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PPBE, Technology Transition, and "The Valley of Death"

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Abstract

Before they can be developed and deployed to help the U.S. warfighter accomplish its military objectives, all defense capabilities must obtain funding by passing through the stages of the Planning, Programming, Budgeting, and Execution (PPBE) process. While PPBE has undergone systematic changes since its inception in the early 1960s, various issues have been attributed to its largely unchanged framework. In particular, the defense community has reported PPBE-related setbacks affecting technology transitions, joint efforts, and program lifecycles. This paper explores six case studies for critical or cutting-edge defense programs and organizations and PPBE's impact on their progress. Findings suggest PPBE can slow the development of new capabilities supporting the warfighter, hamper fiscal flexibility, and make it harder for programs to adjust to the evolving needs of the combatant commands and services. However, findings from the six case studies also suggest PPBE's impacts on technology transition are often exaggerated by the defense community. PPBE-related challenges can also be mitigated through strong senior leadership, the consolidation of program elements, the use of agile approaches such as the Middle Tier of Acquisition, sufficient congressional engagement, and other special efforts.

Introduction

In support of the efforts of the Commission on Planning, Programming, Budgeting, and Execution Reform, George Mason University's Baroni Center for Government Contracting was tasked with the following research objective:

Pursuant to Sec. 1004(f)(2)(c), conduct "a review of how the [PPBE] process supports joint efforts, capability and platform lifecycles, and transitioning technologies to production."

To address this research task, the research team examined the role of the PPBE process within the context of six diverse U.S. Department of Defense (DoD) programs and organizations. The case studies comprised the following four programs and two organizations:

- Navy Large and Medium Unmanned Surface Vessels (LUSV/MUSV)
- Air Force Collaborative Combat Aircraft (CCA)
- Army Robotic Combat Vehicle (RCV)
- Army Tactical Intelligence Targeting Access Node (TITAN)
- The Space Development Agency (SDA)
- Joint Rapid Acquisition Cell (JRAC)

All six case studies were chosen for their current relevance, operational importance, or dependence on cutting-edge technologies to meet joint strategic or Service-specific needs. All case studies, with the exception of JRAC, also explored fairly new programs, in which the speed of technological development and program advancement have thus far been critical to enable early success. Each of the case studies were conducted using the following methodology. First, the research team conducted a literature review of key publicly available documents, including the DoD's budget justification books (J-books). After identifying major issues inherent to the PPBE process and its functions, the research team conducted interviews with over 20 subject matter experts associated with the programs and organizations. The majority of interview participants were key government personnel, but industry perspectives were also provided by personnel associated with contractors on several of the case study programs. The interviews abided by the Chatham House Rule whereby all identities of the interview participants and information during the interview are to remain unidentified.

Top-level case study research findings aligned with common PPBE criticisms. The research team observed that PPBE had tangible impacts on the rapid development and deployment of new capabilities to support warfighter needs and complicated the government's ability to accommodate adjustments needed to rapidly respond to evolving programs and requirements. The PPBE process posed added obstacles when the need for fiscal flexibility was greatest, particularly during the year of execution. However, many of the widespread PPBE criticisms reported by the defense community were found to be exaggerated, as case study interview participants cited a wide range of other exogenous factors affecting program success.

Research efforts focused on the link between PPBE and technology transition. The objective was to examine whether the PPBE process is a root cause of technology transition failure in the so-called "valley of death" as experimental projects evolve into programs of record. Therefore, as part of the case study reviews, the research team was also asked to address two crucial questions of technology transition, including:

1. Are higher-valued opportunities foregone at the expense of continuing lower-valued programs?
2. Is the PPBE process a significant root cause of failure to reallocate resources to higher-valued uses as distinct from the JCIDS or Small "A" acquisition process?

In response to the two questions of technology transition, the research team concluded the affirmative for both, but with caveat. Interviews with subject matter experts revealed that higher-valued opportunities are indeed delayed or foregone due to the PPBE Program Objective Memorandum (POM) cycle's tendency to prioritize pre-existing programs. In some cases, these pre-existing programs were considered of lower-value or not seeing adequate returns on funding. The PPBE process was cited as one cause of failure to reallocate resources to higher-valued uses, including urgent warfighter needs and cutting-edge programs. As with other top-level findings obtained by the research team, the PPBE's relationship to the valley of death was nevertheless found to be one of many other influencing factors—not necessarily the *root* cause.

The case study research findings were not all negative regarding the PPBE process, however. The success of certain defense programs seemed to suggest that cutting-edge defense capabilities can traverse the normally lengthy PPBE process without lagging in the valley of death. The PPBE process was found to have acted as less of a hurdle when programs were championed by strong senior leadership or entailed congressional engagements characterized by consistency and cooperation. The PPBE process was also found to be a more neutral influence in programs that utilized agile approaches such as the MTA pathway or broader program elements (PEs) in their budget structure enabling flexibility in program execution.

This paper seeks to provide in-depth yet concise summaries for the PPBE-related impacts on the technology transitions and program success within the six case studies and to present possible recommendations for PPBE reform or for navigating program success to defy limitations inherent to the PPBE process. Where possible, this paper also seeks to assess how the case study findings aligned with the recommendations explored by the PPBE Reform Commission in its interim and final reports. To set the context in which the research was conducted, the paper will provide a brief background of the PPBE process and the factors that led to the formation of the PPBE Reform Commission. The paper will then explain key findings for each case study. Lastly, it will provide relevant conclusions and recommendations.

Background

Planning, Programming, Budgeting, and Execution (PPBE) is a calendar-driven process used by the DoD to allocate resources in support of its capability needs.

In PPBE's efforts to align top-level, long-term strategy with optimal resource allocation, each step must conform to various fiscal, time-related, and other constraints. It can take 2–4 years for a defense program to transverse the PPBE process through each of the phases up to and through the contracting stage. The ability of a weapons system to transverse the PPBE process is also tightly linked to the other elements of the DoD's acquisition process trifecta, which also includes the Joint Capabilities Integration and Development System (JCIDS) for the defining requirements of a weapons system and the Defense Acquisition System (DAS) for guiding the multiple acquisition pathways of defense capabilities. PPBE was formerly known as PPBS, or the Planning, Programming, and Budgeting System. Former Secretary of Defense Robert McNamara established PPBS in the early 1960s with the aim of using scientific protocol and management methods to align the DoD's strategic needs with capabilities and reduce wasteful redundancies in the defense budget (Sapolsky et al., 2017).

Many entities have a stake in the budget formulation and oversight: three Service Secretaries, five Service Chiefs, the Office of Management and Budget (OMB), four congressional defense committees, and the defense industrial base comprising those companies under contract with the DoD. Each military department conducts the PPBE process slightly differently to generate and justify their shares of the budget. While the Executive Branch maintains its leverage as executor of the budget, it is still the weaker player vis-à-vis Congress, which maintains its Constitutional authority to "provide for the common Defense" (MacGregor et al., 2022). Appropriation accounts (e.g., RDT&E; Procurement) PEs and other organizational subdivisions within defense programs such as budget activities (BAs) comprise the main organizational features of defense programs within the J-books, compiled during the Budgeting phase to provide details to Congress that justify program budget requests.

Each phase of PPBE serves of a distinct role. The Planning phase identifies changes in the strategic environment and necessary updates for the military's strategic allocation, directing the ensuing Programming phase. During the Programming phase, the military services develop their own Program Objectives Memorandum (POM) outlining their intended resource allocation

and priorities to meet their future objectives. This kickstarts the Program and Budget Review (PBR) cycle, in which OSD leadership and the DoD's Office of Cost Assessment and Program Evaluation (CAPE) evaluate the POMs. In the Budgeting phase, the defense budget is formalized within documentation that contains program cost estimates and complies with top-level strategy and regulation—as subjected to OSD and congressional review. The defense budget is obligated, and funding deployed, under a continuous program performance feedback loop, in Execution. The phases of PPBE often overlap; while one POM is being built, funding could be executed for several years' worth of prior year funding. Programmatic changes can occur up to the last minute in the Programming and Budgeting phases, but within top-line funding and oversight constraints set by OSD (*Interim Report*, 2023).

Case Study 1: Navy Large and Medium Unmanned Surface Vessels (LUSV/MUSV)

For its first case study, the research team examined two new U.S. Navy programs in tandem: the Large Unmanned Surface Vessels (LUSV) and Medium Unmanned Surface Vessels (MUSV) programs. The programs comprise two different variants of unmanned surface vessels (USV) to be developed, fielded, and remotely operated by the Navy in a semi-autonomous or fully autonomous fashion. The two USV variants are described in the FY 2024 Navy Budget Justification Book as "affordable, high endurance, reconfigurable ships able to accommodate various payloads for unmanned missions and augment Navy's manned surface force." LUSV and MUSV will support the Navy's transition from a traditional emphasis on fewer high-dollar ships toward a fleet with more low-cost and adaptable USVs (Zoldi, 2023). Both programs benefited from the progress of previous research programs, with MUSV inheriting Sea Hunter and Seahawk ships from the DARPA/Office of Naval Research Medium Displacement Unmanned Surface Vessel program, and LUSV inheriting four ships from the Overlord Unmanned Surface Vehicle development effort within the Ghost Fleet program run by the DoD's Strategic Capabilities Office/Uncrewed Maritime Systems Program Office (*Uncrewed Maritime Systems*, 2022).

