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IS 2010 THE YEAR ARMY ACQUISITIONS TURNED THE CORNER TO AFFORDABILITY?

December 2017

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Since 2012, the Department of Defense (DOD) and Government Accountability Office (GAO) have observed lower cost growth in the acquisition of the largest weapon systems. Although the acquisition environment is complex, much of the success is being attributed to the management program, Better Buying Power (BBP). BBP was first introduced in 2010 by the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD[AT&L]) and it provides best practices for the acquisition community with the goal of achieving affordability. Since 2010, two more iterations of BBP have been initiated, highlighting lessons learned and additional areas of focus. Along with the published guidance is continuous oversight from the highest levels of acquisition authority.

Our project analyzed multiple programs and examined their compliance with BBP and other acquisition best practices. Using available cost data and program documentation, we analyzed how the implementation of BBP has affected affordability measures of the programs. While the cost data is encouraging, we could only conclude that there is a correlation between implementing BBP and the reduction in cost growth observed.

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IS 2010 THE YEAR ARMY ACQUISITIONS TURNED THE CORNER TO AFFORDABILITY?

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ABSTRACT

Since 2012, the Department of Defense (DOD) and Government Accountability Office (GAO) have observed lower cost growth in the acquisition of the largest weapon systems. Although the acquisition environment is complex, much of the success is being attributed to the management program, Better Buying Power (BBP). BBP was first introduced in 2010 by the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD[AT&L]) and it provides best practices for the acquisition community with the goal of achieving affordability. Since 2010, two more iterations of BBP have been initiated, highlighting lessons learned and additional areas of focus. Along with the published guidance is continuous oversight from the highest levels of acquisition authority.

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LIST OF ACRONYMS AND ABBREVIATIONS

ADM	Acquisition Decision Memorandum
APB	Acquisition Program Baseline
APUC	Average Procurement Unit Cost
AW	Alternative Warhead
BBP	Better Buying Power
CPAF	Cost Plus Award Fee
CPFF	Cost Plus Fixed Fee
CR	Continuing Resolution
CRS	Congressional Research Service
CSB	Configuration Steering Board
DOD	Department of Defense
DAMIR	Defense Acquisition Management Information Retrieval
DAU	Defense Acquisition University
DAVE	Defense Acquisition Visibility Environment
DAWIA	Defense Acquisition Workforce Improvement Act
DCAPE	Director, Cost Assessment & Program Evaluation
DDR&E	Director of Defense Research and Engineering
DPICM	Dual Purpose Improved Conventional Munitions
ER	Extended Range
EMD	Engineering and Manufacturing Development
FARA	Federal Acquisition Reform Act
FASA	Federal Acquisition Streamlining Act
FFP	Firm Fixed Price
FMS	Foreign Military Sales
FPIF	Fixed Price Incentive (Firm Target)
GAO	Government Accountability Office
GMLRS	Guided Multiple Launch Rocket Systems
GMLRS AW	Guided Multiple Launch Rocket Systems Alternative Warhead
GWA	Goldwater–Nichols Act
IAMD	Integrated Air and Missile Defense
IMPROVE	Implementing Management for Performance and Related Reforms to Obtain Value in Every Acquisition
IPT	Integrated Product Team

JRCO	Joint Requirements Oversight Council
JTN	Joint Tactical Network
LCC	Life cycle Cost
LRIP	Low Rate Initial Production
MAIS	Major Automated Information Systems
MDS	Milestone Decision Authority
MDAP	Major Defense Acquisition Program
MLRS	Multiple Launch Rocket System
MRL	Manufacturing Readiness Level
MSE	Missile Segment Enhancement
OSD	Office of the Secretary of Defense
OUSD(AT&L)	Office of the Under Secretary of Defense Acquisition Technology, and Logistics
O&S	Operations and Support
PAC-3 MSE	Patriot Advanced Capability-3 Missile Segment Enhancement
Patriot MEADS CAP	Patriot/Medium Extended Air Defense System Combined Aggregate Program
PAUC	Program Acquisition Unit Cost
PDR	Preliminary Design Review
PM	Program Manager
PUC	Procurement Unit Cost
RAM	Reliability, Availability, Maintainability
RDT&E	Research, Development, Test and Evaluation
RFP	Request for Proposal
SAR	Selected Acquisition Report
TDP	Technical Data Package
TRA	Technology Readiness Assessment
TRL	Technology Readiness Level
UCR	Unit Cost Report
USD(A)	Under Secretary of Defense for Acquisition
USD(AT&L)	Under Secretary of Defense for Acquisition, Technology, and Logistics
WIN-T	Warfighter Information Network–Tactical
WSARA	Weapon System Acquisition Reform Act

I. INTRODUCTION

The 2009 Weapons Systems Acquisition Reform Act (WSARA) and the 2010 Better Buying Power (BBP) initiatives were significant defense acquisition reform initiatives. Better Buying Power is being credited with successfully lowering cost growth in major defense acquisition programs (MDAPs) by both the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics (OUSD[AT&L]) and the Government Accountability Office (GAO). The OUSD(AT&L) produces an annual *Performance of the Defense Acquisition System* report and the GAO produces the annual report *Defense Acquisitions: Assessments of Selected Weapon Programs*. Both of these reports draw conclusions that cost growth in MDAPs is lower as a result of the implementation of WSARA and BBP. In order to fully understand the contemporary need for acquisition reform, a brief history of past reform efforts is needed.

A. ACQUISITION REFORM: A BRIEF HISTORY

Coming out of World War II, concurrent development was the common practice for defense procurements. In this model, multiple stages of the acquisition took place simultaneously. Brown describes concurrency as building production facilities and training personnel on a system that is still in the research and development phase. The system was effective during the World War II years when the urgency to win the technology battle was a key to victory (Brown, 2005). After World War II, technology started to become much more complex. Concurrent development became a risky strategy to execute well. Any modifications in any phase might have ripple effects across the entire development and have negative consequences in cost, performance, and/or schedule. Brown wrote of concurrency in the 1970s as a negative. According to then Deputy Secretary of Defense David Packard, troubled programs all had the same problem: They had started production before engineering was complete (Brown, 2005). Packard went on to commission studies and reviews that resulted in the Defense Systems Acquisition Advisory Board reviewing major weapon system milestones and the publishing of the first volumes of the Department of Defense (DOD) Directive 5000.1

and DOD Instruction 5000.2. These actions set the stage for the modern process of defense acquisition (Brown, 2005).

1. The Carlucci Initiatives

Acknowledging the shortcomings of the acquisition process, the newly elected Reagan administration, directed Deputy Secretary of Defense Frank Carlucci, to create the Acquisition Improvement Program. The first actions were to align the planning, programming, and budgeting system to the acquisition of major weapons systems while giving the services more responsibility of the process. A thorough review of the acquisition process resulted in 32 initiatives to improve the process. The initiatives released on April 30, 1981, centered around eight principles with an aim of streamlining and shortening the acquisition process. The core principles sought to enhance planning, delegate responsibility away from the Office of the Secretary of Defense (OSD), reduce risk, and realize cost savings throughout the process. None of the principles or initiatives shed new light or provided groundbreaking reform, but served to provide emphasis on acquisition inefficiencies and ways to improve. Unfortunately, the services were not receptive to the initiatives. A GAO report in 1985 found that only eight of the 32 initiatives were fully implemented (Fox, Allen, Lassman, Moody, & Shiman, 2011). These initiatives were similar to Better Buying Power in that the initiatives were not intended to be a dramatic change in how acquisition was executed, but were meant to emphasize efficiencies that could be gained.

2. Nunn–McCurdy Amendment of 1982

The Nunn–McCurdy amendment to the 1982 Defense Authorization Act directed the DOD to notify Congress of weapon system cost over-runs. A recent Congressional Research Service (CRS) report summarized important aspects of the amendment such as the two forms of breaches—significant and critical (Schwartz & O'Connor, 2016). Significant breaches occur when a program's program acquisition unit cost (PAUC) or procurement unit cost (PUC) exceeds 15% of the current baseline or 30% of the original baseline estimate. A critical breach occurs when cost exceeds 25% of current baseline estimate or 50% of original baseline estimate PAUC or PUC and the program is

presumed terminated at this point. In the case of a critical breach, the secretary of defense will identify what caused the cost growth through a root-cause analysis and conduct a full assessment of the program. After the assessment, the secretary of defense must certify to Congress to retain the program as an essential capability or allow termination. The report states that Congress utilizes Nunn-McCurdy as a reporting mechanism and not a management tool (Schwartz & O'Connor, 2016).

3. President's Blue Ribbon Commission on Defense Management

The Blue Ribbon Commission, also known as the Packard Commission after its chairman David Packard, was formed by the Reagan administration in response to several scandals and low public opinion of defense spending. Much of the public had little confidence in the Pentagon's ability to manage its budget, and was critical of Congress inaction due to defense industry influence (Fox et al., 2011). The commission was composed of a notable assembly of defense experts. The commission found the procurement process to be inefficient, overly complex, and expensive. To address the issues in defense programs the commission made four significant recommendations:

- Create the position of under secretary of defense for acquisition to set policy and supervise the procurement process.
- Create a service acquisition executive in each service to report to the new under secretary.
- Create program executive officers to oversee program managers.
- Give the Joint Chiefs of Staff more authority and create a vice chairman to participate in the requirements management process (Fox et al., 2011).

4. Goldwater–Nichols Department of Defense Reorganization Act of 1986

In response to both the Packard Commission and intense inter-service rivalry that caused operational difficulties, Congress initiated its own studies of the Pentagon's structure. As a result, Congress passed the Goldwater–Nichols Act (GWA) of 1986. The legislation sought to streamline the chain of command from the president down to the combatant commanders and delegate additional responsibility to the Chairman of the Joint Chiefs of Staff (McInnis, 2016). From an acquisition standpoint, the GAO found the

legislation implemented many recommendations from the Packard Commission (Government Accounting Office [GAO], 1988). GWA established the USD(AT&L), service acquisition executives, and program executive officers. Beginning with the program managers to the service acquisition executive, a clear chain acquisition chain of command was established. The next key portion of the legislation was the inclusion of the vice chairman of the Joint Chiefs of Staff, along with the USD(AT&L) to co-chair the Joint Requirements Review Board. Finally, Goldwater–Nichols implemented a single office in each military department to supervise acquisition (GAO, 1988).

