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# THE GOVERNMENT FUNDING APPROPRIATION PROCESS AND ITS INABILITY TO KEEP UP WITH SOFTWARE AND DIGITAL TECHNOLOGY

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# NAVAL POSTGRADUATE SCHOOL

**MONTEREY, CALIFORNIA**

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**JOINT APPLIED PROJECT REPORT**

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**June 2022**

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Software development and fielding is a fast-paced environment that is constantly evolving. In order to better keep up with the latest software technologies, the current funding process, to include the planning, programming, budgeting, and execution (PPBE) process and the funding appropriation breakout categories, must be reformed and updated. This project conducts a comparative analysis of the timeline for appropriations actions vs. the software development/fielding timelines to which the DOD is hoping to transition. After analyzing the current funding method, it is clear that methods such as the "colorless money" initiative or software-specific funding should be explored. Furthermore, a software-specific funding category would be best in promoting a rapid software acquisition environment, but more data and piloting still needs to be conducted to determine overall success.

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Allison A. Calabria, Civilian, Department of the Navy

Submitted in partial fulfillment of the
requirements for the degree of

**MASTER OF SCIENCE IN PROGRAM MANAGEMENT**

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# THE GOVERNMENT FUNDING APPROPRIATION PROCESS AND ITS INABILITY TO KEEP UP WITH SOFTWARE AND DIGITAL TECHNOLOGY

## ABSTRACT

Software development and fielding is a fast-paced environment that is constantly evolving. In order to better keep up with the latest software technologies, the current funding process, to include the planning, programming, budgeting, and execution (PPBE) process and the funding appropriation breakout categories, must be reformed and updated. This project conducts a comparative analysis of the timeline for appropriations actions vs. the software development/fielding timelines to which the DOD is hoping to transition. After analyzing the current funding method, it is clear that methods such as the "colorless money" initiative or software-specific funding should be explored. Furthermore, a software-specific funding category would be best in promoting a rapid software acquisition environment, but more data and piloting still needs to be conducted to determine overall success.

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# LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AAF | adaptive acquisition framework |
| BES | budget estimate submission |
| CAPE | Cost Assessment and Program Evaluation |
| COPT | Corporate Office Properties Trust |
| CY | calendar year |
| DA | decision authority |
| DAS | Defense Acquisition System |
| DAU | Defense Acquisition University |
| DOD | Department of Defense |
| DSB | Defense Science Board |
| FY | fiscal year |
| FYDP | future years defense program |
| IDA | Institute of Defense Analyses |
| IOT&E | initial operation test and evaluation |
| IP | intellectual property |
| IT | information technology |
| JCIDS | Joint Capabilities Integration and Development Systems |
| JIEDDO | Joint Improvised Explosive Device Defeat Organization |
| LFT&E | live fire test and evaluation |
| LRIP | low rate initial production |
| MDA | milestone decision authority |
| MILCON | military construction |
| MILPERS | military personnel |
| NDS | National Defense Strategy |
| NEPS | NAVSEA Enterprise Planning System |
| NMS | National Military Strategy |
| NSS | National Security Strategy |
| O&M | operation and maintenance |
| OMB | Office of Management and Budget |
| OSD | Office of the Secretary of Defense |

| | |
|---|---|
| PM | program management |
| PMO | program management office |
| POM | program objective memorandum |
| PPBE | planning, programming, budgeting, and execution |
| R&D | research and development |
| RDT&E | research, development, test and evaluation |
| ROI | return on investment |
| SECDEF | Secretary of Defense |
| SLOC | source lines of code |
| SWOT | strengths, weaknesses, opportunities, and threats |
| T&E | test and evaluation |
| USD | Under Secretary of Defense |

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# I. INTRODUCTION

Software development and acquisition is a growing piece of the Department of Defense (DOD) and the commercial world. Whether a new weapon system or a legacy system, software is an integral part of most systems the DOD procures. With that said, many DOD legacy programs currently still utilize a waterfall development approach for software development and acquisition. However, this development process is outdated and does not allow for the DOD to keep up with the current and rapid software trends, and thus inhibits the DOD's ability to maintain the national and military mission strategies along with its ability to keep close competition with adversaries. Therefore, it is critical that the DOD transition to a more continuous iterative software development process. Doing so would allow the DOD to ensure the software produced is not only the latest, but also continuously being improved to address defects and/or deliver new capabilities.

One issue that currently puts some restraints on achieving the agile software environment is the current government funding process. As a big "A" requirement, software acquisition programs, along with all other acquisition programs, are required to go through the planning, programming, budgeting, and execution (PPBE) process. Between the lengthy PPBE process and the specific budgeting appropriation categories, it could prove difficult to reach and maintain a continuous, iterative software acquisition process. The current funding process requires at least 2 years of planning in advance and overall has a timeline of 5–7 years total, while the agile software development process can be seen to be much quicker and more iterative than the current funding process allows. Thus, options to improve this funding process for software development must be explored if the DOD wishes to keep up with the current software trends.

One option currently being piloted is the concept of "colorless money." While a good recommendation that would allow for more flexibility and speed, this option still displays some limitations and constraints that need to be considered and analyzed. Another option that is slowly emerging is derived from the "colorless money" initiative but would allow software acquisition to receive its own funding appropriation category, and thus would not take funding from any of the existing appropriation categories. Even this option

has its own limits, but it also has many benefits. An analysis of both of these funding methods alongside of the current government funding process, will allow a conclusion to be reached the best funding process reformation, if any, required to support agile software development.

The following chapter will provide a brief background and understanding on big "A" requirements, the PPBE process, the government funding appropriation categories and process, and also the software acquisition development processes. This background information will give insight on the current issues with funding software development and will also lead to a better and more thorough understanding of the current and potential funding methods for software acquisition programs. Furthermore, a literature review was also conducted to provide research data and studies in support of the necessary funding method reforms or changes that must be seen to support a rapid software environment. By analyzing the three current and/or potential funding methods via Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis, a recommended funding solution may be reached in support of maximizing the DOD's software acquisition process. The ultimate goal of this research is to find a funding solution that will allow the DOD to operate in a continuous, iterative software environment; and based off the data and analysis, creating a new funding appropriation category for software to engulf all tasks from research and development to operations and maintenance, is the best solution in support of the overarching objective.

# II. BACKGROUND

Software is constantly evolving and changing both commercially and for the Department of Defense (DOD). More specifically, software is an integral piece to weapon systems and thus is essential to the nation's military strategy (Defense Science Board [DSB], 2018). In order to compete with its adversaries, the "The Department of Defense (DOD) must be able to develop and deploy software as fast or faster than its adversaries are able to change tactics, building on commercially available tools and technologies" (McQuade et al., 2019, p. S76).

However, in order to keep an agile environment for software development, the resources and funding must be in place and ready to support within the constantly changing environment. The issue presented then is that the funding process is complex and lengthy, thus questioning its ability to keep up with an agile software acquisition process. As part of the acquisition process, the big "A" requirements include the following: the Joint Capabilities Integration and Development Systems (JCIDS) process, the Planning, Programming, Budgeting, and Execution (PPBE) process, and the Defense Acquisition System (DAS) process. With that being said, the PPBE process is an integral piece and requirement of the big "A" acquisition process.

Thus, from ensuring the correct funding appropriations to the five to seven years of the PPBE process, it may prove difficult for the proper resources and appropriations to keep up with the rapid, agile environment of software acquisition. The subsequent sections will provide background information on the following topics: big "A" requirements, five main funding categories, PPBE process, and software acquisition process.

## A. BIG "A" REQUIREMENTS

As a major acquisition program, there are a few steps and requirements that must be met and followed. These big "A" requirements include the following: the Joint Capabilities Integration and Development Systems (JCIDS) process, the Planning, Programming, Budgeting, and Execution (PPBE) process, and the Defense Acquisition System (DAS) process (Lofgren, 2019). The JCIDS process assists in identifying the

needed weapons system and its requirements, the PPBE process is responsible for the budget and allocations, and the DAS process, guided by the DOD Directive 5000.01 and DOD Instruction 5000.02, assists with the development and procurement of the system (Lofgren, 2019). Figure 1 displays the big "A" process and the necessary integration of its requirements.

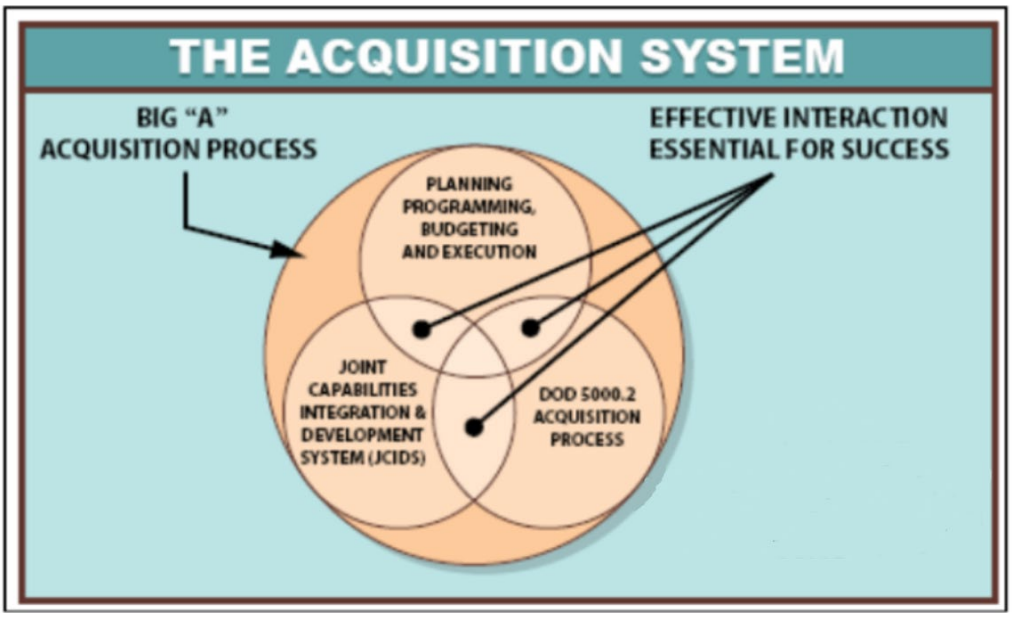


Figure 1. Big "A" Acquisition Requirements. Adapted from Lofgren (2019).