LUSV and its associated USV Enabling Capabilities program were new starts in FY 2020. The Navy is currently using LUSV prototypes to develop new concepts of operations and intends to equip the reconfigurable model to carry multiple launch tubes for anti-ship and land-attack strike payloads (Zoldi, 2023). MUSV, identified in the Navy J-books as the Medium Displacement Unmanned Surface Vehicle (MDUSV) program, was a new start in FY 2019; it was designated in the FY 2024 Navy Justification Book as a Rapid Prototyping Program following the MTA pathway for rapid acquisition and delivery. Despite growing uncertainty about the utility of MUSV due to its surveillance mission overlap with smaller and cheaper programs, the Navy has moved forward with its plans to develop and procure the medium-sized variant (Eckstein, 2022).

LUSV/MUSV Program Key Finding #1: Several aspects of the PPBE process make it more cumbersome to move a program forward. Several LUSV/MUSV interview subjects expounded on inefficiencies when managing congressional marks during program and budget review. One interview subject observed that when the House Armed Services Committee and Senate Armed Services Committee marked two different amounts for one funding line spread across three programs versus individual programs within the line for the USV program, the Navy ultimately appealed to the slightly lower mark, but this rendered one program component inexecutable. Another interview participant observed that the USV program office struggles without being able to move monies in or out of marked-with-prejudice budget lines, reducing program flexibility.

The tight execution schedule of the PPBE was also cited as being highly incompatible with continuing resolutions, which puts program offices behind when it comes to executing their

funds. Defense programs typically cannot access new funds until two months after a continuing resolution ends, resulting in only half a year of properly funding execution. According to interview subjects, this can foster perceptions of non-performance by Congress:

> In a normal [program], the PPBE should work. Congress passes October 1st, OSD can say, OK, this is the impact to 24 programs. I can adjust 25 to maybe so when we submit to Congress, you know in February things will work. The sponsor can look at that and say … I can adjust 26. We haven't been able to do that in probably a decade. So, any problem where you get a little bit behind … Congress marks you for being behind [even though] they start you six months late ... This is what you have to plan for or you're going to run out of money before the money shows up in the execution year.

In the LUSV/MUSV case study interview, there was also a brief discussion about budgeting constraints which limit a program's evolution, namely the small size of the reprogramming threshold limit and the lack of a management reserve. First, the interview subjects said that the reprogramming threshold limit was too low considering the overall size of budgets. They felt that the low limit hamstrings a responsible department from solving smaller issues on their own recognizance. As summarized by one of the interview subjects:

> The $10 million below threshold reprogramming versus the above threshold reprogramming and the need to go talk to all four committees about the moving money means that even if we did have a good idea of something that can happen, the chance that good idea is gonna get from the working level all the way through and be approved is very minimal. The limit on below threshold reprogramming definitely seems like it's out of date. I totally understand the power of the purse, and the limit of a 20% threshold seems like something that could work, but the $10 million limit just doesn't work.

The same interview subject also addressed how a lack of a management reserve means that the budget may not be an accurate reflection of what can be expected as a project evolves:

> We're not supposed to budget in management reserve. As the federal government, we're supposed to budget to target, not budget, to what we think is reality. So regardless of the fact that 0.5% of projects complete on cost schedule and with existing requirements, we're supposed to budget to that existing kind of spot versus being able to budget to that kind of management reserve. So, we're not necessarily allowed to put in those planned unknown rework steps that we know is gonna happen.

LUSV/MUSV Program Key Finding #2: A one-size-fits-all PPBE process does not work well for new technology programs with no significant cost or development history. Interview subjects spoke about how the PPBE tends to be monolithic and fails to adequately distinguish between major capability acquisitions and programs that need to adjust to rapidly evolving technologies:

> We reformed the acquisition system, but we didn't reform the associated budgeting system. There are things about the PBBE process that do work. I do think [it works] in major capability acquisition where you're buying very large, very slow-moving things like ships. It sets up a nice structure with nice guardrails that allow you to get a highly complex, very large amount of money committed … Now you're using this process that works great for buying billion-dollar things for things that cost hundreds of thousands of dollars or small millions. It's the one-size-fits-all process that quickly becomes onerous to the point of, almost, we work around the system rather than let the system work for us.

The interview subjects for LUSV/MUSV emphasized the difficulties of cost estimating for programs with evolving requirements or with new technologies having little to no precedence or budgeting history. In particular, they detailed the challenge of explaining the unique nature of

new technology programs to other entities like the U.S. Government Accountability Office (GAO) and Congress. Interview subjects characterized those parties as relying on "napkin math" to judge their program primarily from budget books without appreciating the full story of how hard it is to plan and cost estimate for such a program.

Another example was provided by interview subjects about how the PPBE process can interfere with strategic planning for a new technology program. The Navy received a one-time congressional add of $42 million in 2019 to make an early purchase of a prototype four years earlier than serial production had been scheduled to begin. The funding was described as poorly aligned with the Navy's strategy because, as a one-time add, the money was received too early to fit into the overall development timeline for the program. Ultimately, the single boat unit purchased by the Navy was considered an "orphan child" for which the acquisition documentation, long-term budget, cost estimates, and contracting pieces were ill-prepared to accommodate.

LUSV/MUSV Program Key Finding #3: J-books are not realistic for projects with many interrelated parts because they appear as an "à la carte" menu. According to the observations of personnel associated with LUSV/MUSV, the individually segregated budget lines of the J-books tend to convey a wrongful impression of how projects with multiple interrelated parts function. One Navy program office interview participant described how the J-books might appear to congressional staffers and result in congressional marks that impact program funding:

> The budget justification books appear like an à la carte menu, and that's not reality. The budget books, the way that we're supposed to break it down for staffers is: "here's how much [I'll fund] each of these individual items when actually those items are interrelated. And then they mark a portion of it that they think equates to that exact line item which actually breaks several other areas. … The marks are a huge problem, and the way that they mark it in that à la carte menu is not directly how we're gonna be able to apply it.

Another government interview subject had observed congressional staffers failing to understand economies of scale when making budget cuts or appropriately pricing quantity units, assuming the same per-unit price to hold even when fewer quantities were purchased. He provided a hypothetical example, warning that he has seen this occur repeatedly in the past, whereby they were originally going to buy three units at $10 million each, but Congress only permitted purchasing two units. Moreover, contractor interview subjects also observed that congressional marks made during the evolution of the project appeared to reflect simplistic assumptions that did not fully appreciate the integrated nature of the hardware and software requirements.

Case Study #2: Air Force Collaborative Combat Aircraft (CCA)

The Air Force's Collaborative Combat Aircraft (CCA) effort aims to develop unmanned combat air vehicles which are capable of operating as either tethered (in combination with) or untethered (operating autonomously) to manned combat aircraft. It was described in the FY 2024 Air Force Budget Justification Book as a program for "un-crewed weapons systems capable of enhancing crewed weapons systems to achieve air superiority." The effort comprises part of the Next Generation Air Dominance (NGAD) initiative to develop advanced sixth-generation jet fighters. Per the FY 2024 Budget Request, CCA is intended to augment the advanced platforms through providing lower cost, complimentary systems to increase lethality in contested environments.

CCA's unique creation was an administrative realignment rather than a budgetary new start. It is derived from the Autonomous Collaborative Platform program element (0207179F),

which first appeared in the FY 2023 budget justification book as a continuation of previous work accomplished under the Skyborg Vanguard Program for integrating artificial intelligence into autonomous unmanned air vehicles and enabling teaming capabilities (Department of the Air Force, 2021). The core effort was supplemented by two ancillary programs in FY 2024 and now comprises three major lines of effort to develop and test an artificial control system dubbed the "autonomy package" (Harper, 2023). CCA began concept exploration, integration studies, technology risk reduction efforts, and prototyping in FY 2024, and the Air Force plans to spend more than $6 billion on CCA through FY 2028 (Harper, 2023).

CCA Key Finding #1: High levels of coordination with other government entities and commercial partners were integral to effective operations. Interview participants emphasized the importance of working closely with science and technology (S&T) partners from whom CCA's developmental technology was inherited, with the Navy on current platform interoperability concerns, and with Cost Assessment and Program Evaluation (CAPE) on budgeting concerns. In particular, extra effort had been needed to keep the multiple collaborating bodies cognizant of common standards for joint platform and software development.

Although the interoperability concerns were not driven by the budgeting process, PPBE appeared to have a segregating effect on the various agencies and add further layers of consideration to the strategic planning processes in inter-service efforts to develop quality joint capabilities. While interview participants expressed positive views regarding Air Force–Navy collaboration, they did notice that divergent acquisition strategies could lead to uneven budget line funding among different services if programs like CCA become a higher priority for the Air Force than the Navy, for instance. He noted that the process "introduces a lot of uncertain and risk if one of those budget lines doesn't get funded. It actually affects the overall outcomes for both services."