5. Defense Acquisition Workforce Improvement Act, 1990

Passed as part of the 1991 National Defense Authorization Act, Defense Acquisition Workforce Improvement Act (DAWIA) was a congressional attempt to standardize and professionalize the DOD's acquisition workforce. The regulations implemented by the DOD covered all facets of the workforce from hiring, training, certifications, and career development. Positions within the OSD and each of the services were created to help manage the workforce. A director of acquisition education, training, and career development was installed within the USD(A) to implement the act, provide guidance to the services, and prepare workforce status reports. Each of the services established a director of acquisition career management to implement policy and guidance. The final step of DAWIA incorporated each of the services acquisition education organizations into a single Defense Acquisition University (DAU; GAO, 1993). DAWIA's effects are still felt in the acquisition community today. Training certifications are important qualifications for many positions and key to maintaining a workforce that is current with the changing policies and best practices.

6. Federal Acquisition Streamlining Act, 1994

In an effort to simplify the federal contracting process, the Federal Acquisition Streamlining Act (FASA) was an amendment to the Competition in Contracting Act of 1982. A simplified acquisition threshold was established, a preference for commercial items was conveyed, and attempts to relieve administrative burden of the contracting process was sought. Much of the amendment was focused on the contracting process, but

Title V focused on acquisition management. The act required that cost, schedule, and performance goals be approved by the secretary of defense, cost goals be evaluated by the DOD comptroller, and annual reports be submitted to the president and Congress on performance (Federal Acquisition Streamlining Act, 1994).

7. Federal Acquisition Reform Act, 1995

Much like FASA, the Federal Acquisition Reform Act (FARA) attempted to simplify the government procurement process. The act reduced competition requirements in federal contracting. Full and open contracting could at times become counterproductive to the benefits produced. While competition was still highly encouraged, a certain degree of flexibility was granted to the administration's contracting efforts. The act also relieved government agency requirements for certified cost or pricing data, in accordance with the Truth in Negotiations Act, for commercial items. The act also established a government-wide acquisition computer network to advertise and receive offers from industry, reducing staffing requirements. The final major aspect of FARA was to consolidate the protest process into a single board (*Procurement Reform*, 1995).

B. IMPORTANCE OF AFFORDABILITY

Ensuring affordable weapons programs is an essential part of our national security. With the current budgetary uncertainty, it is vital to use resources effectively and with a purpose. The budget concerns to the military planners are two-fold. The first is uncertainty in the top-line. During the height of the Global War on Terror, funding was continually on the rise in response to the requirements in Iraq and Afghanistan. Drawdowns in both theaters of war have forced defense planners into a period of declining budgets (Candreva, 2017). This decline forces tough fiscal decisions and places a premium on programs that execute within their cost targets. Second is uncertainty in the approval of the annual appropriation acts by the start of the fiscal year. The budget is a major political tool in Congress. As such, partisan fights persistently delay the budget process resulting in short-term continuing resolutions. Not knowing how much or when

budget allocations will be distributed dictates flexibility in the planning of defense acquisition programs.

Flexibility with technology is another key. With the speed at which technology is moving in the commercial sector, the DOD is in a perpetual state of catch-up, creating an even greater need to manage weapon system affordability. As soon as a system is fielded, introduction of technology upgrades will maintain an advantage over foreign adversaries. With no slowdown in technological advances in sight, the DOD must continue to emphasize modular designs and incremental development.

Potential adversaries in today's climate are more varied than ever. Therefore, the weapons portfolio must include the means to confront highly adaptive, relatively low-tech terrorists in Iraq, Afghanistan, and Yemen, while equipping a conventional force with the means of confronting near peer adversaries in the future. Although not a silver bullet, balancing the affordability of weapons system acquisition programs is a key measure to successfully maintain such a diverse array of weapon systems.

As described earlier, acquisition reform is not a new idea or process. The DOD and Congress have been introducing legislation, policy, and initiatives for decades. In recent years, the GAO and USD(AT&L) are attributing success in controlling program cost growth to BBP. Each version of BBP contains dozens of initiatives. Some initiatives are focused at the service level and above and others may take decades of data to fully understand their implications. Looking critically to identify the factors that led to the relatively quick results is an important analysis to undertake. We, as a community, should be able to reinforce success and recognize other areas for improvement.

C. ORGANIZATION OF THE REPORT

This report looks to answer the question, "Is the affordability success in defense acquisition programs the product of the implementation of BBP?" Secondary questions include "How well are programs implementing the Better Buying Power initiatives?" and "Does a review of cost data from Selected Acquisition Reports corroborate the cost savings being touted by the GAO and USD(AT&L)?" To answer these questions, it is important to understand BBP, acquisition reform measures, and the reasons for

implementation. To answer our research questions, we focus on individual programs and their compliance with acquisition best practices. Affordability of the DOD portfolio begins with meeting cost goals at the program level. This project is organized into four additional chapters.

Chapter II is a thorough literature review of the WSARA and BBP and the factors leading up to their implementation. The review emphasizes the outputs of the legislation and initiatives. Finally, the literature review presents initial findings from the GAO and USD(AT&L) on the success of WSARA and BBP.

In Chapter III, we present the methodology used to analyze the data. Through a set of factors, we narrow down programs for analysis. The data that we gather for the programs are the average procurement unit cost (APUC) and expenditures. We also review any supporting literature to identify Better Buying Power initiatives and other management best practices utilized to control cost growth and affordability. Primary sources of data are Defense Acquisition Management Information Retrieval (DAMIR) and DOD Defense Acquisition Visibility Environment (DAVE).

In Chapter IV, we present the data of the selected programs. We compare the APUC and expenditures of the programs and note commonalities of which best practices are used. Of particular note is how the APUC and expenditures change after 2010.

Chapter V presents analysis and findings of the data collected.

Chapter VI concludes the project with a summary, conclusions, and recommended areas for further research.

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II. LITERATURE REVIEW

A. WEAPON SYSTEM ACQUISITION REFORM ACT, 2009

The Weapon System Acquisition Reform Act (WSARA), 2009 was enacted as public law on May 22, 2009. The goal of the legislation, summarized by President Obama will

> limit cost overruns before they spiral out of control. It will strengthen oversight and accountability by appointing officials who will be charged with closely monitoring the weapons systems we're purchasing to ensure that costs are controlled. . . . This law will also enhance competition and end conflicts of interest in the weapons acquisitions process so that American taxpayers and the American military can get the best weapons at the lowest cost. (Berteau, Hofbauer, & Sanok, 2010)

An implementation guide produced by the special assistant, Acquisition Initiatives Acquisition Resources & Analysis, OUSD(AT&L), in 2009 summarized the act, stating that there were three major reforms in the law changing organizational arrangements and personnel, acquisition policy and process, and congressional reporting requirements (Lush, 2009).

The organizational changes, highlighted in the DOD assessment, include creating the director, Cost Assessment & Program Evaluation (DCAPE), with two deputies. This office will lead and approve analysis of alternatives guidance, provide cost estimate policy, review DOD cost estimates for MDAPs and major automated information systems (MAISs), and conduct independent cost estimates for MDAPs and MAIS in which the milestone decision authority is the USD(AT&L) (Berteau et al., 2010). Several other personnel changes were a part of WSARA, but those changes focused on congressional oversight and are less-related to program affordability.

The policy changes in the legislation identified by USD(AT&L) follow six key areas. The first is requirements formulation where combatant commander input must be sought, cost/schedule/performance tradeoffs are to be considered, and the Joint Requirements Oversight Council (JROC) must establish initial operational capability

schedule objectives. The second area is acquisition strategies that must include competition throughout the life cycle, prime contractors must consider all qualified sources during "make or buy" decisions, and competitive prototyping is required prior to Milestone (MS) B. The third area is the Milestone A certification process, which mandates a Nunn–McCurdy–like review to Congress; the milestone decision authority (MDA) must consider termination if the program is more than 25% over the original cost or schedule targets. The fourth policy change is to the Milestone B certification process, which mandates a preliminary design review prior to approval and annual reviews by the MDA for programs receiving any MS B waivers. The fifth policy update is that all programs that have already received milestone approvals will retroactively receive certification. The last policy change amends the Nunn–McCurdy process to require root cause analysis, to presume program termination in the event of a critical breach, and to require that all funding changes resulting from cost growth are reported (Lush, 2009). The policy changes identified here all either directly or tangentially relate to affordability. Many of the changes are implemented through the Better Buying Power initiatives.

The last set of changes identified by Lush in the implementation guide were congressional reporting requirements. The DCAPE is responsible for an annual report assessing cost estimation activities and a one-time operating and support cost baseline report for all MDAPs. Finally, several elements are added to the annual earned value management report to Congress (Lush, 2009). Oversight is a main responsibility of Congress, and this aspect of WSARA adds another set of requirements onto the acquisition community without relieving them of any current requirements. Better Buying Power started an effort to collect data on the number of reports to Congress to identify redundant requirements to lessen the reporting burden (Kendall, 2012).

Whether the legislation worked is debatable. Eide and Allen acknowledged that WSARA was a significant bipartisan effort with key buy-in from both the executive and legislative branches (2012). President Obama and Secretary of Defense Robert Gates were at the forefront of WSARA, which passed through Congress with unanimous approval. The legislation called for substantial change in the defense acquisition process. Eide and Allen argued that from a behavioral and organizational perspective, it is

unlikely that such a transformation was possible in a bureaucracy as big as the DOD. Changing the acquisition culture that has endured 60 years of struggles and reforms would not happen through legislation. A cultural shock and sustained commitment was necessary for real change (Eide & Allen, 2012). Eide and Allen argued that cultural change is more important than structural changes to the acquisition process. The Carlucci Initiatives, for example, were a set of measures aimed at increasing efficiencies that had limited effects because many programs decided not to implement the recommendations (Fox et al., 2011). This may have been because of a lack of cultural change, as Eide and Allen hypothesized. WSARA implementation through Better Buying Power initiatives, however, might have better staying power. Through three iterations in seven years, the initiatives are still being used in defense acquisitions. While it is difficult to conclude that the acquisition culture has changed, there is a continued emphasis on affordability throughout the acquisition community and evidence of positive effects of implementing BBP initiatives.

