must use the Navy Common Readiness Model (NCRM) to execute RBS" (CNO, 2022).

These quantitative results offer additional insights that were unknown previously. Why was mission capable aircraft barely noticeable in SIMLOX even with significant increases in reliability? Were those the right systems the programs should have been focused on? What else is happening in the "sustainment ecosystem" that is not captured? What are the limitations on some of our COTS products and what role does data rights or industry partnerships play in ensuring the products are build and structured for the right purpose? If preprocessing tools and data curation algorithms do not affect the underlying behavious of the models or simulations, then the DoD runs the risk of convincing itself value is at hand when fundamental issues stll persist.

A New Approach

Integrated architecture

In the prioritization and estimation development of budget submissions, teams will use a wide range of methods to determine and justify their requests. Some approved methods are as straightforward as "back of the napkin math" with the cost avoidance being fewer parts orders multiplied by the unit cost. Other methods include a slightly more sophisticated Analytical Hierarchy Process (AHP) or Multi Attribute Utility Theory (MAUT) which still depends on subjective valuation based on how a team understands the problem and dependencies (Forman & Gass, 2001). In fact, some Navy commands have adopted specific vendors and approaches aligned to this framework (Martin, 2023). The DoD requires better understanding of their decisions to make more informed decisions beyond the approaches of yesterday.

The reoccurring issue with the above approaches is that each, in their own way, are myopic in nature and fail to address the fundamental definition of "the system." A model does not have to be complex but it should be representative and built for a specific purpose with assumptions well-defined (Law, 2015). Each method and approach above were diagnostic in nature without the understanding of the "why" or defining system boundaries. Statements like, "accurately represent and evaluate future maintenance and supply functions for ship- and land-based naval aviation operations," only work to undermine credibility in the M&S profession. Furthermore, without alignment on interoperability and conceptual understanding, technical solutions will limit usefulness (Tolk, 2023). Proper root case cannot be conducted because what you see may not be what you observe, which is only fostered through a transparent and inquisitive mindset.

Integrated architecture, in this sense, are all the business processes and functions that show the flow of data, the consumers and providers, and the purpose of products and services. This is the "as-is" state of understanding of a system. The resolution and fidelity can be scope with understanding of subject matter experts, but one would caution on the recency and comprehensive understanding of said experts. The architecture should not be developed solely by systems engineering, logisticians, operators, maintenance personnel, or any other single group, but in a collaborative group focused on honest outcomes. Through this process of documentation of the architecture, it is important to note that modeling is not the same cataloguing or diagramming. Semantic precision must be adhered to for the broad uses of such a model, especially for programs and teams across various stages of the life cycle, with different partners and relationships and needs and requirements.

The Future is Here

What is possible now? Most anything that is needed or desired. Consider the background and discussion above and think why could that information and those data points be integrated in the a new digitally transformed way of operating? If the traceability and dependencies and usefulness of these models, components, and guidance were linked in a digital space, one could quickly see the dependencies and choose to make a decision to invest in V&V or a more deliberate approach to adoption instead incurring technical debt. Digital transformation is not about IT, tools, data, or people only, it's the integration of all of these elements into a way we transform to think, act, and operate differently. What is preventing a program or command from documenting their processing, architecting their business operations, identifying the investment sources, and instrumenting their workflows to understand where the biggest impacts are being observed? Consider the summary of representations of a *single* model with different *views* for a different stakeholder (Figure 6).

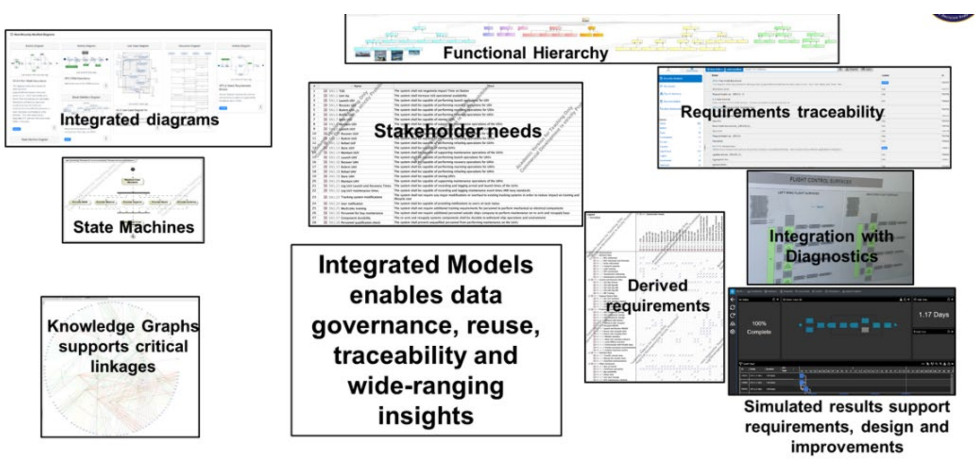

Figure 6. Digital Engineering Examples

The team could have system, mission, or business requirements, stakeholder needs, requirements traceability with triggers or thresholds for quality, and any number of simulations to assess performance. One could easily see how leveraging digital transformation for any number of investment decisions would be captured throughout the *single model* and individuals on the team could be proactive in their planning and recommendations with a common framework and understanding. External stakeholders would have confidence in what funding is being requested and the expected impacts. Furthermore, teams could run “what-if” analyses on deferment of an action, requesting a waiver to policy, or identify if an investment from another appropriation or account (CIP, CTEIP, etc.) will support their needs on a timeframe that is relevant to them. These are engineered systems, but the competency and knowledge resides in architecting and a vast amount of domain knowledge across the acquisition and operational continuum and at multiple tiered echelons. The problem space is full of wicked problems and having confidence in what must be done, what the benefits are, and where the trade space is will only be solved with a new methodology and framework that will be able to meet the demands of insights, speed, and confidence in the world ahead.

Recommendations and Future Work

The framework identified is discussed in many corners and pockets across the DoD, but understanding of the business value appears to be preventing teams from committing to the approach. It is important for each team to know their goals, objectives, and requirements are and what the pain points, user stories, and other methods of soliciting feedback are to understand their system and share that information widely. Transparency must be a foundational element of any future work in the digital and financial space. The DoD’s mission is one of national defense and individuals should not focus on what platform is in the news or on the cover our favorite periodical, but in the collective knowledge we are all doing our part for the warfighter and taxpayer. Teams should not fear the digital future as there’s already too much work to do as it is and knowing we are working on the most important thing only adds to fulfillment, retention, and innovation. It is recommended that future work in this space be on fundamental architecting and measuring various business operations and aligning investments to those areas. It is expected that requirements for investments may be duplicative without being redundant across a myriad of accounts and teams should set aggressive goals leveraging this approach.

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