The CCA program benefited from the Air Force's close collaboration with industry. While the PPBE process tends to fix attention on winner-take-all efforts in the contracting realm and standalone defense projects at the funding level, the CCA comprises part of a high-tech, major joint capability solution as opposed to a single stack of components for one innovation. Thus, CCA benefits from what was described by one interview participant as "the momentum of all of industry going after this problem of fielding a capability, not just a single platform." The Air Force reinforces competition to build a pool of preferred vendors for various key technologies, and it anticipates a large contractor base of at least 35 companies for the program. To maintain executive control over the large industry base and harness the benefits of the extensive competition, CCA personnel maintain independent relationships with both the primes and their suppliers. Interview participants described the various ways in which the Air Force has sustained its active leadership while making efforts to involve the contractors in development, which requires it to keep them each informed of the CCA program's strict budgetary timelines.

CCA Key Finding #2: The PPBE process can interfere with service strategy. Several interview subjects associated with the CCA program expressed concerns that the PPBE process can occasionally be used by Congress as a tool to maintain control, causing project outcomes to deviate from Air Force strategy. Congress plays a powerful role in the PPBE process—it authorizes and appropriates the amount and timing of funding for various DoD activities in all phases, and it provides the limited authority for the DoD to transfer and reprogram funds (McGarry, 2022). One interview subject offered an example in which Congress, through its actions during the PPBE process, might have affected Air Force strategy and program process:

> The Air Force decided that it didn't want to spend a lot of money on 4th-generation capability development and backed away from the program. So, we offered a lot of money up in the omnibus to reallocate those funds somewhere else in the Air Force. Congress came back and denied the source because they want us to go fund 4th-generation and electronic warfare capability. They use the PPBE process to force us down a path where we don't think strategically about we should be going. And then it does have second, third-order effects on programs like CCA and NGAD because we're forced to try to figure out how we make it work at the portfolio level.

In spite of the potential problems posed by Congress' role in the PPBE process, interview participants acknowledged that the Air Force personnel were ultimately responsible for navigating the PPBE process to ensure program success. Moreover, regular communication with Congress can assist in helping to smooth over programmatic issues—such collaboration was identified as instrumental in the successful use of a technology transition process, rather than new start, to build the CCA program. Interview participants explained that a key to the success of a defense program such as CCA lay in maintaining a fine balance between congressional oversight and congressional overstepping.

CCA Key Finding #3: A flexible budget structure helps with navigating the PPBE process. Unsurprisingly, with a lack of flexibility often cited as one of the main issues with the PPBE process, CCA interview subjects spoke about the importance of budget structure in enabling greater flexibility. One reason for this was the improved ability to reprogram or move funds. Embedding CCA within the same program element of the larger NGAD initiative allowed money to be easily shifted between the different lines. On the flip side, one interview participant expressed concerns about the separate program elements belonging to the two ancillary programs of CCA, the Experimental Operations Unit (EOU) and the Viper Experimentation and Next-Gen Operations Model (VENOM). Due to the interrelated nature of the different lines of effort for CCA, they could not be separated from one another at the operational level even if the PPBE process could potentially cause them to be treated as isolated projects.

According to interview participants, a flexible budget structure facilitates rapidly evolving technologies but conflicts with the highly structured PPBE process. Cost estimating new technologies was one result, although the Air Force interview participants acknowledged the impossibility of a perfect budget estimate and the need to make progress without it, noting that "if you let everything shake out and try and get a perfect answer all the time, then you will never field a capability, and that's the only reason we have jobs."

CCA Key Finding #4: Program prioritization by leadership is a critical factor for successfully navigating potential budgeting or political-related issues. According to interview participants, CCA is unique from other Air Force programs and owes a large part of its success to how it has been driven by top-level leadership. Two different subject matter experts explained:

> CCA, is a little bit of a red herring in this conversation because, frankly, it's Frank Kendall's number one priority coming out of the Operational Imperatives. I think we were the only program that got fully funded as part of the process, so that made it a little easier … So, you give us the flexibility and you give us the access to leadership, and we can do things pretty quickly.
>
> It takes having priority access at the top level, and then the brute force at all levels—Air Force staff level, CAPE level, comptroller level, on the Hill—to be able to execute effectively within the PPBE process.

Case Study 3: Army Robotic Combat Vehicle (RCV)

The Army's Robotic Combat Vehicle (RCV) program, also referred to as the Remote Combat Vehicle program in the FY 2024 Budget Request Overview, is developing autonomous and semiautonomous ground combat vehicle prototypes, including the advanced autonomy and artificial intelligence algorithms to support them (GAO, 2020). The Army had originally planned to develop three RCV variants: Light, Medium, and Heavy (RCV-L, RCV-M, RCV-H). However, the Assistant Secretary of the Army for Acquisitions, Logistics, and Technology (ASA [ALT]) recently stated that the Army plans to focus on RCV-L development and will defer RCV-M development for the near future (Feickert, 2023). The RCV program is one of four signature efforts which are part of the Next Generation Combat Vehicles (NGCV) family of ground combat vehicles intended to prioritize rapid development and modernize the existing fleet.

As interview participants explained, the RCV project progressed in a non-linear fashion due to experimentation results, reaching BA 5 status for Development & Demonstration before regressing to BA 4 status for Advanced Component Development and Prototypes and returning to BA 5. With regard to its budget structure, RCV is fairly consolidated—it contains just three lines of effort, including an MTA Rapid Prototyping program, which are contained in one project comprising a single program element. The Army is using multiple competitively-awarded, consortium-based other transaction authority agreements (OTAs) awarded to various contractors to conduct experiments testing and building RCV technologies, and it is planning a down-select to a winning vendor to deliver prototypes.

RCV Key Finding #1: The PPBE process is not necessarily optimal for progress, but it is also not always a hurdle to operations or strategy. Key interview participants associated with RCV expressed observations that other factors had impacted strategic and funding decisions more than budgeting concerns. Major changes to the RCV program were enacted primarily due to non-PPBE-related concerns. For example, interview participants explained that experimentation outcomes played more of a role in major decisions, such as the core strategic decision to shift focus away from developing the light, medium, and heavy variants in order to prioritize the common light chassis to be adapted into the other variants later. One interviewee observed:

> PPBE did not impact the decision to focus on a common platform. It was the second phase, what we call the soldier operational experiment phase two, that was completed about a year ago and from that came the recommendation to shift the strategy for RCV … The feedback from the experimentation, that's probably the most significant piece, combined with it being an investment decision on maturing a capability before expanding on it. I think that is more what's driven it rather than, you know, we didn't have enough money, or we were concerned about being able to justify requests.

Major programmatic changes like the RCV-L prioritization were also attributed to program requirements, according to another interview participant:

> When you looked at it holistically and saw the gap between the light and the medium, it related back to requirements and not necessarily to budgeting at all. When the requirements community changed and we transitioned to a common platform, because we kept separate lines of effort in the totality of just an RCV single budget line, it allowed us flexible space to not delineate between an 'L' and an 'M' and instead focus on the common chassis-type platform, like in our recent public solicitation. So, it's not that we didn't want to look at it [RCV- M] or that PPBE hindered us from exploring it, it's just the investment at the time and the capabilities that go back to the requirements didn't really warrant it given where the Army wanted to go. Personally, I don't see an issue with [PPBE] at all.

One criticism regarding PPBE was that it might have slightly delayed prototyping, but not significantly so. According to one of the interview participants, the real challenge lay in communicating program plans and relating them to resourcing requirements rather than the PPBE process itself. The subject matter expert further explained that good lessons were occasionally learned through PPBE-related delays to obtain better information for informing experimentation and investment.

A different interview subject was harsher in his critique of the PPBE process, describing it as too "archaic" to keep up with emergent technologies and needs. Although he acknowledged it was a deliberate and structured approach, providing potentially important insights to the top-level leadership, he found it in general to be "out of touch with reality in terms of how funds are executed, how emerging needs present themselves, and how we adapt to them." However, the interview participant expressed complimentary views regarding the PPBE process that were similar to those expressed by other subject matter experts, such as PPBE's inadvertent effect of prompting higher-level strategizing about resources, which contributed to the Army working towards a common chassis rather than RCV-L and RCV-M variants.

RCV Key Finding #2: To facilitate programmatic success within the PPBE process, more frequent interactions with Congress are preferable. Key perspectives from RCV interview subjects endorsed more frequent interaction with Hill staffers to enable the program officers to provide more updated context for evolving program strategy, better explain any rapidly changing requirements, and educate the staffers on certain nuances of contracting to fill in any gaps of understanding. All three senior interview subjects expressed several concerns related to congressional relations, observing program offices' inability to continuously update Congress, and Congress' tendency to not inquire on program activities unless something was wrong.