Other reviews of WSARA have found that reforms are influencing the acquisition process. The GAO (2012b) found evidence that programs are focusing more effort and attention on requirements, cost and schedule estimates, testing, and reliability. These examples are found in only the largest programs, and implementation across the entire DOD portfolio remains an issue (GAO, 2012b). A CRS report also attributed improved cost estimating following the DOD implementation of WSARA requirements as one of several interacting factors that led to fewer Nunn–McCurdy breaches starting in 2011 (Schwartz & O'Connor, 2016). Much of the literature that indicates that the DOD acquisition system is functioning at a higher level with reduced cost growth has not attributed exact reasons for the improvements. Much like the CRS and GAO reports, other authors have concluded that there are many factors in the complex acquisition system that may contribute to improvements in affordability.

B. IMPLEMENTING MANAGEMENT FOR PERFORMANCE AND RELATED REFORMS TO OBTAIN VALUE IN EVERY ACQUISITION ACT, 2010

The Implementing Management for Performance and Related Reforms to Obtain Value in Every Acquisition (IMPROVE) Act, 2010 was aimed at reforming areas of the defense acquisition system not addressed by WSARA. The majority of the legislation focuses on the acquisition workforce, financial management, and the industrial base. There are three sections that relate to the defense acquisition system. Section 102 mandates that the DOD increase the level of reporting to the JROC on personnel involved in cost estimates, section 103 requires the DOD to create a system to decrease time necessary for weapon system acquisition, and section 105 mandates a combatant command–led task force be established to validate JROC requirements (Schwartz, 2010). There is not a lot of follow-on reporting or analysis on IMPROVE Act implementation or effectiveness. Much like WSARA however, it appears that additional levels of bureaucracy were added to defense acquisitions without conducting an overarching analysis of existing requirements to identify areas that are no longer relevant.

C. BETTER BUYING POWER

Better Buying Power (BBP) is a set of initiatives introduced by the USD(AT&L), Ashton Carter. The initiatives took a critical look at the acquisition of weapon systems and how to find efficiencies. In all, there are three iterations: BBP 1.0, released in 2010; BBP 2.0, released in 2012; and BBP 3.0, released in 2015. In the first memo, Carter emphasized two main points. First was that savings and efficiencies will not occur over night. Second, acquisition reform is a combined effort from the acquisition community, Congress, and industry (Carter, 2010a). The main purpose of this first iteration was to establish a baseline of principles for the acquisition community. The majority of the guidance focused on executing the defense acquisition system. Figure 1 shows the focus areas and initiatives of BBP 1.0.

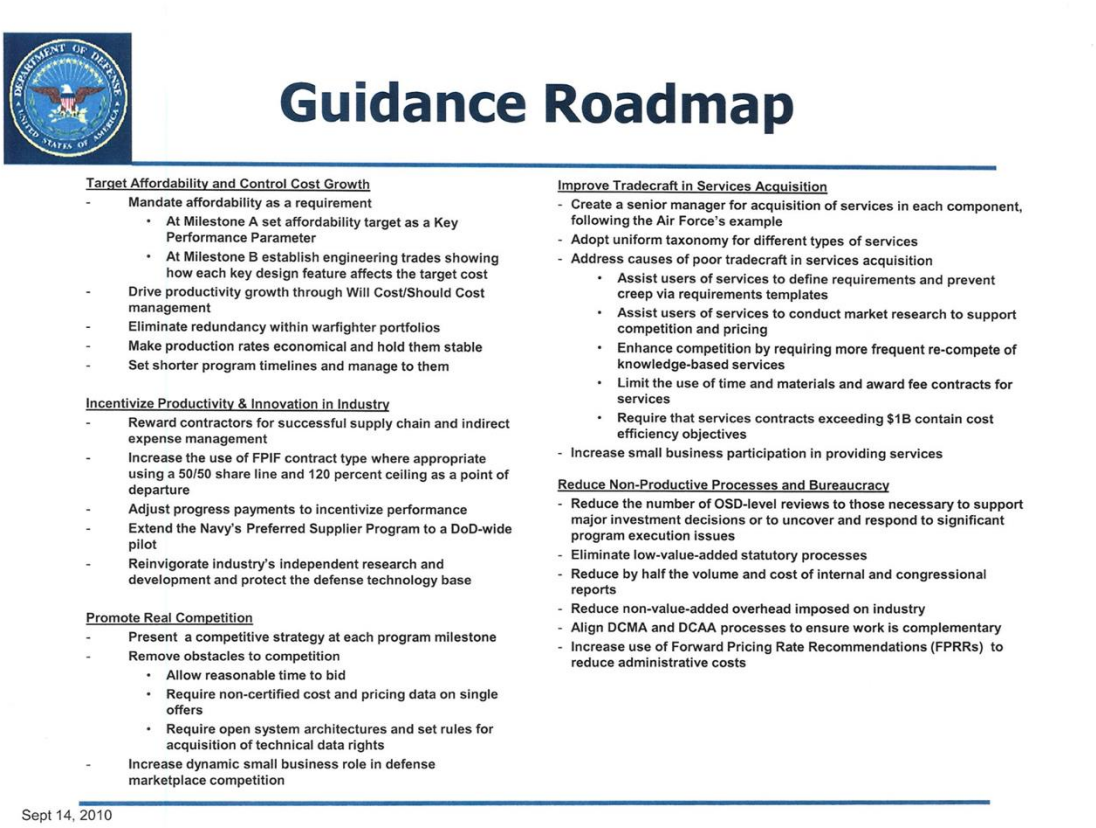


Figure 1. Better Buying Power 1.0 Focus Areas and Initiatives.
Source: Carter (2010b).

The first iteration, BBP 1.0, introduced five concepts related to reducing program costs that are consistent themes throughout the series:

- Mandate affordability as a requirement.
- Implement will cost/should cost management.
- Create incentives for innovation.
- Promote competition.
- Reduce bureaucratic burdens (Carter, 2010b).

Affordability as a requirement establishes metrics that are reported on acquisition decision memorandums. The requirement is the equivalent of a key performance parameter, with the BBP 2.0 encouraging program managers to consider the entire 30–40-year life cycle when establishing affordability goals. The affordability concept was

elevated into its own separate focus area in the BBP 2.0 (Kendall, 2013). Will cost/should cost management is another concept introduced in the Better Buying Power memorandums. This management technique uses an independent cost estimate as the "will cost" figure. Program managers are then responsible for identifying and creating should cost savings that they manage to. The aim of this initiative is to generate efficiencies that can be utilized by the services to acquire additional capabilities (Carter, 2010b).

The memo series looks at creating beneficial relationships with industry. This focus area evolves through the iterations. The first memo emphasizes the use of fixed price incentive contracts (Carter, 2010b), while the second emphasizes flexibility in choosing the contract type appropriate to the requirement (Kendall, 2012). This evolution shows how the memos should be used as a best practice rather than hard rules to follow. The fourth area in the memos is promoting effective competition. Better Buying Power 2.0 highlights the use of open system architectures as a tool to ensure competition (Kendall, 2012), and BBP 3.0 provides guidance to establish a database to provide awareness across the DOD of technology applications to share data and approaches (Kendall, 2015). The last area that traverses all three memos is reducing bureaucratic processes. The first memo establishes data collection metrics to establish a baseline of how many requirements there are and how much time is spent on each reporting requirement (Carter, 2010b). The second memo turns its focus on delegating responsibility to the appropriate level (Kendall, 2012).

Better Buying Power 2.0 continues to re-enforce the principles established in BBP 1.0. A key theme that differs is that of creativity. Guidance directs acquisition professionals to use the initiatives and focus areas as a starting point for executing their programs, but should not feel beholden to them. If a more efficient technique presents itself, professionals should feel free to break with the guidance to achieve savings. Figure 2 shows the Better Buying Power 2.0 roadmap that was published with the implementation guidance.

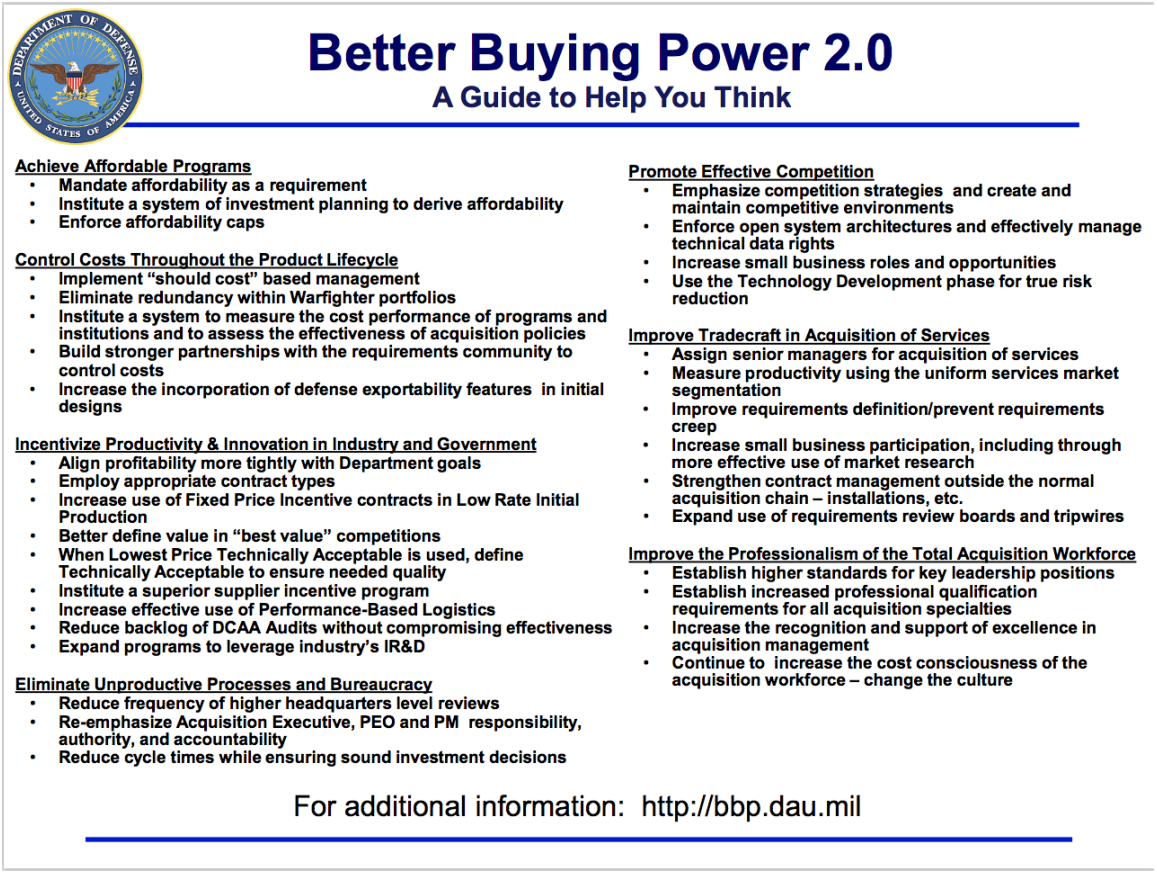


Figure 2. Better Buying Power 2.0 Focus Areas and Initiatives.
Source: Kendall (2013).