## B. PLANNING, PROGRAMMING, BUDGETING, AND EXECUTION (PPBE) PROCESS

In light of the different appropriations, allocations are made based off the PPBE Process. The PPBE process "serves as the annual resource allocation process for the department over a multi-year planning cycle" (McGarry & Williams, 2020, p. 1). By going through this process, the Department of Defense (DOD) is able to balance "forces, equipment, manpower, and support" given the fiscal budget and constraints (McGarry & Williams, 2020, p. 1). This process also allows the DOD to update its spending plan for the next five years, otherwise known as future years defense program (FYDP) (McGarry & Williams, 2020). The budgeting part of the PPBE process begins two years prior to the

planned budget execution (McGarry & Williams, 2020). Figure 2 highlights the PPBE process broken out by fiscal year (FY) over the course of calendar years (CY).

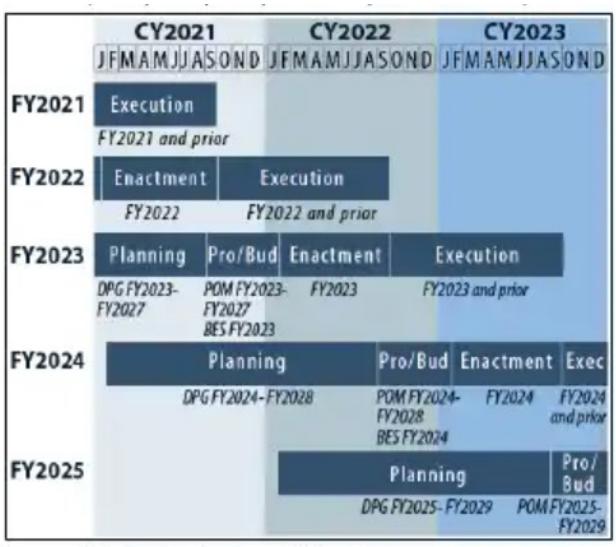


Figure 2. PPBE Process Timeline. Source: Williams (2020, p. 1).

The purpose of the planning phase, as the first step in the process, is to develop a path forward in accomplishing objectives as projected in the nation's military strategy (Holcomb & Johnston, 2008). Thus the planning phase is centered on:

> Defining the national military strategy necessary to help maintain national security and support U.S. foreign policy 2 to 7 years in the future; planning the integrated and balanced military forces necessary to accomplish that strategy; ensuring the necessary framework (including priorities) to manage DOD resources effectively for successful mission accomplishment consistent with national resource limitations; and providing decision options to the Secretary of Defense (SECDEF) to help him assess the role of national defense in the formulation of national security policy and related decisions. (Holcomb & Johnston, 2008, pp. 8–9)

The planning phases consists of the three following planning documents as a basis: the National Security Strategy (NSS), the National Defense Strategy (NDS), and the National Military Strategy (NMS). The NSS receives input from the President, the National Security Council, and other agencies and is the overall strategy to mitigate any of the nation's threats (Holcomb & Johnston, 2008). The NDS is issued by the Secretary of Defense (SECDEF)

and highlights objectives and a plan for the DOD to achieve those objectives in order to meet the overall military strategy (Holcomb & Johnston, 2008).

The programming phase, managed by the Director of the Cost Assessment and Program Evaluation (CAPE) Office, is used to "analyze anticipated effects of present-day decisions on the future force" (McGarry & Williams, 2020, p. 2). This phase begins with the development of the program objective memorandum (POM) per component. The POM describes the expected resources for the program over five years, and also ranks programs and identifies risks for these programs if underfunded or unfunded (McGarry & Williams, 2020). The CAPE will review the submitted POM to determine and predict future resource requirements for the next five years and will update the future year defense program (FYDP) to reflect such (McGarry & Williams, 2020).

After the programming phase is the budget phase of the PPBE process. This phase is led by the DOD Comptroller, in which each component will have a budget estimate submission (BES) starting with its first year in the FYDP (McGarry & Williams, 2020). The Comptroller "reviews the budget submissions for funding and fiscal controls, phasing of the efforts over the funding period, and feasibility of execution within the budget year" (McGarry & Williams, 2020, p. 2). As a part of these budget reviews, the Comptroller will work with the component analysts to ensure the budget requests align with the overall budget and after this review, the final BES is provided to Office of Management and Budget (OMB) to ensure it is included in the President's annual budget request, which is typically submitted to Congress in February (McGarry & Williams, 2020).

Last of the PPBE process is the execution phase. In the execution phase, program results along with funding obligations and expenditures are analyzed and evaluated by the Office of the Secretary of Defense (OSD) and the components during an execution review (McGarry & Williams, 2020). This review looks over a program's objectives versus the results to determine the success of the program with the components responsible for evaluating the program's priority compliance, "SECDEF guidance, performance metrics, and program results" and the OSD staff responsible for reviewing the said evaluation and providing recommendations as needed (McGarry & Williams, 2020, p. 2).

## C. THE FIVE FUNDING CATEGORIES

The Department of Defense (DOD) has five main funding appropriation categories as follows: 1) Research, Development, Test and Evaluation (RDT&E), 2) Procurement, 3) Operation and Maintenance (O&M), 4) Military Personnel (MILPERS), and 5) Military Construction (MILCON) (Defense Acquisition University [DAU], n.d.-a). Figure 3 breaks out the funding categories with their historical percentage of appropriations. By establishing the different categories, funding discussions are more efficient as it is just limited to the funding and policies of that specific category (DAU, n.d.-a). Once the "federal agencies submit their budget requests to Congress," Congress then reviews the budget requests and allocates funding via the annual appropriation acts (DAU, n.d.-a).

**AVERAGE HISTORICAL PERCENTAGE OF SELECT ACCOUNTS WITHIN THE DoD (SUBFUNCTION 051)**
**> Fiscal Years 2001–2007**

| | | |
|---|---|---|
| 41% | Operations & Maintenance (O&M) | Cost of ground, sea, and air operations, equipment repair, and maintenance of defense facilities, healthcare costs, and administration |
| 24% | Military Personnel (MILPERS) | Pay and allowances, and various benefits including military retirement funds |
| 19% | Procurement | Acquisitions of weapons and support systems |
| 12% | Research, Development, Test & Evaluation (RDT&E) | Basic research and development of new weapons and equipment |
| 2% | Military Construction (MILCON) | Facility management and construction |

**Source:** Congressional Research Service report dated March 17, 2017; www.crs.gov

Figure 3. Average Historical Percentage of Funding Appropriations. Source: Corporate Office Properties Trust [COPT] (2020, p. 6).

To further dive into the different funding categories, RDT&E funding is used specifically for research and development (R&D) functions. This is to include government and contract support efforts, equipment, materials, and software (DAU, n.d.-a). This scope also involves "Test and Evaluation (T&E) to include Initial Operational Test and Evaluation (IOT&E) and Live Fire Test and Evaluation (LFT&E)" (DAU, n.d.-a). RDT&E appropriations are only available for two years, and is funded incrementally (AcqNotes LLC, 2021). Typically, this phase is where new, emerging program and technologies are

developed and tested. And upon program success in this RDT&E phase, the program is able to move to the next phase of procurement.

Procurement appropriations fund the "acquisition programs that have been approved for production (to include Low Rate Initial Production (LRIP) of acquisition objective quantities)" (DAU, n.d.-a). This appropriation captures all associated costs that are essential to ensuring the delivery of the operational end item, whether to be utilized or stored in inventory (DAU, n.d.-a). Procurement appropriations are available for three years, with the exception to ships with funding available for 5 years, and are generally fully funded vice the incrementally funded seen in RDT&E (AcqNotes LLC, 2021).

Following the acquisition phase is Operations and Maintenance (O&M). O&M involves the sustainment of the equipment, ships, systems, etc., that are acquired during the procurement phase. Thus O&M appropriations fund the following expense: "civilian salaries, travel, minor construction projects, operating military forces, training and education, depot maintenance, stock funds, and base operations support" (DAU, n.d.-a). O&M appropriations are available for one year and are funded on an annual basis (AcqNotes LLC, 2021).

The last funding categories are Military Personnel (MILPERS) and Military Construction (MILCON). MILPERS funds the "costs of salaries and other compensation for active and retired military personnel and reserve forces based on end strength" (DAU, n.d.-a). While MILCON funds the costs of supporting projects such as "bases, schools, missile storage facilities, maintenance facilities, medical/dental clinics, libraries, and military family housing" (DAU, n.d.-a). Similar to O&M, MILPERS appropriations are also available for one year and are funded on annual basis (AcqNotes LLC, 2021). MILCON appropriations, however, are available for five years and are funded fully (AcqNotes LLC, 2021). Figure 4 graphically captures the appropriation timelines of RDT&E, Procurement, O&M, MILPERS, and MILCON as defined above.