As noted by the RCV subject matter experts, significant changes could occur in the program in the nine months between submission of budget exhibits and staff briefings and the budget being passed into law. As a result, acquisition professionals would sometimes only "get one bite at the apple every year" to deliver their message in March, without any meaningful Hill reengagements thereafter. With regard to the RCV program, this issue could be compounded by the fact that many Hill staffers seemed to lack sufficient training and understanding about the nuances of contracting, such as how critical acquisition authorities work in practice. This would result in budgets being marked for under-execution, particularly with activities using acquisition authorities that were critical to RCV's agility and success. An interview subject provided the example of OTAs, which can go from zero to 100 obligated in a single day, but which lent themselves to perceptions on the Hill that the RCV program was not spending enough if the balance of zero remained too long.

As noted by the RCV subject matter experts, significant changes could occur in the program in the nine months between submission of budget exhibits and staff briefings (February or March) and the budget being passed into law (typically the following December). As a result, acquisition professionals would sometimes only "get one bite at the apple every year" to deliver their message in March, without any meaningful Hill reengagements thereafter. With regard to the RCV program, this issue could be compounded by the fact that many Hill staffers seemed to lack sufficient training and understanding about the nuances of contracting, such as how critical acquisition authorities work in practice. This would result in budgets being marked for under-execution, particularly with activities using acquisition authorities that were critical to RCV's agility and success. An interview subject provided the example of OTAs, which can go from zero to 100 obligated in a single day, but which lent themselves to perceptions on the Hill that the RCV program was not spending enough if the balance of zero remained too long.

To accomplish effective and frequent communications with Congress, it was also imperative, according to three interview subjects, for the Army to present more of a united front when it comes to relaying certain messages, or to at least ensure internal leadership was kept adequately informed of program progress. One of the interview subjects explained that "if my own bosses don't know what we're doing, all the successes we've had, and all the work that we're putting into this and how we're moving the ball forward, then I'm certain Congress doesn't."

RCV Key Finding #3: Greater flexibility in the PPBE process would be more suited to addressing agile acquisitions, specifically when dealing with iterative requirements and different colors of money. Although the RCV program subject matter experts did not see the PPBE process as a major hindrance, as explained by the first case study key finding, they did feel it was a challenge to match the structured PPBE process to a program with evolving requirements, which required a different mindset. While the PPBE process is often better suited to linear technological development and "full-stack," completed technologies, RCV is progressing in terms of new iterations of technologies, which requires a different mindset in terms of development and long-term planning for new technologies, and being comfortable that "over these years being an 80% solution is good enough for the time now, knowing that eventually we'll get to 100%."

Per the experiences of those involved with the RCV program, increased flexibility in the PPBE process might entail providing program leadership with more budgetary authority, which could allow program leadership to be more open about program budget management reserves without fear another actor in the PPBE process could take it away. It also might entail developing a "colorless" type of money distinct from other DoD appropriations categories, which can be devoted to emergent technologies or innovative programs at the service-wide level. Reprogramming was viewed as an insufficient mechanism for redirecting funds to accommodate new technologies and address new threats.

RCV Key Finding #4: Consolidating program elements helps in achieving greater program flexibility. As described in the previous case study finding for the RCV program, the highly structured PPBE process can benefit from increased flexibility wherever possible. Therefore, when it comes to budgeting for a cutting-edge program, one of the ways to achieve that is through keeping the budgetary lines of effort within a single program element. This facilitates the ability to move funds as needed for a rapidly evolving program. All three interview participants involved with RCV supported the idea of consolidating activities into a single budget line to handle the risks of evolving requirements, and the RCV program budget has been intentionally designed to retain all its lines of effort within a single project and single PE.

The purposeful budgeting structure of RCV was reported to have had several benefits. Firstly, it enhanced RCV's ability to deal with congressional marks in situations when there is a "mark that is unspecified or there is a cut to the program line for no specified reason," because the structure provides the ability "to move and decide where to take the hit internally." Secondly, the structure allowed RCV to adapt to new experimentation outcomes and priorities, and to potentially move monies back and forth between the autonomous program and the platform as necessary due to the hardware and software being so integrated. The interview subjects stressed that funds that can be transferred or executed on an as-needed basis are especially helpful during the developmental phase of programs, while budget-related limitations are more understandable for the Procurement phase of a program.

Case Study 4: Space Development Agency (SDA)

The mission of the Space Development Agency (SDA; n.d.) is to "create and sustain lethal, resilient, threat-driven, and affordable military space capabilities that provide persistent,

resilient, global, low-latency surveillance to deter or defeat adversaries." To accomplish this mission, the SDA is developing and fielding a Proliferated Warfighting Space Architecture (PWSA) consisting of multiple layers (or "tranches") of satellite constellations providing navigation, surveillance, deterrence, defense, communication, and various other functions to the joint U.S. warfighter. SDA intends to launch at least five tranches of commercially-procured satellites, each developed through two-year cycles using the MTA pathway for rapid prototyping and fielding and enabled by artificial intelligence. The rapid cycles are part of a "spiral model" that facilitate regular technology upgrades and contract competition.

The SDA was created in 2019 by the Office of the Under Secretary of Defense for Research and Engineering, and it was officially transferred to the United States Space Force (USSF) in 2022. As such, it follows a split authority, with the director of the SDA reporting to the Assistant Secretary of the Air Force for Space Acquisition and Integration for acquisition matters and the Chief of Space Operations for all other matters. The SDA shares one PE with Space Command, in addition to launch costs that are separately funded by Procurement in the Space Force's Systems Command budget per the National Security Space Launch (NSSL) central contract. However, the SDA has retained a unique level of autonomy and maintains three of its own separate RDT&E PEs. It also does not use the JCIDS process for validating requirements—interestingly, it tends to conduct programming before planning, as it budgets for tranches before specific requirements are developed through a Warfighter Council.

SDA Key Finding #1: SDA's use of the MTA pathway and the agile, iterative incorporation of commercial technologies are central to rapid product delivery. Feedback collected from SDA personnel stressed that the organization's agile and iterative acquisition model remains its most important asset for achieving success in terms of technology transition and schedule adherence:

> SDA's unique model relies on speed to achieve its mission and represents a departure from big, slow, expensive acquisition programs. Our model works because it doesn't rely on delivering the perfect solution, which tends to focus on capability over schedule and cost and instead choosing to provide 'good enough' capability to the warfighter at the speed of relevance.

One criticism of the PPBE is that it encodes divisions between research, production, and operations, thus stymying iterative or feedback-based development (Greenwalt and Patt, 2021). However, the SDA's spiral model for prototyping and fielding emphasizes iterative development, which facilitates the agency's ability to adapt to new technological advances, as well as continuously benefit from the knowledge that is gained after each satellite tranche is launched. The SDA is able to incorporate its spiral model and combat the PPBE's tendency to stymie iterative development through two principal enablers—a heavy use of the MTA pathway, plus a strategy of acquiring relatively cheap commercial technology.

Case study interviews and feedback expressed that SDA efforts to improve upon satellite tranche deployments have largely been guided by what was learned through the execution of previous tranches. MTAs were highlighted as essential for the SDA to rapidly improve satellite technologies through incorporating lessons learned. In pursuit of successful rapid deployment, a key interview participant felt that "the greatest near-term risk to our model is failing to use the Middle Tier of Acquisition pathway, or any pathway that enables speed," as opposed to an "obsolete acquisition model and strategies that are no longer adapted to the new threat environment, or that fail to provide timely, effective, and credible solutions."

Case study research indicated that SDA's iterative approach to satellite development and its contracting efforts in the commercial sector have supported affordable operations. When satellites can easily be replaced in the future, it can reduce non-recurring engineering costs and

accelerate fielding. SDA also benefits from innovative commercial sector technological progress and incorporates lessons learned through its leveraging of small business programs like the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs. SDA's public sharing of its technology roadmaps to help companies determine what will be needed, and when. The agency fosters "full and open competition for each layer of each tranche, as much as possible. Through that model, we hope to create a reliable and predictable marketplace that allows industry to invest, plan, and compete on a predictable timeline while also avoiding vendor lock."

Although SDA prioritizes commercial sector technologies, it is not only commercial technology that SDA adopts. It also provides a suitable environment for other cutting-edge projects that originated from the government. One example of this was when the Defense Advanced Research Projects Agency (DARPA) initiative FOO Fighter was transferred to SDA when Air Force partners were averse to taking on the technological risk of the new program. FOO Fighter failed to be included in the Space Force POM during two annual budget cycles, until Secretary of the Air Force Frank Kendall became alert to it and incorporated it into one of his operational imperatives. Facilitated by this critical endorsement of top-level leadership, SDA has been able to support maturation of FOO Fighter technology and is ensuring it will achieve funding:

> SDA is the ideal transition partner for mature capabilities … FOO Fighter was seen as a technology that could be incorporated into program architectures in the future. The cultural design of SDA is why FOO Fighter is with us right now.