The second iteration of the series begins to create action items with responsible organizations. The third memo establishes itself as a control document that will track progress of the action items established in the previous memos (Kendall, 2015). As a continuing theme, the action items focus on data collection. Figure 3 shows the Better Buying Power 3.0 roadmap that was published with the implementation guidance.

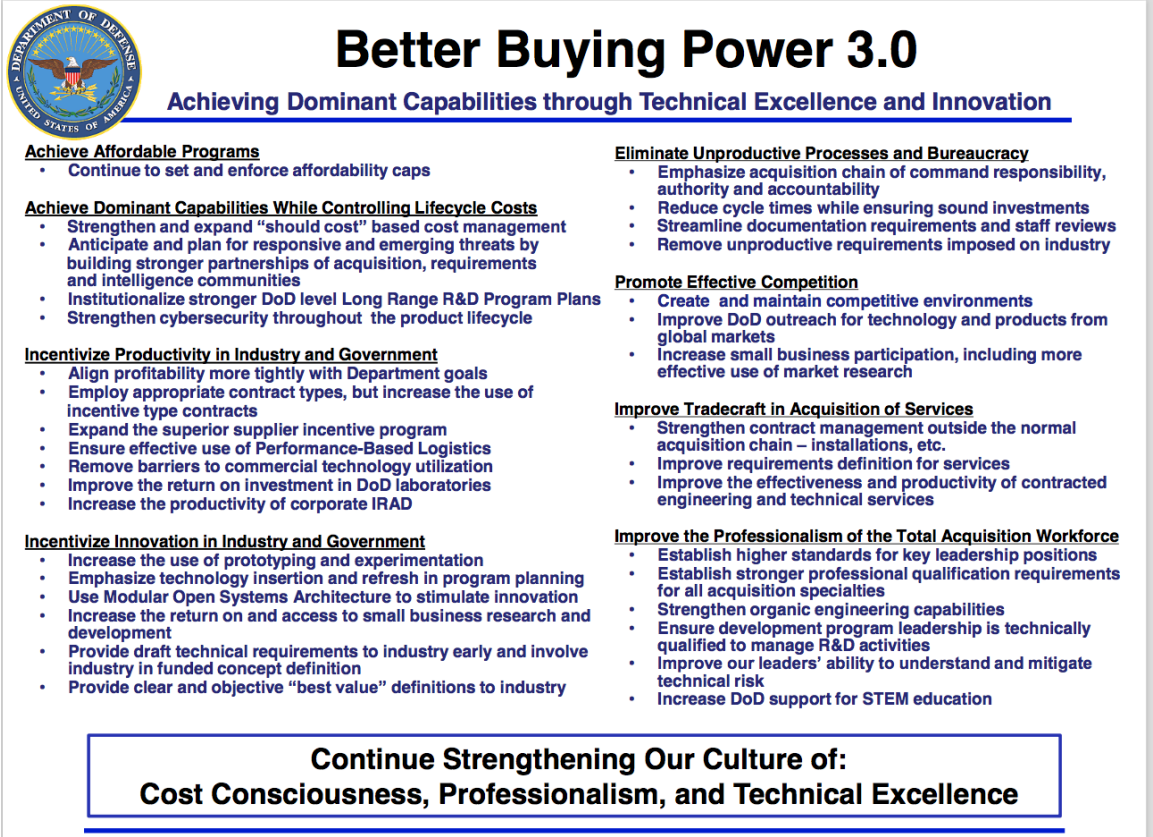


Figure 3. Better Buying Power 3.0 Focus Areas and Initiatives.
Source: Kendall (2015).

The Better Buying Power initiatives are intended to bring transparency between government and industry. The guidance is published both for government and industry use so that everyone can be on the same page. This transparency from the government is a key aspect of the initiatives. The next key aspect of the initiatives is their consistency. Consistent guiding principles with senior leader backing make implementation of the initiatives much more likely. Literature tends to be mixed on whether BBP will actually achieve cost savings. Root cause analysis advisor, Dr. Mark Husband (2015) explained that BBP's focus and consistent messaging is one aspect that is keeping costs under control, notably the decrease in Nunn–McCurdy breaches since 2012. Another survey of Army program managers (PM) state that some initiatives have potential to achieve cost savings and are worthy of resource expenditures, while others are not. An interesting point of this study is that PMs did not show should cost management as an area that would achieve cost savings (Layden, 2012).

D. AFFORDABILITY

Affordability is a key principle of the DOD's BBP Initiatives. The Defense Acquisition University (n.d.) defines *affordability* as

- a determination that the life cycle cost (LCC) of an acquisition program is in consonance with the long-range investment and force structure plans of the DOD or individual DOD components.
- conducting a program at a cost constrained by the maximum resources that the DOD or DOD component can allocate to that capability. (DAU, n.d.)

Affordability assessments are mandated by statute through 10 U.S.C. 2366a, 2366b and DOD Directive 5000.01. These documents force the services to prove that the program being assessed not only fills the required capability gap, but is also funded within the overall service portfolio. Assessments must be completed at Milestone B and C, but more importantly, the service must validate affordability prior to the commencement of the program (DAU, 2012). Using affordability as a Key Performance Parameter (KPP) metric is forcing program managers to conduct thorough and continuous trade-off analysis of their individual programs to ensure affordability.

Achieving affordability at the DOD, or even service, level cannot be done through a handful of programs. Because affordability should encompass a portfolio view of capabilities, affordability caps for an individual program are what the DOD or services determine a program should cost over its life cycle in order to achieve all capabilities in the portfolio. When programs do not execute to their affordability caps, the DOD must then re-assess the funding across the portfolio to achieve the desired capabilities within the allotted funding.

E. GOVERNMENT ACCOUNTABILITY OFFICE REPORTS

Beginning in 1996, the General Accountability Office (GAO) began a study to find commonalities in DOD acquisition programs that outperformed others in terms of cost growth and timeline delays. As a result of the GAO's research, they found that the primary reason why certain programs outperformed others was because of a product development process that was anchored in knowledge. The GAO identified three key

knowledge points in an acquisition life cycle. Figure 4 defines the three knowledge points and aligns them with acquisition milestones.

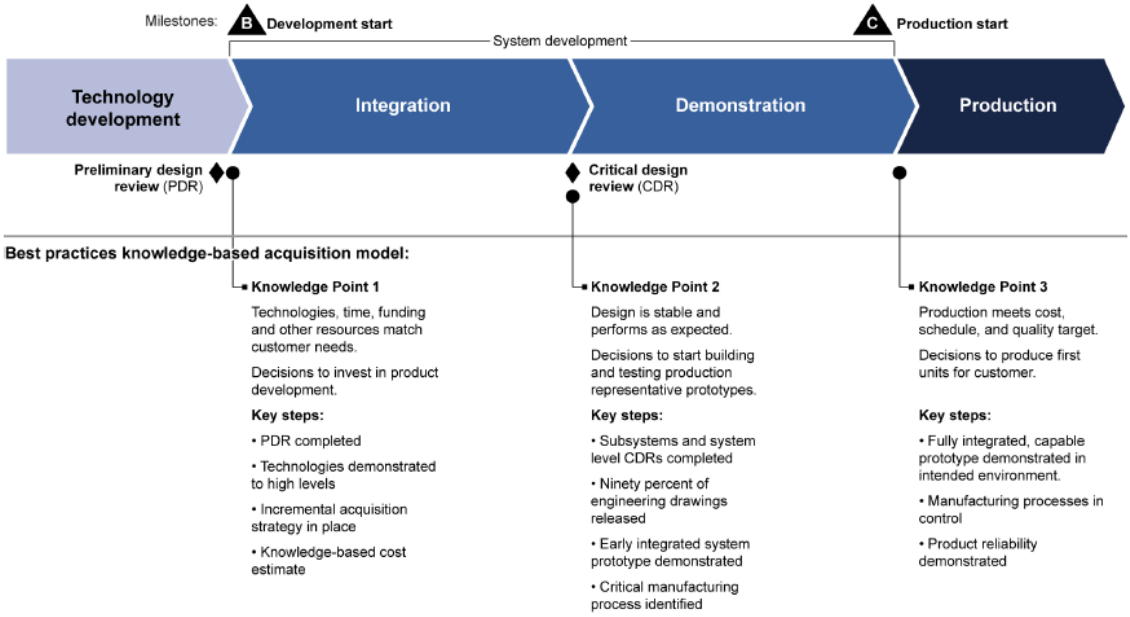


Figure 4. Defense Acquisition Cycle and GAO Knowledge Points.
Source: GAO (2017).

In 2003, the GAO began issuing an annual report titled *Defense Acquisitions Assessments of Major Weapon Systems*. This report started out as an annual report focused on the assessment of DOD programs with regards to their compliance with business best practices uncovered in their prior research studies.

Throughout the years, the contents of the GAO report have changed. The most considerable changes in report documentation occurred after acquisition reform efforts began in 2010. Nonetheless, the annual GAO reports contribute in an effort to determine if there has been less cost growth in DOD acquisitions programs since the implementation of BBP initiatives.