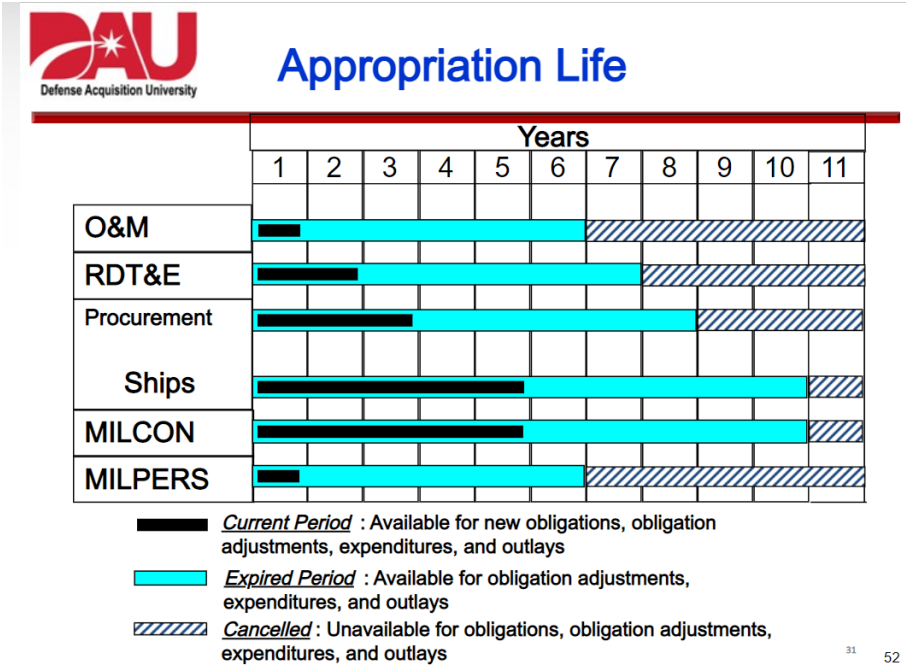


Figure 4. Funding Appropriation Timeline. Source: Tomasini (n.d., p. 52)

As described above and displayed in Figure 4, each funding category has its own period of funding validity. The reason each funding category has time restriction or periods of validity is to allow Congress to maintain oversight (Section 809 Panel, 2019). There are also concerns that if funding does not expire, then there is a chance that programs and agencies will accumulate large sums of unexpended funding (Section 809 Panel, 2019). Thus, these funding appropriations' periods of validity are in place for good reason.

## D. THE SOFTWARE ACQUISITION PROCESS

As mentioned briefly before, software has become an integral piece to weapon systems and the defense strategy. The use of software continues to grow and will continue to affect both new systems and legacy systems alike (DSB, 2018). Because of its complexity, software metrics are typically based off its source lines of code (SLOC) (DSB, 2018). By counting the SLOCs, estimates of the software's "complexity, cost and schedule, and overall centrality" may be determined (DSB, 2018, p. 3). Even with its limitations and questionable credibility, due to use of different programming systems and languages, the SLOC may still be useful when looking at the size of a software system, which continues

to grow drastically over the past few decades. Figure 5 shows this trend of drastic growth using avionics software as an example (DSB, 2018).

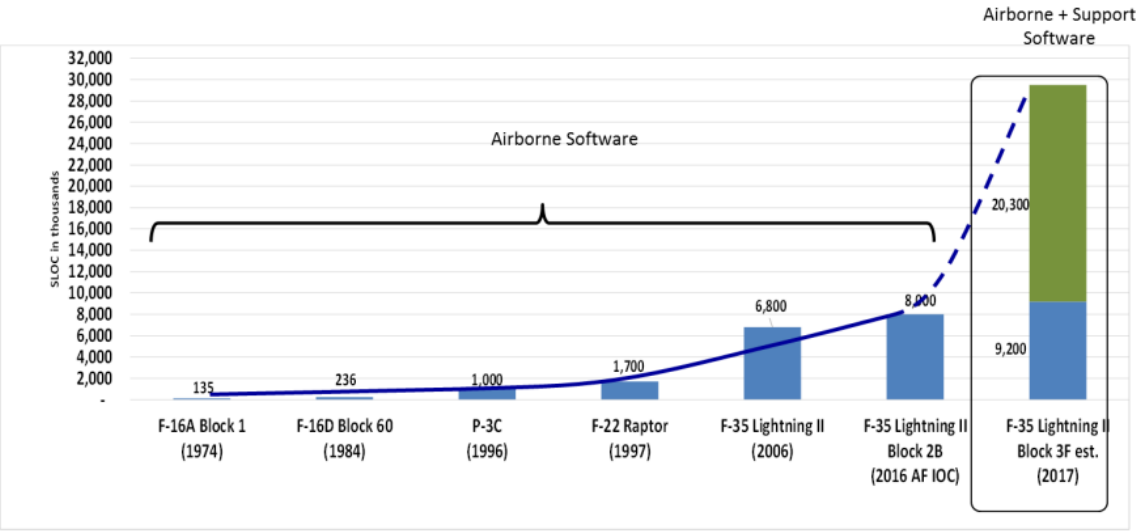


Figure 5. Growth of SLOC in Avionics Software (SLOC vs. Decade) Example. Source: DSB (2018, p. 4)

As seen in Figure 5, software is growing rapidly and the DOD must adapt and utilize different, new processes to keep up with this rapid growth. While there are numerous theories for software development, some of the main software development processes include the following: waterfall development, agile development, agile dev-ops, and iterative development (DSB, 2018). The waterfall development is the linear, "traditional approach" and consists of writing and reaching full function requirements prior to any testing. The software is then a fully complete deliverable upon its successful testing (DSB, 2018, p. 6).

Unlike the waterfall development process, the agile development process is considered to be iterative (DSB, 2018). Beginning with a software factory, the agile development process uses "development and testing sprints," in which specific work is completed in a specific timeframe (DSB, 2018, p. 6). This process thus allows for "a team to do rapid iterations of development, obtain user feedback, and adjust goals for the next

increment" (DSB, 2018, p. 6). The agile development process provides the ability to continuously develop the software throughout its life cycle (DSB, 2018).

Agile dev-ops is the process of concurrently performing a variety of agile projects in support of incrementally developing an application (DSB, 2018). Because of the simultaneous developments, well-planned architectural design, careful and well-defined interfaces between modules and subsystems, and in-depth testing of these interfaces are all necessary pieces of dev-ops to ensure success and reduce the risk of complications (DSB, 2018). Lastly, iterative development is a process carried by the use of the software product, in which defects and/or recommendations are identified and implemented throughout the process and thus much more rapidly (DSB, 2018). Iterative development, compared to the other software development processes, produces iterations with much more speed and granularity (DSB, 2018). Because of its rapid deployment, both issues and improvements are caught much earlier and allow for the software product to be delivered and improved much quicker (DSB, 2018).

A method that captures these iterative development processes is the software factory. The software factory allows the "developers, users, and management to work together" regularly which allows the team to build and test code daily to identify and address any issues and to ensure code requirements are met (DSB, 2018, p. 9). This concept fully embraces iterative development as the code is developed and tested repeatedly to allow the team to update and improve the code as needed to address any known complications and any new requirements or capabilities. The current and past versions of these codes, upon peer review, are all stored in a source code repository (DSB, 2018). This would then allow the team to pull these codes from the repository to update and improve, reuse for other applications, and even potentially use as a basis for applications for new requirements.

Currently the DOD utilizes the waterfall development for most of its legacy systems. Figure 6 depicts the linear waterfall development timeline. As seen in Figure 6, the overall timeline for this style development is over seven years, which is challenging if the DOD wishes to keep up with its adversaries and the commercial world (DSB, 2018). With that said, the DOD is working to transition to a more continuous iterative

development method. Doing so will allow software programs to keep up with the current software climate, and thus "will help the DOD to operate in today's dynamic security environment, where threats are changing faster than waterfall development can handle" (DSB, 2018, p. 11).

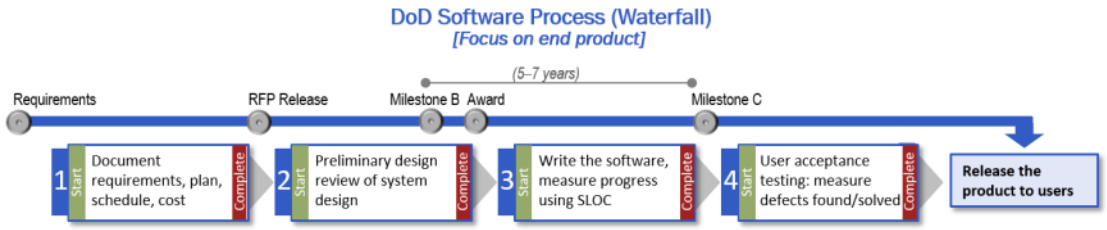


Figure 6. DOD Software Process. Source: DSB (2018, p. 7)

Transitioning to an agile software development process not only benefits software development schedule, but may also result in increased performance, better quality, and costs savings. Although there are not many studies on iterative development, two surveys are particularly noteworthy (DSB, 2018). The first survey consisted of thirty-six studies, four of which contained productivity data of iterative development versus the traditional waterfall development (DSB, 2018). Figure 7 displays the results of these four studies by measuring the SLOCs (DSB, 2018).

| Study | Traditional Productivity | Agile Productivity | Productivity Gain |
|---|---|---|---|
| S7 | 3 LOC/hr | 13.1 LOC/hr | 337% |
| S10 | 3.8 LOC/hr | 5.4 LOC/hr | 42% |
| S14 | 300 LOC/month | 440 LOC/month | 46% |
| S32 | 157 LOC/engr | 88 LOC/engr | -44% |

Figure 7. Survey 1 Productivity Results: Dyba and Dingsoyr Meta-survey. Source: DSB (2018, p. 15)

While the first survey did not result in complete productivity gain for all of its studies, three of the four studies did show a decent increase in productivity. The second survey also displayed trends of productivity. This survey consisted of twenty-nine studies. The results found in this survey "found that Agile development yielded the following return on investment (ROI): 29% lower cost, 91% better schedule, 50% better quality, and 400% better job satisfaction" (DSB, 2018, p. 16). These two studies reiterate the importance of the DOD transitioning from waterfall development to agile development or agile dev-ops, not just to assist with performance, quality and schedule, but also with cost savings.