Several challenges exist for the SDA to maintain its agility in the future, including possible new MTA reporting or other requirements levied on MTA use. One interview participant noted that the creation of an MTA advisory board has already slowed the timelines for MTA approval. SDA interview participants emphasized that while SDA's spiral model could certainly provide an example for other defense agencies to potentially follow, it is most likely not suited for large, exquisite systems, and conversely, SDA (plus other programs and organizations that rely upon the MTA) should avoid the bureaucratic red tape that could undermine agility and make SDA "a lot more like a major capability program."

According to interviews, SDA could potentially face another unusual challenge that contradicts the common experience of other DoD agencies. While many defense programs typically lag behind the commercial market in their incorporation of advanced technologies, the industry segments that SDA relies upon, such as those for optical communication link satellites, do not yet exist at scale to produce for the agency. Thus, SDA must nurture and build up its commercial supply chains, because "no matter what you do to the budget process, you can't acquire things on our timeline if industry is not prepared to respond."

SDA Key Finding #2: Due to SDA's mandate to rapidly deliver capabilities, budget requests must be made before requirements are finalized—programming occurs before planning. In interviews, SDA personnel stated a contrast between their organization's mandated delivery timelines and PPBE process timeline. An SDA interview subject explained that when the agency is acquiring capabilities at speed every two years, a one-year slip in funding in the Future Years Defense Program (FYDP) "can't be absorbed the way it is in legacy programs."

For the SDA, the PPBE's budgetary timeline is ill-suited to support emergent discoveries and new findings during program execution. To remain true to its core mission and maintain the two-year cadence, SDA technically conducts programming before planning. The requirement for a tranche is endorsed by its Warfighter Council six months prior to acquisition as opposed to 2.5 years. With a compressed schedule, SDA determines the budget for each tranche before actual

requirements are known. SDA personnel felt that "reversing" the Ps of PPBE has worked well for the organization, but that its unique approaches have still posed unique challenges juggling cost estimates, requirements, and potential budget changes when budget planning for one tranche while working on another tranche of satellite capabilities and fielding a third.

SDA navigates its compressed timeline through detailed communications with Congress. This case study finding for SDA aligned with the Commission on PPBE Reform's interim and final reports, which emphasized effective engagement between SDA and Congress as an important cornerstone of efficacious transparency. Through frequent staffer engagements, SDA builds trust by providing detailed cost and work structure breakdowns, including comparisons between original cost estimates and actual cost outcomes—for each tranche, each performer on contract, each program element, and other project details.

SDA Key Finding #3: PE consolidation gives SDA more flexibility to successfully navigate program developments, but external stakeholders who seek to impact programs sometimes prefer a divided PE structure. Although the SDA was officially transferred to the Space Force in 2022 for administrative reasons decided by the Department of the Air Force, it has managed to retain the autonomy it has enjoyed since its inception. One of the most important aspects of this autonomy is the organization's budgetary structure of "large PEs encompassing multiple programs" which, according to SDA personnel, allow for the greatest flexibility to move funds when needed to ensure timely mission success—Section 1601 of the FY 2021 National Defense Authorization Act (NDAA) specifies that the SDA's PEs should remain separate from other Space Force programs.

SDA has opposed congressional and DoD efforts to split ground funding for its programs into separate PEs, which it has attempted in part as bids for increased control or transparency. SDA personnel explained that the Space Force attempted to create a separate PE for ground systems, in the same pot of money with Space Systems Command's (SSC's) Medium Earth Orbit-Ground, leading to "a big lump of money for SDA and SSC to figure out." Through increased staffer engagements with Congress to provide more detailed work and funding breakdowns within each of its PEs, plus referring to original statutory language to fight the loss of one of its distinct PEs, the SDA intends to achieve the realignments of funding to its primary program PEs. As one SDA interview participant noted, the ability to manage space platforms, ground stations, transport layer operations, and integration all in single or fewer portfolio-oriented or mission-based PEs allow the program office to be more responsive to events or proactive ahead of challenges.

SDA Key Finding #4: Building and launching SDA tranches can be challenging to manage in existing budgetary categories. SDA capabilities are rapidly developed with RDT&E monies, while the launch vehicles that deliver those capabilities are funded by procurement monies. SDA's management of different appropriation categories or "colors of money"—specifically procurement and RDT&E accounts—has been essential, and occasionally challenging, to the agency navigating PPBE processes while achieving the agency's mandate. Interview participants explained how the split funding impacted operations in fiscal years 2022 and 2023:

> Congress decided they wanted us to accelerate the fielding of our Tranche 1 track. They wanted us to speed up getting to a capability that could cover INDOPACOM by about a year. And they gave us a significant amount of money over the course of two years to do that. What they didn't do was fund the associated launches that go with that. And by the time appropriations passed, it was too late for us to then program for those launches because the budget was already headed to the Hill and closed out. The process for the next fiscal year in which we would have to acquire the launch to go with that was closed.

The interview participant further explained that when the split funding results in discrepancies between different accounts supporting the same mission, it prompts the DoD and Congress to have to work together to resolve the issue, either reprogram the funds or appropriate a plus-up, potentially delaying program executions. In this specific instance, Congress eventually appropriated a plus-up to provide additional funding for the satellite launch. The anecdote supports overall case study findings that the budgetary structures and timelines of the PPBE process can make it more difficult to accommodate immediate operational needs, especially on an as-needed basis by the combatant commands.

Case Study 5: Tactical Intelligence Targeting Access Node (TITAN)

The Tactical Intelligence Targeting Access Node (TITAN) program is the Army's effort to develop a next-generation intelligence ground system to improve upon the existing capabilities of legacy ground systems, which will likely be phased out after TITAN is fielded. TITAN will ingest and fuse massive amounts of incoming sensor data from the warfighting theater, and it will be the first intelligence ground station to use AI and machine learning to classify sensor feedback to turn it into real-time intelligence for the warfighter and deliver it via lethal and non-lethal networks (Army Program Executive Office - Intelligence, Electronic Warfare & Sensors [PEO - IEW&S], 2021). Per the Army's FY 2024 RDT&E budget estimates, TITAN's deep sensing capabilities will support automated target recognition, identification, geolocation, and other functions that enable immediate situational awareness as well as long-range precision targeting and firing.

TITAN emerged as a modernization activity for ground station capabilities within the Distributed Common Ground System-Army (DCGS-A) program, which contains the elements for a vast amount of Army intelligence capabilities at the tactical, operational, and strategic levels. By FY 2022, TITAN was fully initiated into the acquisition process and executed as a rapid prototyping effort using the MTA pathway. As a natural evolution of previous DCGS-A programs, TITAN draws on expertise and resources from various Army organizations and initiatives, particularly the technologies developed through Project 907, known as the Tactical Exploitation of National Capabilities (TENCAP; Hitchens, 2020). Current funding for TITAN prototyping focuses on the advanced variant which will be used for heavier platforms such as tactical trucks and eventually be adapted to a basic variant designed for lighter platforms.

TITAN Program Key Finding #1: The use of a MOSA approach, the MTA pathway, and OTA contracts have led to rapid prototyping and program success in TITAN but still pose unique challenges. TITAN interview participants commented on the inefficiency of a two-and-a-half-year time frame from program offices' budget submissions to service headquarters before funds are made available to the program offices for obligation. However, TITAN's use of rapid and flexible acquisition authorities has insulated it from many negative impacts of extended timelines inherent to PPBE, JCIDS, and FAR processes. One government interview participant concluded: "there are a lot of tools in the toolbox, a lot of flexibility, and it's really on acquisition professionals to determine how to use those tools to best achieve what they are asked to deliver."

For a program like TITAN that heavily incorporates both hardware and software, PPBE's emphasis on planning is irrelevant when technological unknowns outpace the budget as it passes through multiple entities for adjudication, integration, review, and debate before obligation of funds. One interview participant expressed concerns that during this process, technologies can "go obsolete, or you know they're going to go obsolete in two years and you still want to buy, you have to buy it now because it is being programmed. But the replacement can be considerably more money that what you were planning for."

TITAN is heavily dependent on software technologies, and it is incorporating the use of a Modular Open Systems Architecture (MOSA) approach to iteratively incorporate evolving technologies. While the PPBE process can complicate a program's ability to navigate technology transition, acquisition approaches like MOSA can mitigate the hindrance of long timelines and guessing games for program needs. MOSA allows for system-compatible components to be iteratively added, removed, or replaced through the platform lifecycle, making it easier to keep up with the pace of technological advancements, incorporate ongoing soldier feedback, and avoid lock-in with proprietary solutions. Although MOSA can pose new challenges with regard to cost estimating for the plug and play of emergent technologies, it has been enthusiastically embraced by TITAN personnel as a means of working with, rather than against, uncertainty.