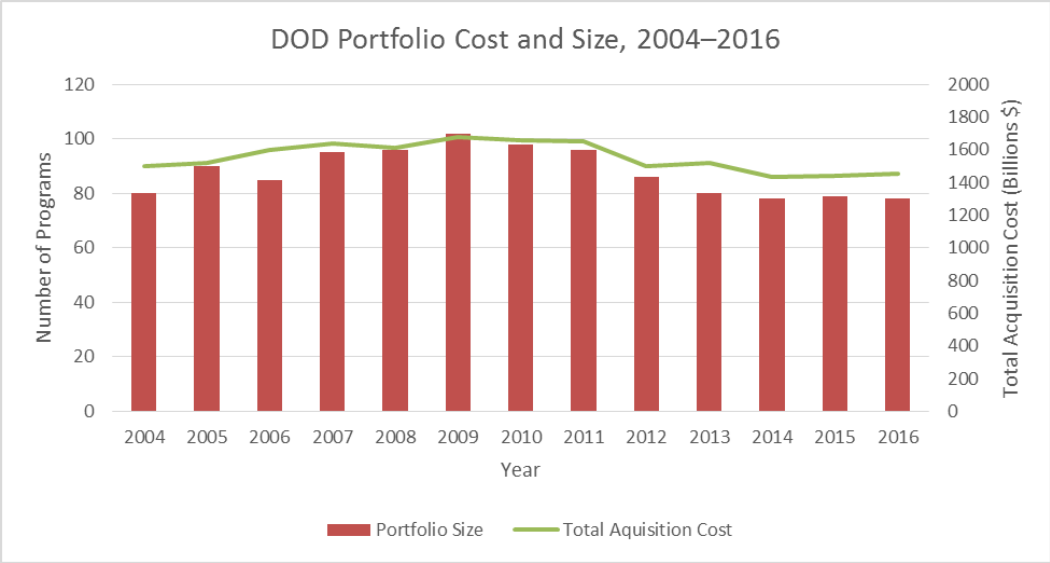
More specifically, the GAO contributes to this project effort by providing the following:

- An annual assessment of the DOD acquisition system as a whole

- Consistent data each year on the total size of the DOD portfolio
- Consistent data each year of the total cost of the DOD portfolio
- Trends in program average unit cost (PAUC) data
- An annual assessment on the level of adherence to a knowledge based acquisition approach within the DOD acquisition system
- Annual assessments on the implementation of DOD acquisition reform efforts including BBP initiatives and the level of success associated with those efforts
- Annual surveys of current MDAPs on the level of should cost analysis implementation and realized or anticipated cost savings

1. Total Size of the DOD Portfolio

Each year, the GAO reports the total DOD portfolio cost and size. The total cost of the DOD portfolio that the GAO publishes is based on the total planned commitments and the number of programs in the DOD portfolio refers to the number of MDAPs as defined by the DOD. A summary of the GAO findings each year are summarized in Figure 5.



Adapted from GAO (2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012a, 2013, 2014, 2015, 2016).

Figure 5. DOD Portfolio Cost and Size

Furthermore, the GAO goes slightly further than simply stating the size and cost of the portfolio during each current year. The GAO also occasionally gives insight into planned DOD spending on the portfolio over time. Figure 6 was published in the 2016 GAO report on defense acquisition systems and it shows the future development and procurement funding compared to the invested funding each year. It is clear from the graph that in the decade following 2005, the government saw a large decrease in future development and procurement funding while there was an increase in development and procurement funding invested. This provides insight into the relative level of average program maturity within each year's portfolio.

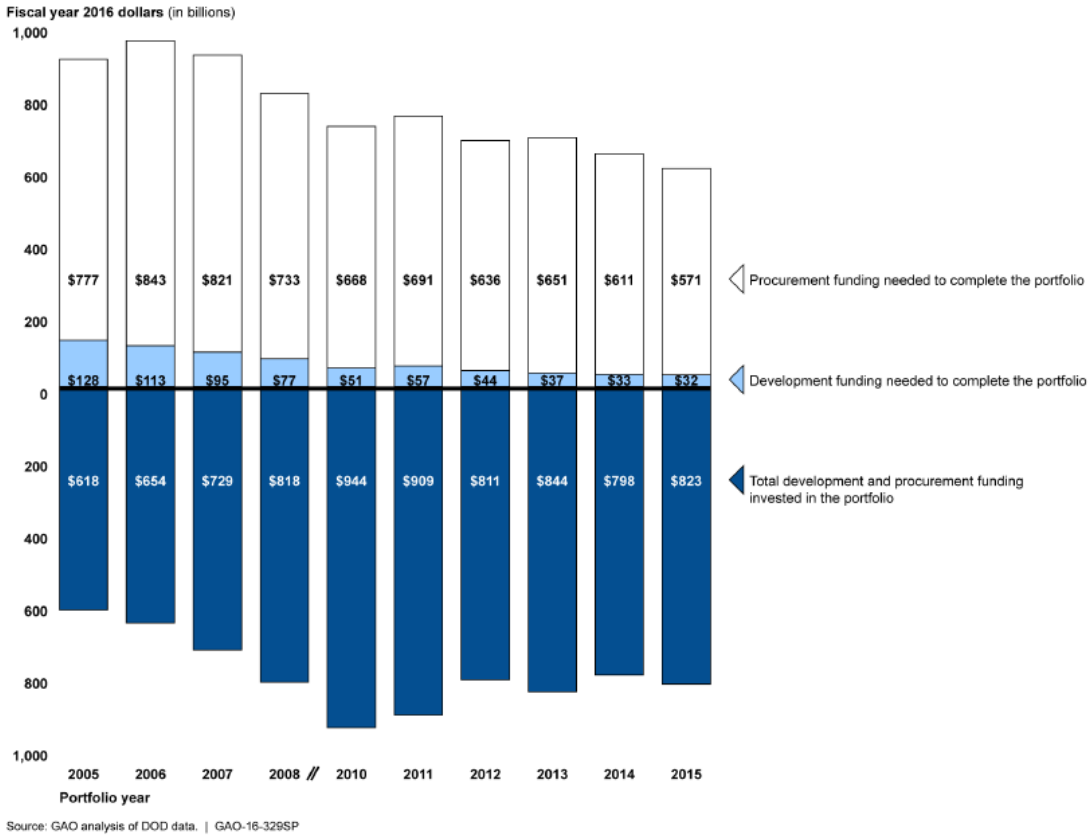


Figure 6. DOD Portfolio Future Development and Procurement Funding in Comparison to Invested Funding by Year, 2005–2015.
Source: GAO (2015).

Unfortunately, the GAO does not provide reasons for the decrease in total portfolio cost and size or the decreases in planned funding over the years.

Considering total portfolio cost and total portfolio size, and comparing future development funding to funding already invested provides insight to the DOD acquisition environment over the years. When trying to determine whether there has been less cost growth due to Better Buying Power one must take into consideration external factors.

Unfortunately the externalities are numerous and can cause huge changes in the costs of DOD programs. The following is a list of potential external factors that could result in the data presented in Figure 5 and Figure 6. However, this list is neither all-inclusive nor completely applicable to every program. The purpose of this list is provide examples of external factors that could have influenced the DOD portfolio.

- A change in DOD leadership resulting in a greater DOD-wide emphasis on cost reduction
- Reduced emphasis on cutting-edge technology due to inherent program risk
- Reduced or anticipated reduction in DOD budget causing more prioritization in completing current systems instead of fielding new systems
- Utilizing incremental approaches for complex DOD systems
- Inclusion of interdependent acquisition programs that rely on each other to obtain full functionality
- Continuing resolutions

2. Trends in Unit Cost

The GAO has made a notable effort throughout the years to record unit cost of DOD programs. Unit cost is an important figure because it reveals a slightly different aspect of procurement spending. Generally speaking, the unit cost comparison from year to year reveals the buying power of the government dollar for each unit of acquisition. The problem with tracking only program cost is that procurement quantity can decrease thereby decreasing the cost without providing the same level of buying power for the warfighter. The highlight of the unit cost measurement is that it factors procurement

quantity to help provide a better picture of the relative level of efficiency in the DOD acquisition system. The DOD uses two separate unit cost reporting criteria in selected acquisition reports (SARs). The first is the program acquisition unit cost (PAUC), which is the sum of total development dollars, procurement dollars, acquisition operation and maintenance, and construction dollars, divided by the total program quantity. The second reporting criterion is average procurement unit cost (APUC) and it only factors in procurement data by totaling procurement dollars and dividing by procurement quantity. Program SARs must report both figures and as a result the GAO recorded both figures and attempted to summarize the DOD portfolio performance each year with either set of reporting criteria. Unfortunately the GAO makes year to year comparison of portfolio average unit data difficult by changing the data reporting method nearly every year. There are years where the GAO records portfolio unit costs with APUC and other years with PAUC. They further complicate direct comparison by selecting a specific group of programs to represent the DOD portfolio and other years they take the DOD portfolio average. Although the data comparison is difficult, the GAO does however provide a unit cost average nearly every year and some years are directly comparable to other years. The following is a brief summary of what was said about APUC through the years:

- 2005: The GAO selected 26 programs due to their availability of data and congressional interest. Within those 26 programs selected, the weighted average PAUC was approximately 50% higher than initial estimates (GAO, 2005).
- 2006: The GAO selected a slightly different set of 26 programs generally using the same criteria as in 2005. Within the selected programs, the GAO found a 57% increase in APUC compared to initial estimates (GAO, 2006).
- 2007: The GAO selected a slightly different set of 27 programs generally using the same criteria as in 2005 and 2006. Within the selected programs, the GAO found a 39% increase in APUC compared to initial estimates (GAO, 2007).
- 2008: The GAO still took note of increase in PAUC in DOD programs. However, they no longer selected specific programs to monitor. Instead the GAO reported that 42% of MDAPs increased PAUC by more than 25% (GAO, 2008).

- 2009 and 2010: The GAO provided no information on PAUC of DOD acquisition programs.
- 2011: The GAO reported that 80% of programs increased PAUC since initial estimates. The GAO also noted that the majority of cost growth occurred after production indicating that engineering designs were not stable among many programs that had entered production. The GAO offered no analysis on the relative performance potential of the programs that increased or decreased PAUC (GAO, 2011).
- 2012: The GAO reported that 60% of programs increased PAUC since the previous year. The GAO offered no analysis on the relative performance potential of the programs that increased or decreased PAUC (GAO, 2012a).
- 2013: The GAO reported that 60% of MDAPs decreased PAUC thereby increasing buying power for those programs. Additionally, the GAO noted that 42 of the 52 programs that experienced decreased PAUCs had no change in procurement quantity (GAO, 2013).
- 2014: The GAO reported that 64% of MDAPs decreased APUC over the past year thereby increasing buying power. Fifty-one programs increased buying power and 35 programs increased buying power with no quantity changes. Twenty-five programs decreased in buying power. Sixteen programs decreased buying power with no quantity change (GAO, 2014).
- 2015: The GAO reported that 34 programs decreased APUC thereby gaining buying power and 21 programs gained buying power without quantity changes. Forty programs lost buying power and 26 programs lost buying power without quantity changes (GAO, 2015).
- 2016: The GAO reported that 38 programs decreased APUC thereby gaining buying power. Twenty-six programs gained buying power without quantity changes. Thirty-five programs lost buying power. Twenty-five programs lost buying power without quantity changes (GAO, 2016).
- 2017: The GAO reported that 33 programs decreased APUC thereby gaining buying power. Twenty-four programs gained buying power without quantity changes. Forty programs lost buying power. Twenty-five programs lost buying power with no quantity changes (GAO, 2017).