The DAS, mentioned briefly in the beginning of the background, is the development and procurement piece of big "A" acquisition. As part of the DAS process, the adaptive acquisition framework (AAF) is a tool used to support "the objective of delivering effective, suitable, survivable, sustainable, and affordable solutions to the end-user in a timely manner" (AcqNotes LLC, 2022). The AAF presents six individual pathways that provide direction to the milestone decision authorities (MDAs), decision authorities (DAs), and program managers (PMs) when it comes to acquisition strategy and process for their programs, with each pathway unique to "the capability being acquired" (AcqNotes LLC, 2022). The six AAF pathways include the following: urgent capability acquisition, middle tier acquisition, major capability acquisition, software acquisition, defense business system, and acquisition of services (AcqNotes LLC, 2022).

As listed above, software acquisition has its own AAF pathway. The goal of this pathway is to "facilitate rapid and iterative delivery of software capability to the user" (DAU, n.d.-b). Rapid and iterative software acquisition "reduces costs, technological obsolescence, and acquisition risk" and consists of the following two phases: planning and execution (Office of the Under Secretary of Defense [USD], 2020b, p.8). The following Figure 8 maps out the planning and execution phases highlighting details for each phase. The planning phase focuses on defining the requirement, the acquisition strategy, the intellectual property (IP) strategy, the test strategy, cost estimates, and the life cycle product support strategy (Office of the USD, 2020b). The planning phase is followed by the execution phase of which the main goal is to "rapidly and iteratively design, develop,

integrate, test, deliver, and operate resilient and reliable software capabilities that meet the users' priority needs" (Office of the USD, 2020b).

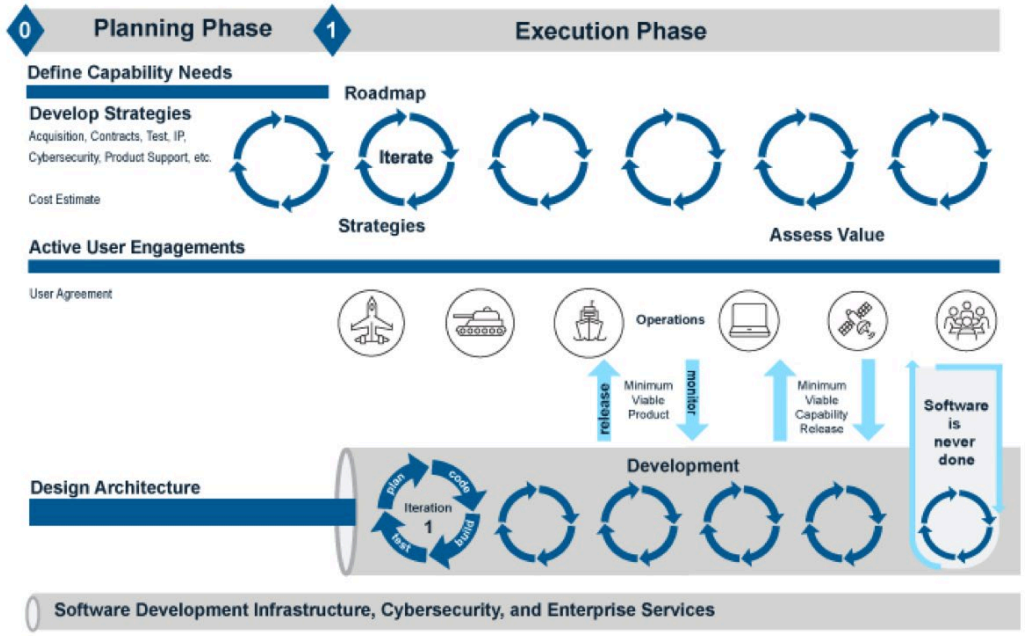


Figure 8. "The Software Acquisition Pathway." Source: Office of the USD (2020b, p. 8)

In conclusion, as a big "A" requirement, software acquisition programs must go through the PPBE process. Upon the budgeting phase, Congress appropriates funding as one of the following funding categories: RDT&E, O&M, Procurement, MILCON, and MILPERS. Both these processes can be lengthy and complex which poses a potential issue when it comes to software acquisition. As software development becomes more and more pertinent in the defense world, it is essential that the DOD transition to a rapid software environment to keep up with industry and adversaries. And thus as rapid software acquisition becomes more accepted and used by the DOD, the funding process currently utilized does not support this quickened timeline. The following chapter, Literature Review, will provide and highlight current studies, research, and data that identify the current funding process as inadequate to support rapid software acquisition.

# III. LITERATURE REVIEW

As described briefly in the background, a defense acquisition process has many moving parts and pieces that must be integrated effectively to ensure acquisition program success. On top of that, the software acquisition environment is fast-paced and constantly evolving. Thus, maintaining a rapid software development environment with the current funding processes is proving to be difficult. In regard to this issue that is being presented, there have been many articles and reports written to address the current problem and thus some suggesting recommendations and reform. The following chapter will summarize a few of these reports that address the current funding and software acquisition process issues along with identifying potential solutions to this problem. The reports to be assessed include the following: the Section 809 Panel's Report of the Advisory Panel on Streamlining and Codifying Acquisition Regulations Volume 3, the Defense Science Board (DSB) Task Force on Department of Defense Policies and Procedures for the Acquisition of Information Technology, and the Institute of Defense Analyses (IDA) with the Assessment of Accelerated Acquisition of Defense Programs.

## A. REPORT OF THE ADVISORY PANEL ON STREAMLINING AND CODIFYING ACQUISITION REGULATIONS VOLUME 3

In this report, the Section 809 Panel sets to tackle the following issue: "how to change defense acquisition from an outdated, industrial-era bureaucracy to a more streamlined, agile system able to evolve in sync with the speed of technology innovation" (Section 809 Panel, 2019, p. EX-1). They suggest that the DOD currently lacks the flexibility and "war footing approach" to meet warfighter capabilities and requirements along with any current threats (Section 809 Panel, 2019). In an effort to counter these concerns, the Section 809 Panel has performed extensive research, "brainstorming," and collaboration to identify and recommend potential solutions and improvements (Section 809 Panel, 2019). Volume 3 of this report provides fifty-eight recommendations, on top of the thirty-five recommendations that were identified in Volumes 2 and 3 of this report (Section 809 Panel, 2019).

The Report of the Advisory Panel on Streamlining and Codifying Acquisition Regulations Volume 3 is broken into a total of thirteen sections with recommendations provided for each of the topics covered by these sections. Of the thirteen sections, the two most relevant to this research effort was Section 3: Information Technology (IT) Procurement and Section 4: Budget. More specifically, the two recommendations most applicable include Recommendation 43 and Recommendation 49, as presented in Section 3 and Section 4 respectively. Recommendation 43 proposes the following: "Revise acquisition regulations to enable more flexible and effective procurement of consumption-based solutions" (Section 809 Panel, 2019, p. 136); while Recommendation 49 suggests "Provide increased flexibility to the time periods within which contract obligations are permitted to occur" (Section 809 Panel, 2019, p. 195).

Section 3 on IT Procurement addresses the following: "Because the commercial IT market has outpaced the DOD market for decades, DOD regularly acquires outdated and inferior technology, often at higher prices and slower rates" (Section 809 Panel, 2019, p. 134). The DOD's outdated efforts directly effects the warfighter and the current capabilities in terms of performance, cost, and schedule (Section 809 Panel, 2019). As a result, Section 3 recommendations target potential strategies to promote and implement a quick, rapid software environment for the DOD (Section 809 Panel, 2019).

More particularly, Section 3 has highlighted funding and "fiscal issues" as one of its key challenges (Section 809 Panel, 2019). The current "Budgeting rules and appropriation law have created IT acquisition challenges in DOD for almost as long as the term IT has existed" (Section 809 Panel, 2019, p. 142). Through the analyses of many studies, this report suggests that the "DOD needs more fiscal flexibility to effectively acquire high quality IT" (Section 809 Panel, 2019, p. 142) and identifies the use of "colorless money" and working capital funds as the only current solutions (Section 809 Panel, 2019). However, there are still limitations with these solutions, especially when it comes to planning and budgeting. As the report states:

> Not knowing in advance how much of a service will be used means the amount obligated on a contract is at best an estimate based on a set of assumptions, and at worst simply a guess. The ramifications can be substantial. If the estimate is high, funding must be de-obligated, putting the next year's budgets

> at risk in the government's use it or lose it culture. If the estimate is too low, the contracting officer risks an Anti-deficiency Act violation, punishable by suspension without pay, removal from office, fines, and even imprisonment. (Section 809 Panel, 2019, p. 143).

From this it is clear that the current DOD funding processes are not optimized to handle the constantly changing, uneasily defined, and fast moving environment that the software development process presents.

As a result of these findings, the Section 809 Panel landed on "Recommendation 43: Revise acquisition regulations to enable more flexible and effective procurement of consumption-based solutions" (Section 809 Panel, 2019, p. 136). The Panel, in conclusion to its studies, suggests that "Congress should provide funding flexibility, so acquisition professionals can confidently procure consumption-based solutions without fear of running afoul of the Anti-deficiency Act or Impoundment Act" (Section 809 Panel, 2019, p. 147). Furthermore, the Section 809 Panel even offers guidance on implementation in support of its recommendation and proposes the Legislative Branch "Revise appropriation law and budgeting rules to address the unique aspects of buying consumption-based solutions" (Section 809 Panel, 2019, p. 148), referring to the next, highlighted recommendation in this report review, Recommendation 49, which proposes the flexibility required to support this implementation (Section 809 Panel, 2019).

Section 4 on Budget addresses the concerns associated with the current budget and funding process, in which "current rules limit the flexibility of DOD's acquisition workforce in dealing with the realities of the marketplace" (Section 809 Panel, 2019, p. EX-4). While this report is not intended to reduce Congressional oversight and function nor reform the current PPBE process, it does suggest that, like other acquisition systems, the PPBE process should be criticized and reformed every so often as to keep up with the current acquisition climates (Section 809 Panel, 2019). Reforming the budget process would better support the acquisition process and the procurement of warfighting requirements needed "maintain technological dominance— competitors already have" (Section 809 Panel, 2019, p. 176).