TITAN personnel also highlighted the MTA pathway as a great enabler of the program's speed, facilitating a rapid succession of prototypes and a maturation of relevant designs before final requirements documents are written. A TITAN program lead contrasted TITAN's use of the MTA pathway with the complicated timelines of typical major capability acquisitions:

> Say for example, if we had approached TITAN as a major capability acquisition program, we would've gone to a milestone B, we would've had an ADM [Army Design Methodology], we would've had an APB [Acquisition program baseline], and that would've established specific parameters for the program that by the time we initiated, we probably would've been oriented on that procurement funding and a lower RDT&E number than where we've gone to in the rapid prototyping program. Which would've led to us initiating a program and then probably doing a significant deviation or a breach within the first year, because we learned so much in the first six months that caused us to have to look at different funding alignments and what we would resource and program. And that's where the interaction of PPBE and the MTA approach was beneficial to the TITAN program, otherwise we probably would've had to re-baseline program at least once, already, in the first 15 months of this program.

A major aspect of TITAN's system design and contracting approaches has been its use of down-select competition for prototyping, and it has awarded two major OTA contracts as part of its extended competitive prototyping effort by Palantir and Raytheon (Gill, 2023). Perspectives on OTA procurement authorities were nuanced in industry interviews. Understandably, the nontraditional contractor perspective placed greater value on the OTA's ability to level the playing field for industry competitors, while the traditional contractor perspective valued the protection afforded by structures of FAR-based contracts as opposed to OTAs. The nontraditional industry interview perspective designated the treatment of the OTA contract like a FAR-based contract as the biggest challenge currently faced from an industry perspective. The insertion of more FAR clauses was said to have reduced flexibility, increased bureaucratization, slowed funding timelines in the POM cycle, and hamstrung the government from moving forward more quickly with decisions and future phases due to fear of bid protest.

The traditional contractor perspective acknowledged the potentially negative impact of treating OTAs like FAR-based contracts but cited several issues inherent to OTAs. The first issue was the creation of middle barriers between government and industry, possibly leading to communication delays and loss of information in translation, as well as reducing direct collaboration. A second concern was that certain development programs might not be as effective because of their competitive nature cost driving relationships and adding an artificial element to contracts which do not always increase the pace of technological progress. Lastly, OTAs can necessitate a large cost-sharing component, impacting a traditional contractors' ability to innovate.

TITAN Program Key Finding #2: TITAN has benefited programmatically and technologically as a continuation of previous Army research efforts and funding lines. TITAN personnel explained that the program has faced fewer challenges in the PPBE process in part due to its privilege as a high-priority, high-profile program derived from a major legacy program. As such, it has enjoyed robust Army and other government support which has facilitated coordinated progress, and it inherited a more streamlined budget structure which contributes to program agility and success. One interview participant believed that if the program was a new start, the Army would still be waiting to start advancing the program and obtain dedicated funding lines.

> If we had completely approached this from a traditional method, we probably would just be barely starting TITAN in '24 if we had truly followed the full PPBE process for initiating. But we were able to find ways in 2020, 2021 in particular, to begin the program and start doing work to advance it in advance of having funding lines specifically for TITAN. And that was done through coordination with OSD, with Congress, and everyone else being very transparent on it. We would begin applying money within the scope of existing programs towards these future requirements.

Thanks to the advancements of its parent programs plus strong ties with other Army entities, TITAN has avoided the hassle faced by new programs waiting for their turn to be rolled into a crowded portfolio of existing programs of record during a service's POM process. It has also leveraged the technological expertise of other programs and organizations to save money and move more quickly without growing an entirely new workforce. Interview participants were keen to highlight BA-4 as an effective transition vehicle for segueing technologies from the TENCAP 907 line into TITAN, especially for the space-based component of TITAN's ISR function. One interviewee described the TITAN-TENCAP link as a "habitual relationship where they're an incubator as new space technology comes online. There's a logical bridge there over the valley of death where it's a natural transition from the TENCAP Office into the TITAN program of record."

Interview participants further noted that while TITAN benefits from the increased agility of a more streamlined budget structure than its parent DCGS-A program, it can still be challenging deciding how to present funding for congressional justifications. One interview participant described the balancing act of providing Congress with necessary budget information:

> For a program like TITAN, having one funding line is helpful. With DCGS, which was twice the order of magnitude (it was a giant program, ACAT I), that can look like just a large bill fare for the rest of the Army when you have one giant funding line. And now they will take that to pay bills and the PMs are left to figure out how you execute the remainder of the dollars. Having more specificity is nice because it makes it easier to defend cuts to one of our individual program lines, but it also kind of locks you in; you just have less flexibility. So, it's definitely a balancing act in how we write our P and R Forms and how we lay out funding lines. It's a little bit of an art and a science.

TITAN Program Key Finding #3: The shift of program funding from Procurement to RDT&E, accomplished with effective stakeholder alignment, ensured that appropriate investments were made in prototyping but had downstream effects on industry efforts. Early on, the need for Procurement funding for FY 2024 had been overestimated, and as TITAN evolved, the Program Office recognized that RDT&E funding was more appropriate to developing and integrating new technologies into the program. Annual President's Budget requests for the TITAN program were changed between FY 2023 and FY 2024. While FY 2023 projected $298.9 million in procurement funding for FY 2024, the actual FY 2024 budget materials included zero procurement funding.

The consensus among the interview participants was that the funding realignment was done quickly and without any negative impact on the TITAN program – largely due to effective stakeholder engagement. The staff noted this success as an example of Program Office "collaboration across the enterprise, between Army and OSD and the Hill to work on right-sizing the funding lines … it was the Army speaking with a unified voice, it wasn't a bunch of different opinions … It was quite effectively communicated and supported at all levels." The interview participants placed particular emphasis on an engaged and positive relationship with Congress, marked by regular communications, as an enabler of flexible execution. When funds needed to be moved from Procurement to RDT&E during the budget phase following the President's budget submission, Congress was asked to change the budget, marking budget lines and moving money, before the budget submission was approved prior to the year of execution. Funding adjustments were made within the portfolio without adding dollars to the program.

Both the literature review and the interviews highlighted that program managers are graded on how they spend appropriations and are penalized (i.e., "dinged") if they don't spend within a prior ordained timeline. As a consequence, the speed of spending is often a greater concern than the effectiveness of the spending. As a result, spending decisions are made which could easily be called into question if the standard was effectiveness, efficiency, or even performance, rather than whether money is spent according to a quarterly sequence. Often, as exemplified by the TITAN Program Office's decision to extend the prototyping phase, it is more important for the PPBE process to allow for flexibility to change course when needed, rather than for finding ways within PPBE to accelerate technology transition within the program of record. One interview participant contrasted TITAN with other Army programs as such:

> Because we're now in a different situation, we're doing a lot of prototyping and we're using a lot of RDT&E to buy that hardware. And the problem with that is you do not have disbursements in your RDT&E until you receive that hardware. I don't think that's an issue per se with the TITAN program, but we have other programs where it might take two or three years to receive a piece of hardware, and if you don't have disbursements showing that as you're going through your under-execution with OSD, you're getting dinged constantly.

Although the funding realignment was accomplished with relative ease and without noticeable impact to TITAN's early success, industry interviews captured some of its downstream effects and potential implications. The realignment, due to initial overestimation of Procurement funding needed for TITAN at the start of the PPBE process, adds an additional 18–20 months to the competitive down-select process. It is estimated that approximately one-third of the delay, comprising the final months, will be caused by government deliberation on selecting the winning contractor. While the extension of the competitive cycle and additional months required for decision-making could support TITAN's development efforts, the resulting timeline delays have several implications.

One industry interview participant highlighted the final months of government deliberation as the main culprit for any potential negative impacts of a delayed technology transition. He explained that "not only is it delaying program progress, but [the government is] also spending extra money to keep both vendors on an additional 18 months before they can actually move to an award decision." Another interview participant working for a different contractor rationalized that such delays are not unique to the TITAN program—rather, that they are inherent to development efforts that occur alongside competitive scenarios. It occurs due to a variety of reasons, such as difficulties balancing fair competition between suppliers with specific standards for innovation and broad requirements.

Case Study 6: Joint Rapid Acquisition Cell (JRAC)

The Joint Rapid Acquisition Cell (JRAC) is a small organization within the DoD that is uniquely positioned to coordinate with the services (and sometimes DoD agencies) in helping them fulfill their mandated obligation to fund, deploy, and sustain solutions for the urgent operational needs (UONs) of the warfighter within a rapid time frame. UONs, defined as capability requirements impacting contingency operations, originate from combatant commands and are further classified as either Joint Urgent Operational Needs (JUONs) for ongoing contingency operations or Joint Emergent Operational Needs (JEONs) for anticipated contingency operations (CJCS, 2018). As JUONs/JEONs must be reviewed and validated at multiple levels of authority, represent combatant command priorities, and require the services to make tradeoffs in their defense portfolios, the threshold for their approval is high: the potential for unacceptable loss of life and/or critical mission failure if the capability is not provided. The mission of the JRAC is twofold: firstly, it should facilitate the resolution of JUONs or JEONs through the designation of the DoD entity (almost always a military service branch) responsible for funding and filling the operational capability gaps. Secondly, the JRAC must monitor and ensure the timely fulfillment of the solution from development to sustainment, helping to resolve issues that arise as the UONs transition into a program of record.