Due to reporting format, a direct year-to-year unit cost comparison is not possible. However, the reports prior to 2013 show a negative cost efficiency trend. The 2013 GAO report of 2012 selected acquisition reports reveal a decrease in APUC across 60% of the MDAP portfolio. Additionally, 42 of the 52 highlighted programs did not change

procurement quantity, change requirements, or change contract type to reduce cost (GAO, 2013). Unfortunately, the GAO does not comment whether the government gained or lost any level of performance.

3. Trends in Best Practice Implementation

During its research, the GAO found that on average, PAUC increased about 1% for MDAPs that reached knowledge point 1 by development start, whereas programs that did not reach knowledge point 1 (critical technologies tested in a realistic environment) by development start incurred a 30% increase since the initial estimate (GAO, 2007). Furthermore, the GAO found in all cases that it assessed, MDAPs that reached knowledge point 1 by development start incurred less cost increases than programs that did not (GAO, 2005). Therefore, it is relevant to assess the relative level of portfolio technology maturity throughout the years according to the GAO.

In 2005, the GAO reported that the DOD suffered from a defense deficiency in knowledge-based best practices. The DOD proceeded forward in product development with lower levels of knowledge than suggested business best practices and less than DOD policy. (GAO, 2005).

In the 2006 report, the GAO reported even worse conditions. The GAO found that the DOD portfolio of MDAP generally suffered from even greater cost overruns in total cost and unit cost. They largely attributed the poor performance to further degradation in knowledge based practices (immature technologies at the beginning of product development, lack of design knowledge, and lack of manufacturing knowledge; GAO, 2006).

The general summary from the 2007 report was very similar to what was said in the 2006 report in regards to program compliance with knowledge-based best practices.

The GAO reported in 2008 that the general trend since 2005 was that programs were achieving less and less maturity at each knowledge point (GAO, 2008).

The 2009 GAO report had a more positive message. The GAO studied technology maturity based on the year that each program entered system development. The result of

the GAO study was that programs that began system development after 2006 experienced much greater levels of technology maturity than programs that began system development prior to 2006. This was a great observation by the GAO but their findings were slightly incomplete because they did not comment on why programs were gaining more technology maturity (GAO, 2009).

In 2010, the GAO found a general trend toward greater technology maturity and design maturity at their respective knowledge points. They reported once again that programs that began system development after 2006 experienced much greater levels of technology maturity than programs that began system development before 2006 (GAO, 2010).

In 2011, the GAO found that newer programs were generally doing better than past programs at demonstrating knowledge at key decision points. However, knowledge based acquisition guidance was still not implemented in many programs in the portfolio. (GAO, 2011).

In 2012, the GAO again commented that newer programs continue to show higher levels of best practice implementation at the knowledge points. The DOD portfolio is still not doing a great job with most the programs not adhering to best practice guidance. The GAO chose 37 programs to assess best practice implementation. Of those 37 programs, eight programs passed through key acquisition points in 2011. They found that only one of the eight programs implemented all knowledge based best practice guidance (GAO, 2012a).

In 2013, the GAO reported again that newer programs were demonstrating higher levels of best practice implementation, but most were not adhering to the guidance. They chose 32 programs to assess best practice implementation and found that only five reached fully maturity at the start of development (GAO, 2013).

In 2014, the GAO assessed 38 programs from the 2013 portfolio and found that most programs were not following all guidance for a knowledge-based approach. Instead they found varying degrees of best practice implementation (GAO, 2014).

The overall summary of the GAO findings from 2015 were the same as the findings from 2014.

In 2016, the overall summary of best practice implementation was the same if not relatively degraded from the past couple years. The GAO assessed 43 programs with seven of those programs beginning system development in the past year. The GAO found that none of those seven programs implemented all of the knowledge-based best practices (GAO, 2016).

In 2017, the GAO assessed 45 current and nine future programs and determined that the level of best practice implementation was about the same as previous years. Four programs entered system development in the previous year and only one of those programs complied with all best practice initiatives (GAO, 2017).

4. Trends in Should Cost Analysis

One of the most apparent figures that the GAO provides in terms of cost savings as a result of BBP is the survey responses from program offices on the implementation of should cost analysis. Each year, beginning with the 2012 annual report, the GAO issued surveys to individual programs on their experience with should cost analysis. Often, should cost analysis resulted in realized and/or anticipated cost savings through various efficiency methods and those realized savings were then redistributed to DOD priorities making the overall portfolio more affordable.

In 2012, the GAO received survey responses from 16 future and 37 current MDAPs on their implementation of should cost analysis in 2011. The GAO reported that six future and 23 current MDAPs indicated that they had implemented should cost analysis in accordance with BBP. The GAO did not report on whether or not should cost analysis had resulted in any cost saving for the DOD portfolio. However, they did mention that one Navy program that did complete a should cost analysis benefited from the newly acquired knowledge by negotiating a 4.5% reduction on a production contract (GAO, 2012a).

In 2013, the GAO received survey responses from 40 current MDAPs on their implementation of should cost analysis. Thirty-five of the 40 programs reported that they did implement should cost analysis while 29 of the 40 programs identified cost savings. The GAO broke down reported cost savings into three categories: realized, future, or a combination of realized and future cost savings (GAO, 2013). The results of the GAO survey are indicated in Figure 7.

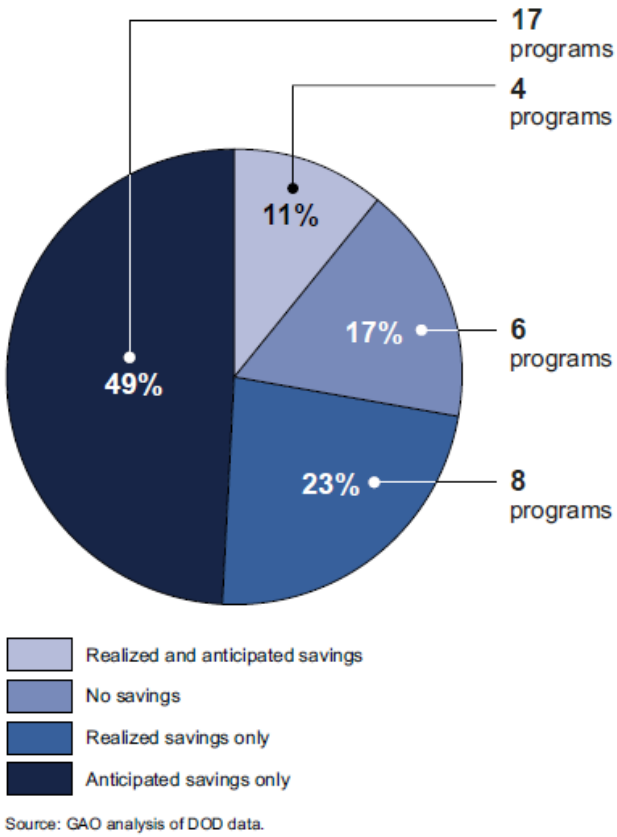


Figure 7. Type of Cost Savings Reported by the 35 Programs with Should Cost Analysis. Source: GAO, (2013).

In 2014, the GAO received survey responses from 38 current programs. They found that only six of the 38 programs had not implemented should cost analysis. Of those six programs, three programs were restructuring and one had just entered system development. The GAO found that 31 of the 32 programs that implemented should cost analysis realized or anticipated cost savings that totaled to $24 billion. Of the $24 billion

in savings, $9.9 billion was reported as realized savings while $14.1 billion were reported as anticipated cost savings. Eighteen programs reported realized cost savings and they reported the following reasons for the savings:

- Ten programs reported an improvement in vendor/supply chain management.
- Twelve programs improved efficiency in testing.
- Twelve programs reported that they realized cost savings in design trade-offs balancing capability with cost (GAO, 2014).

In 2015, the GAO received survey responses from 38 current programs. Thirty-four of the 38 programs reported that they conducted should cost analysis. Of the four programs that did not conduct should cost analysis, three programs were in the process of completing it. The 34 current programs that did conduct should cost analysis reported $32.3 billion in realized or anticipated savings. Within the survey responses, 23 programs reported that the following activities resulted in the realized savings:

- contract negotiation efficiencies
- cost savings in design trade-offs balancing capability with cost
- cost saving through modification of program requirements or capabilities (GAO, 2015).

In 2016, the GAO received survey responses from 43 current programs on should cost implementation. The GAO found that 39 of 43 programs conducted a should cost analysis with 35 of those 39 programs reporting realized or anticipated cost savings. The programs that realized cost savings reported generally the same activities as the previous two years as responsible for their should cost savings. The 35 programs reported a total of $35 billion dollars in realized or anticipated cost savings (GAO, 2016).