Section 4 provides the necessary recommendations "to reduce inefficiency and dysfunction" in the current funding process, mainly focusing on ways to effectively and

efficiently allocate DOD resources (Section 809 Panel, 2019, p. EX-4). One explicitly relevant issue with the current funding process is the periodicity, or period of funding validity, that each funding appropriation category falls subject to (Section 809 Panel, 2019). Overall, defense spending is subject to many deadlines to include those imposed by the Congress appropriation categories (Section 809 Panel, 2019). As such, these impositions may negatively affect a multitude of defense acquisition programs (Section 809 Panel, 2019). To combat this, the Section 809 Panel reached Recommendation 49 to back the concept of increased flexibility of funding periodicity (Section 809 Panel, 2019).

As touched briefly in the Background Chapter, the defense appropriation categories may be for single-year use or multi-year use, with little flexibility to interchange between the categories and funding periodicities (Section 809 Panel, 2019). Thus "by constraining DOD's ability to move money back and forth from one time-period category to another, the appropriation system may inhibit the flexibility of DOD contracting and program management" (Section 809 Panel, 2019, pp. 210–211). While single-year funds, such as O&M, are intended for lower risk programs and projects, the flexibility of this funding may be beneficial to the software acquisition process (Section 809 Panel, 2019). In result to this study, the Section 809 Panel reached "Recommendation 49: Provide increased flexibility to the time periods within which contract obligations are permitted to occur" (Section 809 Panel, 2019, p. 195).

As part of Recommendation 49, one solution proposed is the use of "no-year money" otherwise known as "colorless money (Section 809 Panel, 2019)." This "no-year money" would have no time constraints and would be accessible to any agency at any time (Section 809 Panel, 2019). This would provide fully flexible funding that would "remain available until expended" or transferred (Section 809 Panel, 2019). However, because of the lack of oversight this method is very uncommon and provides uncertainty as to "whether no-year money is a scalable way of addressing the problems of budget periodicity" (Section 809 Panel, 2019, p. 214). The "colorless money" initiative is starting to be explored in terms of software acquisition efforts, but the current method of implementation is still not fully flexible and is still subject to funding periodicity policies.

Though this report and its findings are not explicitly tied to any software acquisition programs, the funding appropriation categories and their periodicities do affect the software development process. Thus Recommendation 49 is very applicable in terms of improving the funding process to support software acquisition. In conclusion, Recommendation 49 would help promote the increased flexibility in the funding process that is necessary to increased "efficiency and effectiveness" for software acquisition and all other platforms (Section 809 Panel, 2019).

## B. DEPARTMENT OF DEFENSE POLICIES AND PROCEDURES FOR THE ACQUISITION OF INFORMATION TECHNOLOGY

This report reviews the current DOD policies and processes used for information technology acquisition (Defense Science Board [DSB], 2009). Upon their review, the DSB task force determined that "that the conventional DOD acquisition process is too long and too cumbersome to fit the needs of the many IT systems that require continuous changes and upgrades" (DSB, 2009). As a result, the DSB task force concludes that the information technology and software programs require a new acquisition system that is specifically designed to support as such (DSB, 2009). One recommendation proposed by the DSB task force is that "A new acquisition process for information technology should be developed—modeled on successful commercial practices, for the rapid acquisition and continuous upgrade and improvement of IT capabilities" (DSB, 2009). And this new acquisition process should support the incremental delivery of software capabilities in "18 months or less" (DSB, 2009).

Previously, the traditional waterfall development process proved to be successful and was shown to yield acceptable results when a lengthy development timeframe was available (DSB, 2009). However, in this current, rapid software environment the waterfall development process is inefficient and ineffective (DSB, 2009). Based off this information, the DSB suggests that "without an acquisition process that accommodates, and takes advantage of, IT's rapid pace of change, future DOD acquisition officials will likely be frustrated in their efforts to equip the nation's war fighters and weapon systems with the needed information technologies" (DSB, 2009).

In the past, Congress' response to these identified concerns have been to add more legislative mandates and thus inherently more restrictions (DSB, 2009). However, more restrictions equal less flexibility, which is an essential piece to a successful software acquisition environment. Continuing on the concept of flexibility, the DSB task force suggests that the new software acquisition process must have "continuity of funding, to maintain a solid funding stream for following, sometimes overlapping, capability releases" (DSB, 2009). In conclusion, the DSB identifies the current software acquisition process, including funding, is too lengthy to support the rapid software environments seen today; and thus the software acquisition process, along with its funding process, must be reformed to support rapid development.

## C. ASSESSMENT OF ACCELERATED ACQUISITION OF DEFENSE PROGRAMS

In this report, the IDA performed a research study "focused on the 'cycle time' of DOD acquisition processes—i.e., how long it takes to acquire and field new force capabilities" (Van Atta et al., 2016, p. iii). In an effort to analyze the rapid, accelerated acquisition process, it became clear that "immediately available funding" is a key piece to rapid acquisition success (Van Atta et al., 2016, p. vii). With that said, "by definition, rapid acquisitions cannot be funded through the standard PPBES processes, since, as an absolute minimum, 18 months elapse between the time money is requested by an acquisition activity to be included in the President's Budget to the time that the funds are available for obligation on a contract" (Van Atta et al., 2016, p. 63). Because the current funding process is naturally long, it does not align with the current efforts to transition software development into a rapid acquisition process.

As a result, there have been many recommendations to establish funds to be set-aside in support of urgent needs (Van Atta et al., 2016). Another recommendation explored by the IDA in this report is the "colorless money" initiative. The IDA uses the Joint Improvised Explosive Device Defeat Organization (JIEDDO) as an example for this "colorless money" concept (Van Atta et al., 2016). The JIEDDO program "was funded in a 3-year appropriation with 'colorless' money, meaning it could be spent within any budget title, and more time was allowed before funds expired" (Van Atta et al., 2016, p. 64). The flexibility of this funding allowed for the success of a rapid acquisition process (Van Atta et al., 2016). Even with this

success, the IDA concluded that "Having such a funding source on a long-term, continuing basis, while advantageous in theory, also has drawbacks making it difficult to implement and sustain—primarily the real risks that such funds will not be used as intended" (Van Atta et al., 2016, p. 64).

While this piece does not directly talk software acquisition, it does talk rapid acquisition. As the DOD continues to transform the software acquisition process into a more rapid environment, the findings in this study may be used to support the general concept of funding process reform. As mentioned, the current PPBE process and rapid acquisition process, have challenges supporting software intensive acquisition efforts. While the IDA also addresses valid concerns with the "colorless money" concept, it is one of the few funding solutions needed to maintain rapid software development.

In conclusion, each of these pieces support the overall arching concept of how the current government funding process is too long and how rapid software acquisition is a must for the DOD. In the first report, the Section 809 Panel identifies the following two recommendations in support of reforming the currently too lengthy funding process: "Recommendation 43: Revise acquisition regulations to enable more flexible and effective procurement of consumption-based solutions" and "Recommendation 49: Provide increased flexibility to the time periods within which contract obligations are permitted to occur" (Section 809 Panel, 2019, pp. 136, 195). As part of the second report, the DSB identifies the DOD's current software acquisition process to also be too long for the current software climate and suggests reform of this process to support more rapid acquisition of software. Finally, the last report, though only focusing on rapid acquisition and not specific to software, also suggests funding process reform to support any quick acquisition programs or needs. Combining the findings from all three reports, it is clear that the current funding process does not support rapid acquisition and must be reformed as such to align with the rapid acquisition process and therefore the rapid software acquisition process. The following chapter will provide further analysis on the current funding methods versus the "colorless" money initiative, and the software specific funding initiative.

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# IV. ANALYSIS

In an effort to combat the timeline issues seen with the DOD funding process and software acquisition process, the following funding methods have been analyzed: the current funding method, the "colorless money" initiative, and the software specific money. The Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis was the research method used to analyze each of these funding concepts, thus determining whether each concept could be successful and/or suitable for a rapid software acquisition process.

As discussed previously, the software acquisition process is rapid with software and information technology constantly evolving. The best way to keep up with software development and acquisition is through a continuous, iterative development process such as agile dev-ops. However, because it is a quick, iterative and continuous process throughout its life cycle, the typical funding methods of the DOD may be inadequate. With that said, other funding options must be explored in order to maximize software acquisition effectiveness and efficiency. Some alternatives of the current methods could include the concept of colorless money for software and/or a new funding category specifically for software. The following will go through the current funding method, a colorless funding method, and the 'software color of money' initiative, and will also provide a SWOT analysis for each of these to determine their potential for success, or lack thereof.

## A. CURRENT METHOD

The current funding method for software acquisition is the typical DOD funding process used for all programs. As mentioned in the Background chapter, this means that a software acquisition program not only goes through the typical five to seven year PPBE process but must also have funding broken out by the funding categories of RDT&E, Procurement, and O&M. These different funding categories are often referred to as "colors of money" and are typically associated with "hardware-centric phases" (McQuade et al., 2019). Each phase of the acquisition process is associated with a different "color of money." Figure 9 displays the DOD cost profile of the different acquisition phases with the different funding categories for each phase noted in red (McQuade et al., 2019).