Comprising one of several measures designed to meet the demands of asymmetric warfare during the wars in Iraq and Afghanistan, the basic structure of the JRAC was established in a 2004 memorandum emanating from the Office of the Deputy Secretary of Defense (Middleton, 2006). Although the JRAC itself cannot fund a capability or roll it into a program of record, it is equipped to accommodate the urgency of operational needs through a set of acquisition and funding authorities known collectively as Rapid Acquisition Authority (RAA). The JRAC uses its RAA to help translate the operational priorities of the combatant commands into the POM cycles of the services, and it allows certain DoD components to make use of available funds on a flexible basis without following the typical phases of the planning, programming, and budgeting phases of the PPBE (GAO, 2023). Along with its RAA, the JRAC is also empowered to facilitate rapid acquisitions for JUONs and JEONs by serving as a single point of contact and intermediary for critical decisionmakers within the DoD.

JRAC Key Finding #1: JRAC efforts highlight the challenges of developing and deploying urgently needed capabilities to support operational needs via the services' respective PPBE processes. A critical takeaway from interviews was that even after the JRAC has handled the initial difficulties of coordinating with DoD leadership to validate UONs and designate a service (sometimes a DoD agency) for incorporating a capability, there are often many delays and difficulties adapting the JUONs or JEONs into capabilities within the services' portfolio. These challenges adapting urgent operational needs stem from the difficulty of capturing reliable new funding lines through PPBE and the nature of PPBE which induces the services to segment their own priorities separately from the Defense Department and combatant commands.

Despite the JRAC's unique authorities and position to assist with the fulfillment and funding of JUONs and JEONs post-validation, the JRAC does not duplicate the functions of service-unique rapid acquisition processes, and once a service adapts a JUON or JEON into a capability within its portfolio and obtains the relevant new funding lines for it, the schedule to deployment is contingent upon the service. Moreover, despite the JRAC's RAA and the statutory requirement for DoD components to address JUONs or JEONs, the JRAC lacks a forcing mechanism for the services to turn a possible solution into a program of record.

A recurrent theme throughout interviews was that the services are averse to adjusting their programming and budgeting for UONs because it requires them to make tradeoffs affecting their priorities. The interviews suggested that funding for ongoing military service modernization

efforts are among the most selected sources of quantity and funding cuts to accommodate the solutions. Since services designated for fulfilling a JUON/JEON are responsible for full lifecycle costs, the JRAC sometimes struggles to insure against "drive-by acquisition," a phrase that was coined to describe instances where material solutions are fielded to the warfighter without adequate Service support for long-term program management and oversight (Middleton, 2006).

An example of drive-by acquisition in one recent scenario in which the JRAC helped oversee the development of a hardware solution, valued at approximately $25.7 million, that was initiated in FY 2018 and sustained through FY 2021. Although the Service designated for oversight had identified the system as a future program of record to be fielded until FY 2025, it chose not to fund further sustainment after the capability lost its JUON designation. To fund continued sustainment, the Service would have had to reduce the PE funding levels and quantity purchased for another unrelated system, which it was unwilling to do. The Service explained that it was "focusing more on strategic long-term modernization priorities, not a short-term band-aid solution." Thus, sustainment funding could not be captured through the PPBE process.

The UONs' budget battles with preexisting service programs of record are a byproduct of PPBE shortcomings because the long timelines of the PPBE process inherently make tradeoffs harder. The PPBE process' emphasis on maintaining or adding funds to prior programs of record negatively impacts the services and other DoD entities attempting to deliver important capabilities to the warfighter within a timely manner. One non-JRAC interview participant with both industry and government experience had observed that in general, programs were rarely cut or slowed down, even when not executing well, "in hopes that these programs would deliver something, someday." Additionally, the interview participant observed an ongoing scenario of a government organization "waiting out the PPBE cycle" to incorporate a new program architecture because ongoing programs of record had left no room in the organization's budget.

Another part of the difficulty transitioning JUONs and JEONs into military service programs of record might be attributed to a disconnect between the combatant commands and the services. Across multiple case study research efforts, interview feedback from the JRAC and non-JRAC personnel associated with other defense programs suggested that the PPBE process for incorporating new funding lines can engender rigidity and lack of fluidity between combatant commands and the services. One JRAC interviewee described a potential dynamic that could occur when the commands' high-level aims are not in alignment with current service objectives:

> For something like long-distance ISR, you might hear from combatant commands that they want ISR [Intelligence, Surveillance, & Reconnaissance] that can remain in the air for days collecting data. The Air Force has the mission for the ISR, but can say they don't need it because they have the ISR program for the MQ-9 and want to focus on manned aircraft rather than unmanned. Meanwhile, the Combatant Command will tell you they need to expand the unmanned need. It then becomes a question of who becomes responsible in that force … Who's going to pay the new bill? At the end of the day what is the requirement? How many hours or platforms? How many people need to get it on this? … The services look at this in terms of having a new bill.

Delays and difficulties rolling urgent capability needs into the services' POM cycles can result in several negative repercussions. Since UONs are validated as high-stakes operational needs for the warfighter, their lack of fulfillment or sustainment, at worst, could negatively impact the mission or the safety of the warfighter. Moreover, drive-by acquisition can also waste money. If a program is not supported to the point of full operational capacity and sustainment, then the funds that went into its development or initial fielding were spent on a solution that had

not been fully capitalized to the intended extent. It can also affect joint operations—even though JUONs and JEONs may be ultimately programmed into the budget of a sole military service, they are considered joint in that their importance overlaps service-specific missions (Middleton, 2006). Finally, the JRAC's difficulties transitioning solutions into viable programs of record can affect the incorporation of cutting-edge technologies, a recurring challenge across the DoD.

JRAC Key Finding #2: Phasing out OCO funding has made it increasingly difficult to secure funding to fill urgent capability gaps, especially JUONs and JEONs. The ability of the JRAC to fulfill its mandate has met with increased challenges since its original conception during the previous wars in the Middle East, when discontinued supplemental funding lines such as the Iraqi Freedom Fund often provided the primary source of funding for JRAC-enabled solutions (Buhrkuhl, 2006). In the past, the JRAC also utilized separate Overseas Contingency Operations (OCO) funding lines, which supported direct war and enduring operations costs and which were unencumbered by discretionary spending caps. JRAC came to rely on the use of OCO, which has shifted into base budgets, to subsidize development and sustainment of new urgently-needed capabilities. Today, JUONs and JEONs are almost exclusively funded by the services.

According to one interview with JRAC personnel, the average dollar amount for a JRAC-facilitated program or capability falls between $25 and $75 million—"small bites, by DoD standards." Despite the relatively small dollar value for most JUONs or JEONs, JRAC-facilitated solutions appear to face increased difficulties obtaining funding through the services' PPBE processes. These challenges suggest that the decline of OCO funding has impacted the ability of the DoD to address and sustain the immediate needs of the warfighter. One JRAC interview participant contrasted OCO-era funding with the current challenges faced by the services as they unwillingly balance their budgetary priorities with those of combatant commands:

> When there was OCO funding for both the Iraq and Afghanistan wars, sometimes that OCO would make it a lot easier to the services to where they didn't have to take funding out of their topline budget. In these cases, even sustainment funding didn't have to come from the services, it was all OCO. So that was certainly much less painful for the services that way because they didn't have to look internally and say they had to kill this ground vehicle program to fund this because this is de facto the highest priority of the Department, even though it doesn't align with our long-term modernization efforts.

When services or DoD agencies must draw from their own funds rather than a specialized funding line for critical wartime operations, the PPBE-related timeline lags and hurdles that hamstring regular acquisitions also become an issue for rapid acquisition processes, like those needed for the fulfillment of JUONs and JEONs within a reasonable time frame. As a result of the decline of OCO, the U.S. warfighter faces budgetary delays that cause it to be without critical capabilities for longer than intended.

JRAC personnel described a recent scenario, well past the era of OCO, in which funding difficulties caused major delays before one capability could be turned into a dedicated program of record and subsequently executed. In FY 2019, the JRAC helped to develop a JUON solution, at an estimated $28 million in cost, which was an adaptation of an existing software merging data from multiple sources. In the POM cycle, the software adaptation failed to find funding for two years, during which the warfighter had to function without this critical capability. The software was eventually rolled into and sustained through a larger Defense Information Systems Agency (DISA) program. The solution eventually succeeded thanks to strong advocacy, proactive action by the JRAC, and the perceived importance of the capability:

> The system itself was very successful, and so it grew into a very useful program that the user community could rely on. And so there was a loud outcry of, "we can't lose this capability," and that was briefed back to us in program review. And my director, to the

three-star that was responsible for funding it, told him to cut another program going forward, and that there was value in [the software]. And the three-star saw the value, understood it. It required person-to-person advocacy, but it was not a hard sell, it just required seeing it across the finish line.