In 2017, the GAO received survey responses from 45 current programs on should cost implementation. The GAO found that 42 current programs conducted should cost analysis and 41 of those programs reported anticipated savings. Twenty-eight programs reported realized cost savings of $23.6 billion. Current programs also reported that they

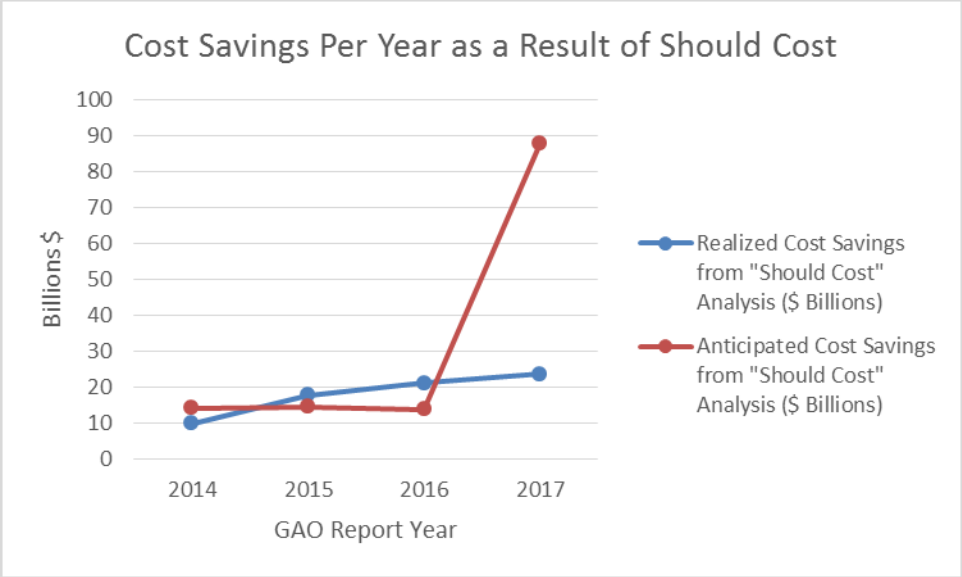
anticipated another $87.9 billion in anticipated savings with over $70 billion in savings from the F-35 program alone (GAO, 2017).

Table 1 and Figure 8 show an overall summary of should cost statistics as reported by the GAO.

Table 1. Reported Should Cost Savings, 2012–2017

	2012	2013	2014	2015	2016	2017
Number of Responses (Current Programs)	37	40	38	38	43	45
Number of Programs that Implemented "should cost" Analysis	23	35	32	34	39	42
Number of Programs that Reported Cost Savings	-	29	31	23	35	41
Realized Cost Savings from "Should Cost" Analysis ($ Billions)	-	-	9.9	17.8	21.2	23.6
Anticipated Cost Savings from "Should Cost" Analysis ($ Billions)	-	-	14.1	14.5	13.8	87.9

Adapted from GAO (2012a, 2013, 2014, 2015, 2016, 2017).



Adapted from GAO (2014, 2015, 2016, 2017).

Figure 8. Anticipated and Realized Should Cost Savings, 2014–2017

The trend since the 2012 GAO report has shown that great percentage of programs are implementing should cost analysis and greater percentage of programs are reporting a realized or anticipated cost savings. The past four years of GAO reports also indicate that the amount of realized and anticipated cost savings continues to increase with each year.

F. PERFORMANCE OF THE DEFENSE ACQUISITION SYSTEM

The *Performance of the Defense Acquisition System* annual reports are in part a method to fulfill statutory requirements of the IMPROVE Act of 2010. The report however looks to provide much more than the stated requirements. The reports generally use data that is readily available, but the reports incorporate data that is requested from the acquisition community (OUSD[AT&L], 2013). The value of data is heavily emphasized throughout the reports. One area that is missing is how analysts intend to use the data in a predictive manner. The reports allude to using pattern analysis to infer the best conditions to start a program, but no models were explained.

The first report, in 2013, sets a baseline for the future reports to compare progress against. The report relies on readily available historic data to augment data generated in the past year. No individual programs are analyzed, but a portfolio view is considered to identify strengths and weaknesses of the defense acquisition system. Overall the OUSD(AT&L) finds that there is still cost growth over the portfolio, but at decreasing rates relative to previous years. The report also notes gaps in the data and plans to fill those gaps in future reports (OUSD[AT&L], 2013). The report is a huge undertaking and generally takes into consideration only the raw data for its statistical analysis. There are however many factors, such as budget, continuing resolutions, congressional inaction that are not taken into account in how they affect performance. Isolating these factors is a near impossible task, but it is important to note.

The second report continues gathering data for comparison to the baseline. The report in 2014 highlights the importance of contract type to the requirement and risk involved. Many factors should be evaluated in choosing the contract type and the correct type will enable benefits to both government and industry (OUSD[AT&L], 2014). As just one more year of data was collected, there is still no basis for sweeping conclusions. As BBP 1.0 stated in 2010, implementation of acquisition reform would not be immediate, but reports like this continue to focus attention on cost control and affordability in the defense acquisition system.

Published in 2015, the third report begins to analyze the data. The analysis shows that cost growth is at or just below historic norms. One issue that the report highlights is that the DOD is executing less complex, and thus riskier weapon systems, placing our technical superiority at risk. The appendix of the report provides a detailed description of the statistical analysis methods used in the analysis. Because the data points are coming from many MDAPs at different points in their life cycles, a direct comparison is not possible. The analysis does what it can to make comparisons. Part of the statistics involves the identification of outliers, which are described in detail, and often excluded from the analysis. Again, 2015's report highlights the pursuit of less risky weapon systems (OUSD[AT&L], 2015). Although the report is very transparent in the types of data and statistical methods being used for analysis, the report highlights 27 out of 78 total programs as outliers. While outliers will skew any statistical analysis and are thrown out, the fact that more than a third of MDAPs are classified as outliers is a concern not addressed in the report.

The last iteration, and last report in Kendall's tenure as USD(AT&L), emphasized the importance of data. Data must drive decision making, and further reforms must be the result of data and not intuition. The report finds that the analysis of lower cost growth is a valid conclusion. The report argues through statistical analysis that quantity changes and schedule manipulation are not factors being used to drive down cost growth. The report shows that the proportion of development costs vs. production costs is stable, meaning that the current portfolio is not trending toward the less risky production phase of the life cycle. By making these assumptions that the portfolio is stable, Kendall is able to attribute the cost growth decreases to should cost management of the BBP initiatives (OUSD[AT&L], 2016). It is significant that success is now being attributed to a specific factor of reforms. The data presents a good case that since 2010 cost growth across the portfolio is on the decline. The justification is that over the years, BBP initiatives are becoming entrenched across the portfolio leading to correlation of reduced cost growth and Better Buying Power. Due to the complexities of the Defense Acquisition System, causation will be challenging to prove in the follow-on reports.

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III. METHODOLOGY

A. INTRODUCTION

In order to adequately answer our research question, "Is the affordability success in defense acquisition programs correlated with the implementation of Better Buying Power?," we conducted a thorough literature review of the applicable GAO reports and annual reports published by the DOD on the performance of the Defense Acquisition System. As indicated in the literature review, these reports found that there was an overall reduction in cost growth among programs that began system development after the issuance of BBP.

A portfolio approach to overall affordability is generally characterized by the GAO's efforts to quantify the DOD portfolio as a whole through a number of programs and total portfolio cost estimates over time. Further analysis of the DOD portfolio as a whole may prove to be useful; however, in order to execute an affordable portfolio, DOD programs must execute within program cost constraints.

In order to better answer our research questions, we analyze several acquisition programs as individual case studies to show how weapon system acquisition reform in recent years contributed to better affordability in those specific instances.

We did not want to cherry-pick a specific program because it did or did not show expected data trends. Instead we used a methodical process to narrow down all available programs to only three that we would dig into regardless of what the data trend revealed.

B. PROGRAM CRITERIA

First, we chose to use DAMIR to retrieve specific cost and schedule data to develop case studies to better answer our research question. DAMIR is a reporting and analysis tool used by the DOD and its primary utility in this research effort was to provide SAR and acquisition program baseline (APB) data on the MDAPs we chose to analyze. We chose to use DAMIR because it is a comprehensive repository of historical

cost data that is accurately recorded since before the major acquisition reform efforts took place in recent years.

Our first set of requirements to narrow down the list of 204 active and inactive programs available on DAMIR were as follows:

1. Listed as a Major Defense Acquisition Program
2. Army program
3. Transitioned through a Milestone B or Milestone C since 2009
4. Not considered an AT&L outlier

The first requirement is somewhat obvious because programs other than MDAPs are not included in the Selected Acquisition Report database in DAMIR. Therefore, we would not have the ability to accurately retrieve program information throughout its life cycle.

The second requirement to be an Army program without joint funding lines and joint interest. This requirement was chosen in order to narrow down the pool of available MDAPs without showing a bias toward one or another due to data influence. Both students are Army officers and had a background and familiarity with some of the Army systems.

The third requirement to have transitioned through a Milestone B or Milestone C since acquisition reform was chosen because there needed to be a "before and after snapshot" of the acquisition program baseline to illustrate how acquisition reform affected cost growth.

The fourth requirement to not be an outlier, identified in the 2015 Performance of the Defense Acquisition System report published by USD(AT&L), was implemented because there are several programs that have shown an incredible amount of cost growth due to the specific nature of the program and the environment. Our research suggests that cost growth to these specific systems are not indicative of the problems that influence weapon systems acquisition as a whole and should be avoided for case study purposes.

The following are AT&L outlier programs:

- Paladin
- MQ-1 Gray Eagle
- TMC CPoF
- Global Combat Support System–Army

C. PROGRAMS TO ANALYZE

The resulting DOD programs that were not eliminated by one of our four requirements were the following:

1. Guided Multiple Launch Rocket System/Guided Multiple Launch Rocket System Alternative Warhead (GMLRS/GMLRS AW)
2. Integrated Air and Missile Defense (IAMD)
3. Patriot Advanced Capability-3 Missile Segment Enhancement (PAC-3 MSE)
4. Warfighter Information Network-Tactical Increment 2 (WIN-T Inc.2)
5. Warfighter Information Network-Tactical Increment 3 (WIN-T Inc.3)

Our methodology for determining affordability is to first conduct a qualitative analysis to determine whether or not the selected DOD programs are in compliance with GAO best practices and Better Buying Power initiatives. Secondly, conduct a quantitative analysis by recording APUC and expenditures over time relative to whether or not they are following Better Buying Power initiatives.

We chose to use a qualitative analysis rather than a quantitative analysis to evaluate the level of overall compliance with GAO best practices and Better Buying Power initiatives in each selected DOD program because of several reasons. First, a quantitative analysis of these programs would have proved to be relatively meaningless due to the inherent unavailability of data in certain aspects of individual programs. Second, we found that there must be a relatively high amount of assumptions needed to

determine the level of compliance with GAO and Better Buying Power due to ambiguity and data omission in source documents. Finally, we chose a qualitative analysis because not all factors in GAO or BBP compliance should be weighted equally, and the GAO and DOD do not indicate how factors should be weighted in relation to each other. The relative scale of compliance for each program is depicted in Figure 9 with complete compliance depicted as green and complete non-compliance depicted as black.