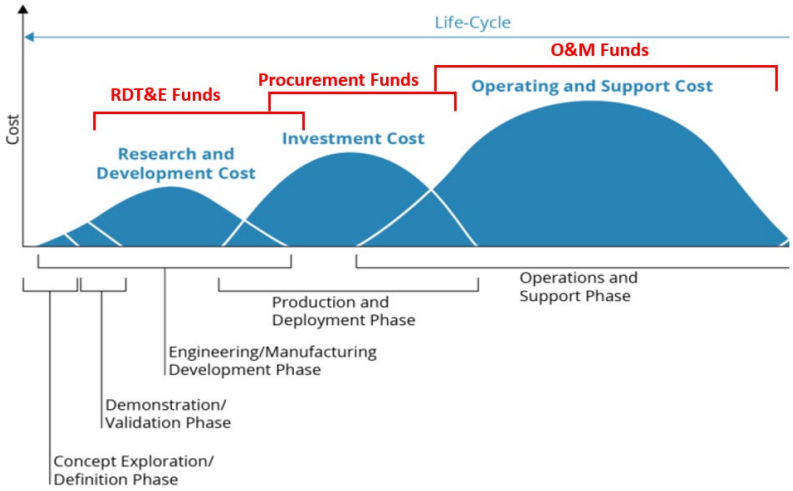


Figure 9. "Notional DOD Weapon System Cost Profile." Adapted from McQuade et al. (2019, p. S125)

This means that the current method to fund software acquisition involves "the separation of software development into research, development, test and evaluation (RDT&E), procurement, and operations & maintenance (O&M) appropriations (colors of money)" (Section 809 Panel, 2019, p. S78). However, in order for software to remain up-to-date, software acquisition must remain agile and iterative and thus may have overlapping funding categories and/or very short-lived and constantly changing funding categories. For example, if iterative development is utilized then development, testing, procurement, and operations and maintenance, all associated with different funding appropriations, may be occurring simultaneously.

Based off the information and data above, a SWOT analysis was conducted for this current funding method. The current funding method presented three strengths, four weaknesses, one opportunity, and three threats. The strengths found for this funding method include Congress' oversight and control, funding is aligned with tasking, and there is better tracking of program progress and expenditures, all of which ensures that the funding is used and executed properly and effectively. Because rapid software development is iterative and jumps between the RDT&E and O&M phases, the weaknesses seen include the inability to quickly interchange between funding categories or to have overlapping funding categories, the lengthy planning phase, less funding flexibility

because of the Congress oversight, and the changing and potentially short funding validity. The opportunity identified would be to reduce current funding restrictions for software acquisition which allows for more flexibility and quicker interchanges between funding, while the threats to the current funding method would include the "colorless money" initiative, a new funding category for software, and the software acquisition timeline. Figure 10 displays the results of this SWOT analysis.

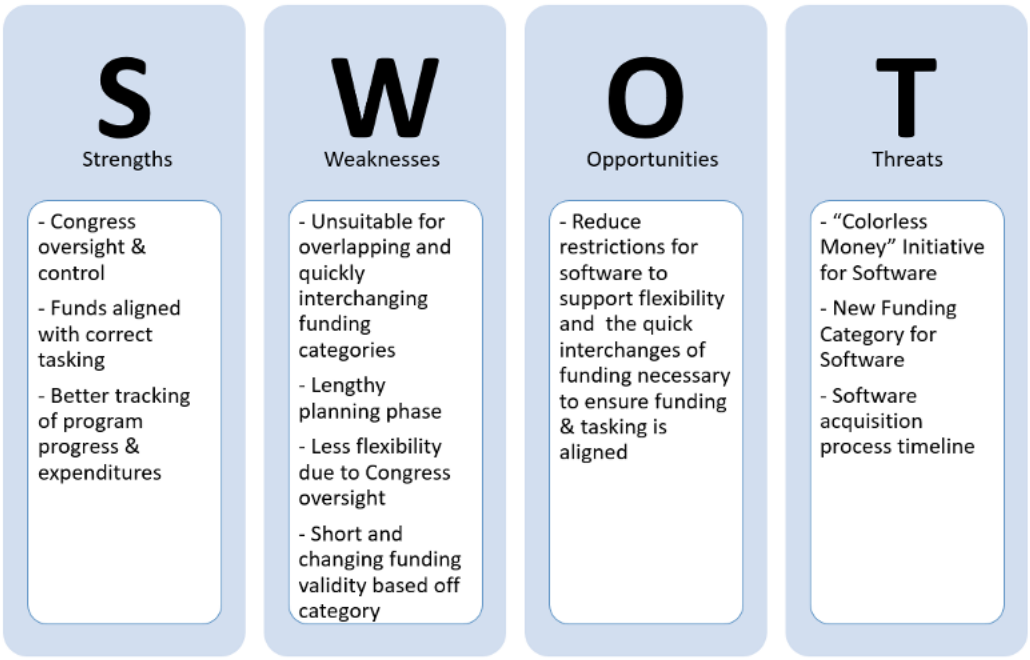


Figure 10. Current Funding Method SWOT Analysis

## B. "COLORLESS MONEY" INITIATIVE

One recommended method is to eliminate the color of money for software acquisition. This colorless money initiative would involve developing "pathways for 'bleaching' funds to smooth this process for long-term programs" (McQuade et al., 2019, p. 16). By eliminating the "color of money" software acquisition programs would not have to be broken into the different funding categories and would thus promote the use of agile and continuous iterative developments. However, the reason there is "colors of money" is to provide Congress with the necessary oversight and control of the DOD's programs'

funding, in terms of RDT&E, O&M, and procurement. Therefore, using colorless money for software would remove any methods of tracking program funding, resources, growth and progress.

As a growing concept, Congress and the DOD have decided to test the "colorless money" initiative by allocating colorless funding to eight programs in Fiscal Year (FY) 2022 (Williams, 2022). This experimentation is referred to as the DOD's software and digital technology pilot program, and "aims to allow for more flexibility when buying software for certain digitally-heavy programs by using research dollars instead of other types of funding" (Williams, 2022). Because RDT&E funding is being used for this "colorless" initiative, funding is only valid for two years and is incrementally funded (Lofgren, 2020). Another potential concern with RDT&E funding is the rigorous planning and approval phases, requiring much detail, specifications, and overall time, all of which impede on the rapid and evolving development of software (Lofgren, 2020).

Using this data, a SWOT analysis was also conducted for this "colorless money" funding method. This analysis presented two strengths, five weaknesses, one opportunity, and three threats. The strengths include more flexibility due to less Congress oversight and control and reduced time since there is no need to overlap or interchange between the funding categories. The five weaknesses identified include the following: less Congress oversight and control, funding not aligned with tasking, lengthy planning phase, inaccurate tracking of program progress and expenditures, and the limiting funding validity of two years. These weaknesses all lead to a lack of program tracking and could present issues when assessing program success. The opportunity presented would be to reduce current funding restrictions on RDT&E funding for software acquisition which allows for more flexibility and a reduced timeline to support the rapid acquisition timeline, and the threats to this funding method would include a new funding category for software, the software acquisition timeline, and Congress since they ultimately have the power over this funding method and its process. Figure 11 displays the results of this SWOT analysis.

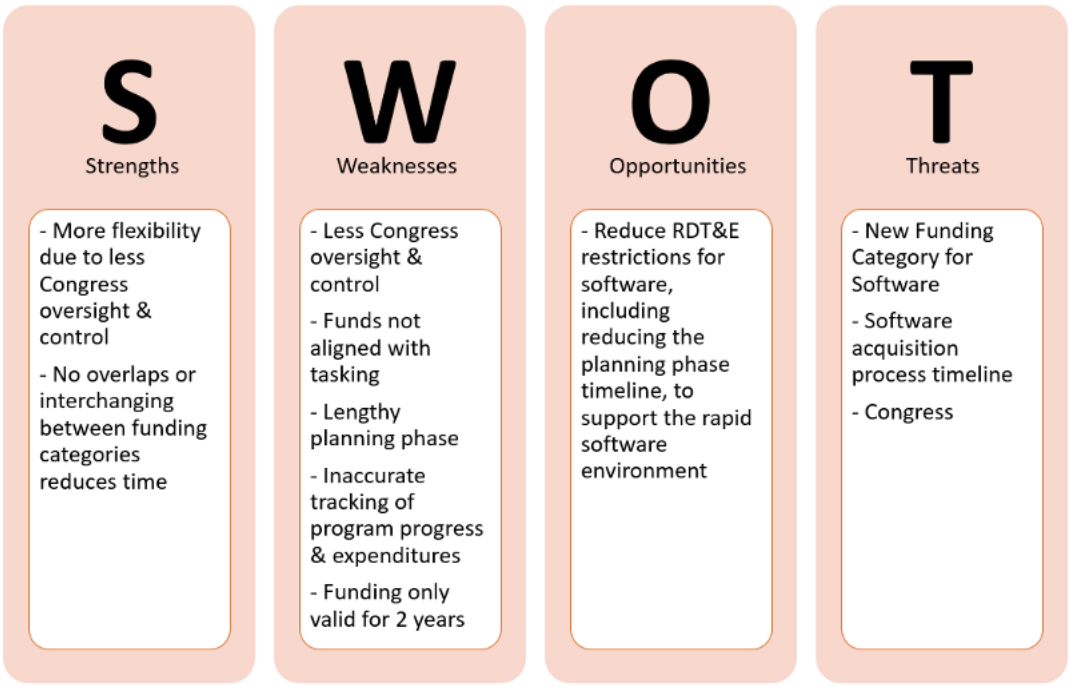


Figure 11. "Colorless Money" Funding Method SWOT Analysis

## C. SOFTWARE SPECIFIC FUNDING CATEGORY

The final method or solution is software specific funding. This method was a result of the "colorless money" initiative but takes it a step further by creating a whole new funding category specifically for software. As Ellen Lord, DOD acquisition chief, said "We know as you move from traditional waterfall software development to agile and dev-ops, we need to be coding every day and testing every night. We have a continuum between development, production and sustainment of hardware. We believe we need a software color of money in order to be able to do that" (Doubleday, 2020). As of right now, the "colorless money" method takes funding from RDT&E, which has a two-year limit. If the software specific funding was to be its complete and own, new funding category, then new funding policies to include full/incremental funding and funding periods of performance/ use, could be created to support an agile software development environment.