As an addendum to this case study finding, it is important to note that JUON and JEON solutions still usually manage to obtain funding on time frames much shorter than acquisitions not facilitated by the JRAC. Per interviews with JRAC personnel, the average length of time from JUON/JEON approval to the obtainment of a funding line is still only two to three months. Moreover, there are other factors that distinguish how rapidly JUONs or JEONs are fulfilled, and difficulties obtaining funding also occurred at the peak of OCO spending, when a wartime sense of urgency prevailed. The impact of the decline of OCO should be examined within the context of the overall mindset shift that has occurred since the ending of conflicts in Iraq in Afghanistan, which has also most likely changed the services' willingness to rapidly fund immediate warfighter needs through their respective PPBE processes.

Additional Conclusions and Recommendations

For all six case studies, interview subjects observed that the PPBE process had tangible impacts on technology transition and program success, but the extent and nature of these impacts varied substantially depending on the unique contexts of each DoD organization or program. Interestingly, the PPBE process did not seem to have as much of a negative or slowing effect on technology transition as the research team had initially hypothesized. Many program disruptions discussed in the cases were linked to the unpredictable nature of technological experimentation or other features of the defense acquisition system, like the requirements process. This suggests that in some instances, the PPBE process can indeed be a faulty scapegoat for the infamous valley of death. Nevertheless, for the technology-heavy programs and efforts discussed in this paper, PPBE was more likely to be viewed as an obstacle rather than an enabler of rapid development and deployment of new capabilities, and it could benefit from targeted reforms.

Many of the top-level findings summarized in the introduction to this paper were consistent throughout each of the six case studies. Strong senior leadership played a vital accelerating role for new or necessary technologies for every instance in which the PPBE's perceived obstacles fostered the semblance of a valley of death. Interview participants associated with nearly every case study also expressed strong preferences for increased budgetary flexibility, enabled in part by budget structure and J-book organizational features—typically more consolidated, mission-focused PEs, and sometimes less division between appropriations accounts. The case studies were also generally characterized by a strong appreciation for agile approaches like the MTA, plus an emphasis on the importance of thorough, positive congressional engagement.

Interview participants generally perceived the PPBE as an annoyance to be dealt with or tamed however possible. Per the interviews, a need for increased coordination with combatant commands and government agencies were discussed as additional points of concern in the PPBE process with regard to technology transition, although these points appeared to be less immediately impactful than the need for regular congressional engagement. Interview participants, particularly those associated with CCA and TITAN, advised increased coordination with government agencies and adjacent program offices. Some also suggested increasing the authority of the combatant commands, including direct allocations of funds to the commands.

The budgetary inflexibilities caused by certain constraining aspects of the PPBE were strong contributors to negative views of PPBE among the government and industry personnel. To combat such constraints, several interview participants, particularly among SDA and

LUSV/MUSV, advised adjusting or streamlining reprogramming thresholds to accelerate or accommodate the changing circumstances of acquisitions or capability delivery. They suggested increasing the reprogramming threshold limit or allowing for further reprogramming changes during the year of execution, after a program budget request for the next fiscal year has been finalized. Per the experiences of those involved with the RCV program, increased flexibility in the PPBE process might entail providing program leadership with more budgetary authority, allowing program offices to be more open about program budget management reserves without fear that another actor in the PPBE process could take it away. It also might entail developing a "colorless" type of monies distinct from other DoD appropriations categories, which could be devoted to emergent technologies or innovative programs at the service-wide or joint levels.

Along with budget structure, interview participants fully endorsed agile approaches like the MTA, OTA contract vehicle, MOSA, and other solutions, although successful use of these approaches is further impacted by other aspects of the acquisition process such as JCIDs, or industry efforts in the contracting realm. However, as illustrated by the JRAC since the decline of funding accounts like OCO, none of the procedural expedients to the acquisition and deployment of new capabilities can compensate for the necessity of a source of reliable funding. If service and congressional priorities do not support that funding, platforms will face a difficult road in technology transition, from development to deployment to maintenance.

Interview participants, both government and industry, observed that poorly performing programs often continued to receive funding at the expense of new capabilities needed, largely due to a reluctance to cut old programs. One solution to this issue might be to assess crowded legacy programs experiencing sprawl with their many funding lines and to utilize BAs to transform some of these funding lines into modernizing efforts that better align with the long-term priorities outlined in current service strategy documents. Per the case study interview perspectives, obtaining reliable funding and achieving service-wide and congressional support appeared to be a smoother process when new defense efforts were descendants of parent or legacy programs. TITAN provided an excellent model for such a transition as a well-supported child of the Army's DCGS-A program through which it inherited legacy technological progress.

For many key enablers of flexibility, rapidity, and success in technological development and deployment among the six case studies, a large number were unexpectedly more likely to be hamstrung by restraints and bureaucratic tape which were not caused by PPBE-related restrictions. While adjusting the timelines of PPBE and increasing communication with Congress could facilitate technology transition, PPBE-targeted reform alone cannot alter the changeable nature of Congress itself as elected officials perform their legislatively endowed gatekeeping role. Nor can it prevent the unpalatable but unavoidable necessity in resource allocation and discretionary defense spending: difficult tradeoffs. The fine balance of navigating the classic military trifecta of modernization, force structure, and readiness has been the challenge for every society's armed forces since the first soldiers were deployed to provide for the common defense.

Case study interview participants touched on a wide variety of non-PPBE-related and exogenous factors that should be taken into consideration to improve the success rate of capabilities traversing the valley of death. All case study sources, especially JRAC personnel, stressed the human element to finding solutions; the importance of advocacy during the POM process to advocate for operational needs, better accessibility to the relevant chain of command, and increased training. Interview participants conveyed experiences in which other key program participants displayed a lack of awareness of PPBE protocol, J-book structure, or other information that was simply critical to DoD functions—for instance, some DoD personnel

were not even aware that they were required by statute and directive to undertake JUONs and JEONs.

In conducting the case study research, it was occasionally difficult to determine whether the so-called valley of death hampered key technological progress or whether it could have provided a useful screening process—not all prototypes or commercial technologies are viable for transition to operational use. The quality of technologies that are transitioned, rather than the quantity and speed at which they are deployed, arguably represents the most vital consideration in the DoD's resource allocation. There were occasionally positive implications to be drawn regarding the timelines and barriers of the PPBE process, potentially fostering more effective, pragmatic funding patterns. Depending on the perspective, positive implications may be drawn from FOO Fighter, as discussed in the SDA vignette. Once FOO Fighter was adopted by the SDA, progress was rapid, and SDA moved quickly to issue its first solicitation for the experimental space-based sensor technology derived from the program. FOO Fighter's lingering in the valley of death could be interpreted as a failure of PPBE, or it could be interpreted as a positive outcome in which the delay allowed for a successful new capability to find an alternative home within an agency that was more culturally compatible with its nature and intended purpose.

The PPBE Reform Commission's final report, with its prescriptions for a new Defense Resourcing System, suitably capture the need to retain elements of the PPBE that serve a critical purpose, while reforming its most glaring flaws, including the need to streamline programming and budgeting functions which overlap. The Commission's final report, in addition to findings from the six case studies, seem to convey that a complete overhaul of PPBE functions may not be necessary. However, they do endorse certain radical changes, and it is worth noting that programs like TITAN and organizations like SDA have found success by following radically different processes from typical capability acquisitions which hardly resemble a typical understanding of PPBE's limitations. Research findings (including further insights derived from interview discussions that were beyond the scope of inclusion in this paper) suggest that the SDA in particular could provide an effective model for other agencies with unique mandates to deliver technologies on a rapid timeline. Its ability to implement iterative improvements and its low-cost incorporation of commercial technologies enable it to circumvent the worst of the valley of death. Employing satellite technologies which are close to or already at full viability, it can escape many of the risk aversion tendencies and fears of elected officials and avoid extended prototyping. Nevertheless, as noted by the interview participants, rapid acquisition models are not necessarily suited to major capability acquisitions for large, exquisite systems.

If any further summary recommendation is to be derived from the case study findings, it is that in a peacetime setting, with new threats on the horizon from technologically advanced U.S. adversaries, stakeholders in the budgetary process should currently prioritize modernization efforts. This entails making space for cutting-edge programs rather than renewing POM cycles for legacy programs with underwhelming track records of performance. It also entails making space for the use of newer defense pathways or contracting strategies (i.e., the Middle Tier of Acquisition, or commercial acquisitions) while avoiding overregulating and applying new constraints which prevent these methods from functioning as they were intended. These mindset changes will facilitate a more suitable pace of technological development and adoption.

Findings and recommendations derived from the six case studies should be taken into consideration with the understanding that the majority of programs and organizations discussed were relatively new and in the earlier stages of technology transition. As such, the full extent of PPBE's impacts on the defense programs discussed in this paper, as they progress to full

operational capability or maturity, is not yet fully known. As such, this paper recommends further relevant research. Continued interviews and data-based analysis efforts are suggested in order to better isolate and assess the impacts of the PPBE process on these as well as other, mature defense programs that have demonstrated long-term successes or failures.

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