Another option to fund this software specific funding category would be to take funding from both RDT&E, O&M and maybe even procurement, rather than just RDT&E as employed in the previous method (Lofgren, 2020). Since an agile software development

process would be a combination of all three of these funding categories, this method would make sense. However, because RDT&E funding is still being utilized, this would mean the software acquisition programs would still require the lengthy planning and approval process, which contradicts the intended use and flexibility of O&M funding (Lofgren, 2020). Unlike RDT&E, O&M funding is not tied to program objectives and end-goals "but rather by organization, object of expenditure, or mission," thus making it more flexible (Lofgren, 2020). This brings to question "Why would you pull flexible O&M funds out and put them into this 'colorless' appropriation which requires detailed budget programming from two years out, and all its bureaucratic approvals?" (Lofgren, 2020).

Utilizing just O&M funding for this new software category may be a solution as well. As mentioned previously, O&M funding is more flexible and thus more supportive of the rapid software development process. However, much of the software process is still research and development and thus would not align the tasking with the fund appropriations. It is also of concern that the software programs will take priority over other O&M tasks and thus may result in actual O&M tasks, such as increased readiness and reduced maintenance, being overlooked (Lofgren, 2020). Finally, O&M funding is only good for one year and is funded on an annual basis. This funding policy, though flexible, may present issues in providing continuous funding resources to support the continuous software efforts.

The best way to implement the software specific money would be to create a whole new funding category separate from RDT&E, procurement, and O&M. By creating a new funding category, there is no need to prioritize O&M funding, no need to worry about the intensive planning and approval process that goes along with RDT&E funding, and the ability to develop its own funding policy that would best maximize the software development process. It would also provide the capability to track and measure the funding that is specifically tied to software tasking. This would eliminate the ability to track what percentage of software efforts go to research and development, procurement and operations. A solution to this potential issue would be a new, internal process or tracking system for each software program, allowing for overall software funding to be tracked along with the breakout of efforts by program.

Lastly, a SWOT analysis for the software specific funding method was performed using the data presented in this section. This analysis presented four strengths, two weaknesses, three opportunities, and three threats. The strengths identified include keeping Congress oversight and control, funding is aligned with tasking, and the weaknesses found were funding not aligned with RDT&E and O&M tasking and therefore the inability to track program progress and expenditures in regards to RDT&E and O&M. the three opportunities with this funding method would be the potential to reduce the planning phase timeline, to create a new funding validity and policy, and to increase flexibility with less restrictions. All three of these opportunities could be done to further support a rapid acquisition environment, lastly, the threats to this method include the "colorless money" initiative, Congress and the presidential budget since they both have power and impacts over this funding method and its process. Figure 12 displays the results of this SWOT analysis.

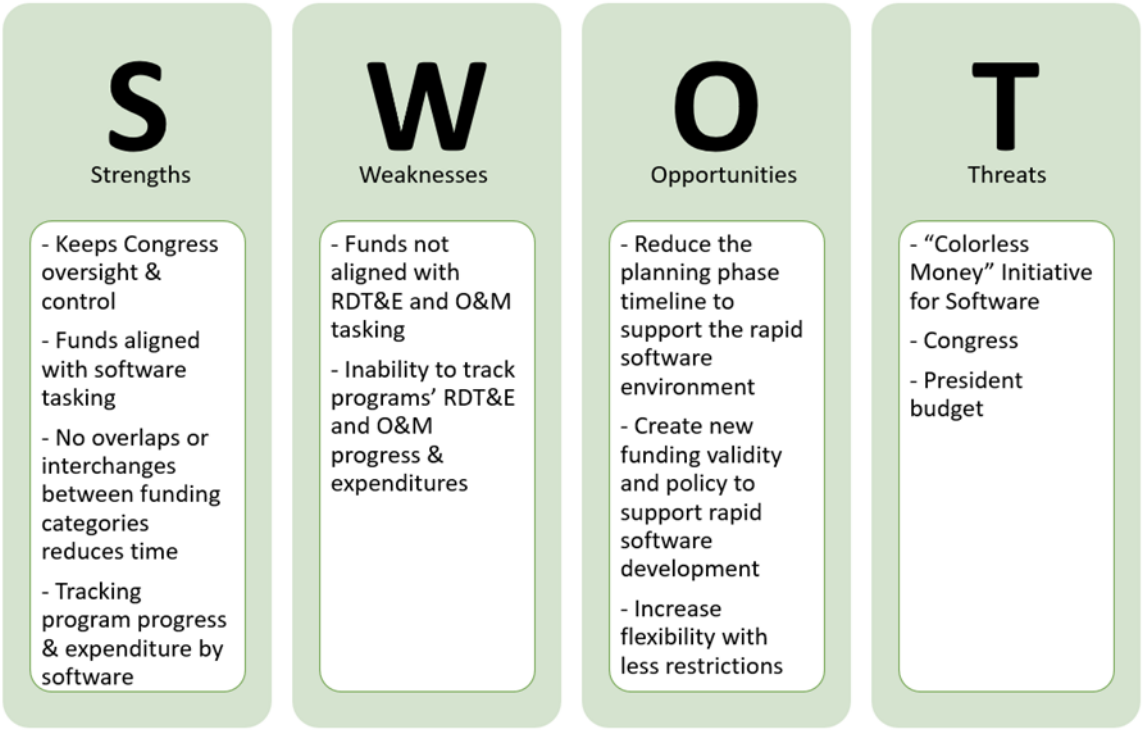


Figure 12. Software Specific Funding Method SWOT Analysis

To summarize the analysis conducted, it is clear that the current funding process poses an issue with the rapid software acquisition process largely due to the lengthy funding timeline and the inability to quickly interchange between the funding appropriations categories. As a result, the "colorless money" initiative and the funding specific category were also analyzed as potential funding method options. The "colorless money" concept actually utilizes RDT&E funding and so while interchanging funds is not an issue, there are some other restrictions such as funding only being valid for two years, funding not aligning with tasking, and the still lengthy planning phase associated with RDT&E funding. As for software specific funding, this would require the development of a new funding category and therefore new funding policies that could promote a quick and flexible funding option. While funding would still not align in the sense of RDT&E and O&M tasking, there would be no need to interchange between funding categories thus embracing the rapid paced and flexile funding environment needed to support accelerated software acquisition. A new funding category specific to software seems to provide the most flexibility and the most potential for tailoring this funding method to the current needs.

To further analyze these three funding methods a decision matrix was created. The three funding methods were compared based off the following categories and their weights: flexibility with a weight of 4, program tracking with a weight of 2, short timeline with a weight of 5, and funding validity timeframe with a weight of 3. Weights of the categories were selected based off the overall goal of shortening the funding process to support rapid acquisition and can be seen in the following Table 1. Based off the SWOT analyses, each funding method was ranked 1 to 5 per category, with 1 being the poorest and 5 being the best. The current funding method received a 1 for flexibility, a 5 for program tracking, a 1 for short timeline, and a 2 for the funding validity timeframe for a total weighted score of 25. The "colorless money" option received a 5 for flexibility, a 3 for program tracking, a 5 for short timeline, and a 2 for the funding validity timeframe for a total weighted score of 57. Lastly, the software specific funding method received a 5 for flexibility, a 4 for program tracking, a 5 for short timeline, and a 4 for the funding validity timeframe for a total weighted score of 65.

Table 1. Funding Method Decision Matrix

| | **Flexibility** | **Program Tracking** | **Short Timeline** | **Funding Validity Timeframe** | **Total** |
|---|---|---|---|---|---|
| **Category Weights** | 4 | 2 | 5 | 3 | - |
| **Current Funding Method** | 1 | 5 | 1 | 2 | 25 |
| **"Colorless Money" Initiative** | 5 | 3 | 5 | 2 | 57 |
| **Software Specific Funding** | 5 | 4 | 5 | 4 | 65 |

With the highest weighted score, the software specific funding method would be the best option to overall promote a quicker funding timeline. The current funding method showed the poorest results, with the least flexibility, the longest funding timeline, and a limited funding validity. The "colorless money" initiative yielded much closer results to the software specific funding, both receiving the highest scores for flexibility and short timeline, However, the "colorless money" initiative showed less potential than the software specific funding when it came to program tracking and the funding validity timeframe. Therefore, as previously suggested, the software specific funding presents the best opportunity to create a shorter funding timeline while also maintaining program tracking structure and funding validity policies. In the following chapter, the results of these analyses will be discussed and compared to assist in determining the best funding method option for software acquisition.

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# V. CONCLUSION OF ANALYSIS RESULTS, LIMITATIONS, AND RECOMMENDATION

## A. ANALYSIS RESULTS

Based off the Literature Review and Analysis chapters, it is clear that the current funding process does not properly align with the software acquisition process. The Literature Review chapter studied three different reports, all of which suggested and supported acquisition process reform for software to include reform of the current, lengthy funding process. The Analysis chapter provided a SWOT analysis for each of the funding method options identified. Figure 13 provides a comparison table of the SWOT analyses conducted. This comparison table shows that the new software funding category yielded the best results, with the most strengths and opportunities and the least weaknesses and threats.

| | S (Strengths) | W (Weaknesses) | O (Opportunities) | T (Threats) |
|---|---|---|---|---|
| **Current Funding Method** | - Congress oversight & control<br>- Funds aligned with correct tasking<br>- Better tracking of program progress & expenditures | - Unsuitable for overlapping and quickly interchanging funding categories<br>- Lengthy planning phase<br>- Less flexibility due to Congress oversight<br>- Short and changing funding validity based off category | - Reduce restrictions for software to support flexibility and the quick interchanges of funding necessary to ensure funding & tasking is aligned | - "Colorless Money" Initiative for Software<br>- New Funding Category for Software<br>- Software acquisition process timeline |
| **"Colorless Money" Method** | - More flexibility due to less Congress oversight & control<br>- No overlaps or interchanging between funding categories reduces time | - Less Congress oversight & control<br>- Funds not aligned with tasking<br>- Lengthy planning phase<br>- Inaccurate tracking of program progress & expenditures<br>- Funding only valid for 2 years | - Reduce RDT&E restrictions for software, including reducing the planning phase timeline, to support the rapid software environment | - New Funding Category for Software<br>- Software acquisition process timeline<br>- Congress |
| **New Software Funding Category** | - Keeps Congress oversight & control<br>- Funds aligned with software tasking<br>- No overlaps or interchanges between funding categories reduces time<br>- Tracking program progress & expenditure by software | - Funds not aligned with RDT&E and O&M tasking<br>- Inability to track programs' RDT&E and O&M progress & expenditures | - Reduce the planning phase timeline to support the rapid software environment<br>- Create new funding validity and policy to support rapid software development<br>- Increase flexibility with less restrictions | - "Colorless Money" Initiative for Software<br>- Congress<br>- President budget |

Figure 13. SWOT Analysis Comparison

While it makes sense to break up the funding by how it is meant to be expended, software is in continuous development and thus overlaps and constantly jumps between a

variety of the funding categories (McQuade et al., 2019). Thus, the current funding method completely constrains software development from reaching its maximum potential. Because software acquisition funding must be broken down into the proper funding categories, this inhibits the "rapid and continuous delivery of working code" for a few reasons (McQuade et al., 2019, p. S125). For one, the current federal budget process was not built to keep up with the rapid development of software and its faster paced acquisition phases (McQuade et al., 2019). Another hindrance is the separation of software acquisition and development into the following funding categories: RDT&E, procurement, and O&M (Section 809 Panel, 2019). The reason this interferes with software acquisition is because it "causes delays and places artificial limitations on the program management office's (PMO) ability to quickly meet the changing needs, resulting in increased lifetime cost of software and slower deployment" (Section 809 Panel, 2019, p. S78).

However, software programs must still plan for their budget two years in advance as part of the PPBE process (Lofgren, 2020). This two year planning period "gives ample time for software to enter a detailed waterfall planning phase to get life cycle cost estimates, sustainment plans, IP plans, etc." (Lofgren, 2020). This still results in a timeline that does not align with the dynamic software environment, and therefore the overall PPBE process and funding appropriation process may need to evolve and adapt a shorter planning period to promote the rapid software climate currently being seen.

As a result, the current method for funding software acquisition programs is inadequate if the DOD wishes to move to an agile software development process. This leads to the following two methods: "colorless money" for software and/or the development of software specific funding. The "colorless money" initiative also has its limitations. As mentioned before, the "colorless money" method currently utilizes RDT&E funds for all software development tasking, which would include any operations and maintenance efforts (Williams, 2022). The individual software tasks would not align with the proper funding per say, and could prove difficult for tracking purposes. Another limitation seen with this method is the funding policy and the lengthy planning and approval process. Software and the software needs and capabilities are constantly changing, updating, improving and so on, which means even the lengthy planning and

approval procedures associated with RDT&E funding and the PPBE process cannot keep up with the rapid software environment (Lofgren, 2020). Figure 14 displays the software acquisition process and its iterative timeline.

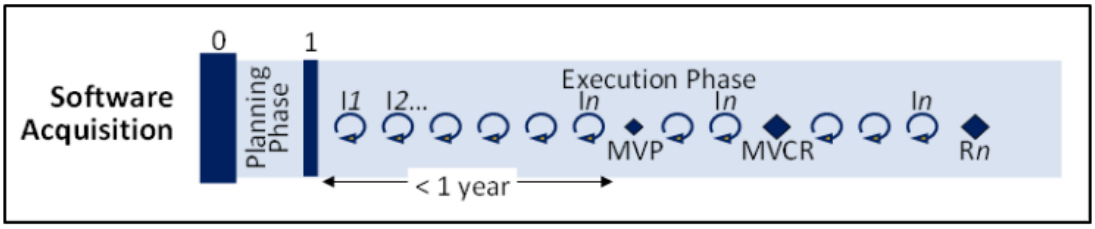


Figure 14. Software Acquisition Process. Source: Office of the Under Secretary of Defense [USD] (2020a, p. 13)

Comparing Figure 14's iterative software process timeline to the timelines of the PPBE process, the planning phase associated with RDT&E funding and the overall funding process in general, it is safe to conclude that the current funding method along with the "colorless money" funding method and its strict use of RDT&E funding, do not support nor align with the iterative software process. The planning, budgeting, and execution that goes into the PPBE process and the overall funding appropriations process were not designed to keep up with the rapid, iterative process seen in software development.

This leaves the last solution of a funding category specifically for software. After analyzing the concept of using a combination of RDT&E and O&M funding, it can be concluded that this process could prove more complex and difficult then helpful. The results of using RDT&E funding have been addressed previously with the "colorless money" initiative. The results of using strictly O&M funding for this new category could be beneficial due to its flexibility (Lofgren, 2020). However, the O&M funding policy is one year funding on an annual basis. It is also considered that the use of O&M funding for software may also result in other operations and maintenance being overlooked, as software development and sustainment continues to be a priority (Lofgren, 2020).

Additionally, the combination of RDT&E and O&M could prove difficult in managing between the different iterative phases and between the acquisition and operations

teams. For example, the acquisition team developing the software would not "have access to the O&M funding to do field testing and smaller deployments" (Lofgren, 2020). While the operators, once the software is deployed, would not "have access to RDT&E funds to go and quickly improve the software on a reasonable timeframe" (Lofgren, 2020). Thus this combination of funding for the software funding category may be too complicated for implementation.

Ideally, the concept of software funding would be its own, complete funding category, separate from RDT&E and O&M funding. A funding category strictly for software would allow for smooth transitions between development, testing, and operations. It would also account for all the funding being budgeted for software programs. Lastly, it would further align with the rapid, agile software environment the DOD is aiming to achieve. While losing track of how software funding is expended between research and development efforts and operations and maintenance efforts, internal tracking methods such as the NAVSEA Enterprise Planning System (NEPS) could be used to keep track of these separate efforts as individual tasks. Thus a new, separate funding category specifically for software is the only successful solution that would maximize the software development process and the DODs ability to keep up with current software trends.

Based off the analyses and the results, it is evident that a new software specific funding category is the best option in pursuing a rapid software acquisition process. However, whether the "colorless money" or the software specific funding, both options do share in some of the same limitations. The following section highlights some of the limitations seen with these funding method options.

## B. LIMITATIONS

As with any solution there will always be some type of limitation(s), and this is true for both the suggested new funding methods of "colorless money" and software specific funding. For one, there is no real-life proof that these concepts would be successful. Another limitation is that most programs are not software specific, and typically involve a combination of both hardware and software. The following will provide more detail on both of these limitations and the problems they may present.

In terms of proof of success, or lack thereof, there is currently more research and data on the "colorless money" method than the software specific funding, and this will continue to be the case as the "colorless money" initiatives are piloted on more and more software acquisition processes. Yet there is still not enough quantifiable data for any real conclusion on whether this funding method would be successful or not. The same is true for the software specific funding. Unlike the "colorless money" method there is no programs piloting this concept and therefore there is no qualitative nor quantitative data available at this time. Unfortunately, there will continue to be no data available to support these concepts until the methods are piloted and implemented on some software acquisition programs. However, data or no data, this is still an option that could be worth exploring and/or at least piloting to determine if it would have real-life success.

The second limitation is largely present due to the fact that most software development efforts and systems are not strictly just software. In fact most software systems and programs have hardware elements integrated into and as part of the overall system. Similarly, there are also a lot of hardware-centric systems and programs that have variety of software elements. The issue with "colorless money" for software and software specific funding is that most of these software programs are not just limited to software; and sometimes the software is part of a hardware system. In this case, software specific funding would either be limited to the small group of software only programs and/or would have to be expanded to the programs that integrate software and hardware elements. Either scenario presents limitations. Targeting software-only programs would leave out many other software systems that also need the proper funding process to promote rapid acquisition. Yet including the systems that have hardware elements as well would mean that software specific funding is not actually software specific and would apply to numerous programs. However, similar to the first limitation, no real results or conclusion can be reached until these funding methods are piloted on real programs.

Thus both "colorless money" and software specific funding share limitations in terms of real data and the commonly crossed platforms and programs of software and hardware. However, until either concept is piloted and tried, there will continue to be a lack of data and ability to determine true success. With that said, the software specific funding

still could provide the flexibility and quick timeline required for software acquisition while the "colorless money" RDT&E funds still could present some issues in terms of flexibility and quickness. Therefore, the software specific funding category offers greater potential for success, but that really cannot be fully proven until more data is acquired.

## C. RECOMMENDATION

Given the results of the analysis, it is evident that the DOD must transition from their current funding process to a software specific funding process in order to support the iterative development of software. As identified above, however, there are limitations to the funding solutions discussed; in particular, the lack of data, proof of success in software specific programs, and overall larger scale programs is concerning. To counter this, it is suggested that the software specific funding continues to be piloted on a variety of programs to produce the data and implementation necessary to determine the potential for success. It is recommended to start the piloting off small, focusing on some of the smaller software only programs and then building and expanding upon this to include some of the larger programs that are not software specific.

Piloting this funding solution on several different programs will assist in identifying issues, risks, opportunities, strengths, and weaknesses of this solution, which will further show where there may be areas for improvement and overall determine how realistic this funding solution may be. The bottom line is that if the DOD wishes to employ a rapid, iterative software development environment, then they must move to a funding method that is better equipped to support the iterative and potentially simultaneous phases of development, testing, and use. And what better funding solution then software specific funding that can be applicable to development, testing and use? Unlike the current government funding method which requires a different appropriation per program phase and a lengthy process to interchange between these appropriations, the software specific funding solution would eliminate the need to interchange between funding appropriations based off the current phase and would therefore support the ultimate iterative development process and maximize the DOD's ability to keep up with the current software trends and capabilities.

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