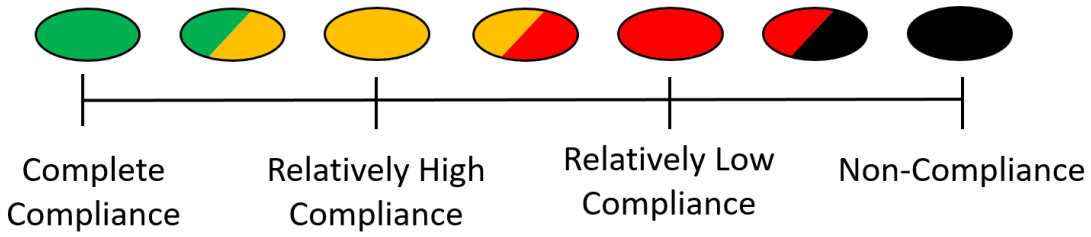

Figure 9. Qualitative Scale of Compliance

We do not look at the effects of schedule and quantity manipulation to drive down cost growth. The 2016 Performance of the Acquisition System report shows that schedule is not used to drive down costs and production contract quantities, since 2000 almost never change (OUSD[AT&L], 2016). While the data tells us that this is not observed in current programs, the risk that programs can manipulate schedule and quantity will always be present.

Here we assume the 2016 Performance of the Acquisition System conclusion that programs are not using quantity and schedule to drive down cost growth. There are many factors that affect affordability, this report is focused on the changes in APUC and expenditures (OUSD[AT&L], 2016).

The Institute for Defense Analyses, (Davis, Goeller, & Horowitz, 2016) looked closely at affordability in a 2016 report. They found that the most common metric is a cap on APUC. A weakness of this metric is there is risk, unfounded in current programs by DOD analysis, that programs can decrease quantities or stretch them over additional years to make a program appear more affordable. The report also notes that yearly

expenditure caps are an obvious method to detail affordability caps. By caps the report suggests placing a top-line dollar amount that a program can expend throughout its program life cycle. The issue with yearly caps is that the services would need to plan funding caps for the life cycle of a program, consisting of over 30 years of expenditure caps. This would be problematic in that Acquisition Executives would lose flexibility if they are tied to yearly caps (Davis et al., 2016). Our data collection included reviewing the selected programs' APUC figures as they change over time. We examined expenditures by year for each program. Expenditures are difficult to analyze on their own but the data is presented in an attempt to discover patterns. The Selected Acquisition Reports used to collect data show expenditures as a single metric. They do not break the metric out by Research, Development, Test, and Evaluation (RDT&E) or procurement accounts which have two- and three-year obligation periods and an additional five years until the monies are canceled. The Office of the Secretary of Defense publishes obligation benchmarks for each appropriation, but expenditure benchmarks only for RDT&E (AcqNotes, n.d). A weighted moving average of RDT&E planned funding profiles could be constructed to develop an artificial affordability cap for that appropriation. However, because there are no expenditure benchmarks for procurement funds, we would have to develop arbitrary expenditure goals over an eight-year period in order to create a weighted moving average to create a similar artificial affordability metric. The program SARs report a single expenditure metric, making it difficult to establish expenditures as an affordability cap which makes analyzing expenditure data inaccurate when dealing with a single data point each year.

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IV. DATA AND ANALYSIS

A. GUIDED MULTIPLE LAUNCH ROCKET SYSTEM (GMLRS) ALTERNATIVE WARHEAD (AW)

The Guided Multiple Launch Rocket System (GMLRS) is an upgrade from the Multiple Launch Rocket System through improvements in range, accuracy, effectiveness, and maneuver force safety. The Alternative Warhead is Increment 3 of the warhead design and is designed to replace the Dual Purpose Improved Conventional Munitions (DPICM) warhead. The Alternative Warhead will provide similar effects at a comparable range to the DPICM warhead but will also satisfy the (Unexploded Ordnance (UXO) requirements on cluster munitions.

The Guided Multiple Launch Rocket System/Guided Multiple Launch Rocket System Alternative Warhead (GMLRS/GMLRS AW) program began in 1998 as an upgrade program to the current Multiple Launch Rocket System (MLRS). The Alternate Warhead utilized the Extended Range MLRS (ER-MLRS) rocket and provided greater accuracy and lethality (DOD, 1997). By 2000, the GMLRS AW program was behind schedule and over-budget due to software development issues and sub-contractor delivery problems causing a re-baseline of the acquisition program baseline (APB; DOD, 1999a). In 2000, the program suffered a critical Nunn–McCurdy breach to the current APUC. The causes were determined to be underestimated design changes, procurement plans, and quantity reductions due to funding requirements (DOD, 2001). In 2002, the launcher portion of the program was re-designated as an Acquisition Category (ACAT) II program. The missile program, re-baselined and continued as an ACAT ID program with two missile systems, the Dual Purpose Improved Conventional Munition (DPICM) which was about to begin Low Rate Initial Production (LRIP) and the Unitary Rocket which just entered MS B (DOD, 2002). In 2003, the program re-baselined to a production estimate (DOD, 2003b). In 2005, the program experienced significant Nunn–McCurdy breaches to PAUC and APUC estimates. The causes of the breach were due to schedule stretch and funding reductions, cost growth, and additions to the requirements. In 2007, the program

obtained Nunn–McCurdy certification. Along with the certification, a new baseline for cost and quantity was established, and the program was delegated to an ACAT IC program (DOD, 2007a). A third missile variant, the Alternative Warhead (AW), to replace the current DPICM, was added to the SAR reporting. Additional funding for the AW caused an RDT&E and Operations and Support (O&S) APB breach as the warhead was not included in the most recent APB (DOD, 2009a). An updated APB to include AW funding was approved in February 2012 (DOD, 2011c). The program experienced two years of decreasing APUC numbers following a high point in 2013. In 2016, an additional variant, the Extended Range Guided Multiple Launch Rocket Systems (ER-GMLRS) was reported for the first time with development expected to begin in FY 2018. As a result, an RDT&E APB breach was reported (DOD, 2016a). Through the program's life, there was a significant amount of requirements volatility. Past 2010, outside of the requirements changes, conducting a qualitative analysis of the APUC fluctuations, there appears to be a stabilized cost growth and even reduction for times when the requirements were stable indicating that effects of Better Buying Power initiatives may be influencing program execution.

1. Compliance with GAO Best Practices

Unfortunately, the GAO did not provide assessments for the GMLRS program throughout its acquisition life cycle. Therefore, this case study does not have the benefit of the research conducted by the GAO to determine compliance with best practices.

Although GAO reporting is not available for the Alternative Warhead, the Assistant Secretary of the Army (Acquisition Logistics & Technology) completed a technology readiness assessment (TRA) in May 2011 indicating the technology maturity level before entering development start. The TRA was performed by a panel of independent subject matter experts and coordinated with the program manager. The panel found that the Alternative Warhead had no critical technologies in its design. Additionally, data collected from a static arena test and three rocket live tests validated the effectiveness/lethality models of the warhead (Lemnios, 2011).

Because these technologies were tested in a relevant environment prior to development start, the program is in basic compliance with GAO best practices at knowledge point 1.

With regards to GAO recommendations for systems engineering technical review, the Alternative Warhead program office conducted a preliminary design review for the warhead. The Integrated Product Team (IPT) chairperson chaired the review and determined when the exit criteria were satisfied (DOD, 2011b).

With regard to knowledge-based practices at design review, the GMLRS AW has 90% commonality with the GMLRS Unitary Rocket. The vast majority of the rocket and warhead design that was chosen to proceed in the Engineering and Manufacturing Development (EMD) phase shared common components and configuration. (DOD, 2014c). Although not specifically stated in literature or GAO assessments, we made the assumption that the product was stable with the release of 90% of design drawings due to the level of commonality with the Unitary Rocket which had already completed production. Figure 10 shows in table format the level of adherence to GAO best practices within the GMLRS.

		GMLRS
KP1	**Knowledge Based Practices at Development Start**	**Feb-12**
	All Critical Technologies TRL 6 (DOD Requirement)	
	All Critical Technologies TRL7 (Fully Mature)	
	Hold system requirements review	
	Hold preliminary design review	
	Constrain development phase to 6 years or less	
KP2	**Knowledge Based Practices at Design Review**	**Mar-13**
	All Critical Technologies TRL7 (Fully Mature)	
	Release at least 90 percent of design drawings	
	Test a system-level integrated prototype	
	Establish a reliability growth curve	
KP3	**Knowledge Based Practices at Production Start**	**May-15**
	All Critical Technologies TRL7 (Fully Mature)	
	Release at least 90 percent of design drawings	
	Identify critical manufacturing processes	
	Demonstrate critical processes are in statistical control	
	Demonstrate critical processes on a pilot production line	
	Test a production-representitive prototype	
	No data available / not applicable	
	Practice Implemented by Program	
	Practice Not Implemented by Program	

Adapted from GAO (2012a, 2013, 2014, 2015, 2016, 2017).

Figure 10. GMLRS Compliance with GAO Best Practices

2. Compliance with Better Buying Power Initiatives

GMLRS conducted the following actions during program execution that demonstrated compliance with Better Buying Power 1.0 initiatives:

1. The 2006–2016 SARs show that the quantities are economical and stable. There is fluctuation in the first nine years of the program, the quantities remain unchanged from 2006 to the present (DOD, 2006–2016).

2. Not in compliance with Better Buying Power, the 2009 and 2011 SARs show that the program used sole source contract types for EMD and procurement contracts (DOD, 2009, 2011).

GMLRS conducted the following actions during program execution that demonstrated compliance with Better Buying Power 2.0 initiatives:

1. The 1997–2016 SAR show the program transitioning from Cost Plus Award Fee (CPAF) type contracts to Firm Fixed Price (FFP)/Cost Plus Fixed Fee (CPFF) and Firm Price Incentive (Firm Target) (FPIF)/CPFF contract types when appropriate (DOD, 1997–2016).

2. The June 2003 Selected Acquisition Report shows the program being delegated to an ACAT IC program in line with reducing the frequency of higher headquarters level reviews (DOD, 2003a).

3. The 2013 Selected Acquisition Report shows should cost initiatives implemented in program execution. The initiative focused on achieving manufacturing readiness level 9 prior to MS C and full rate production decision review (DOD, 2013b).

4. The August 2014 cost analysis requirements description highlights the following initiatives (DOD, 2014c):

    - Employ appropriate contract types based on point in acquisition life cycle.
    - Performance-based logistics is considered but not pursued after analysis.

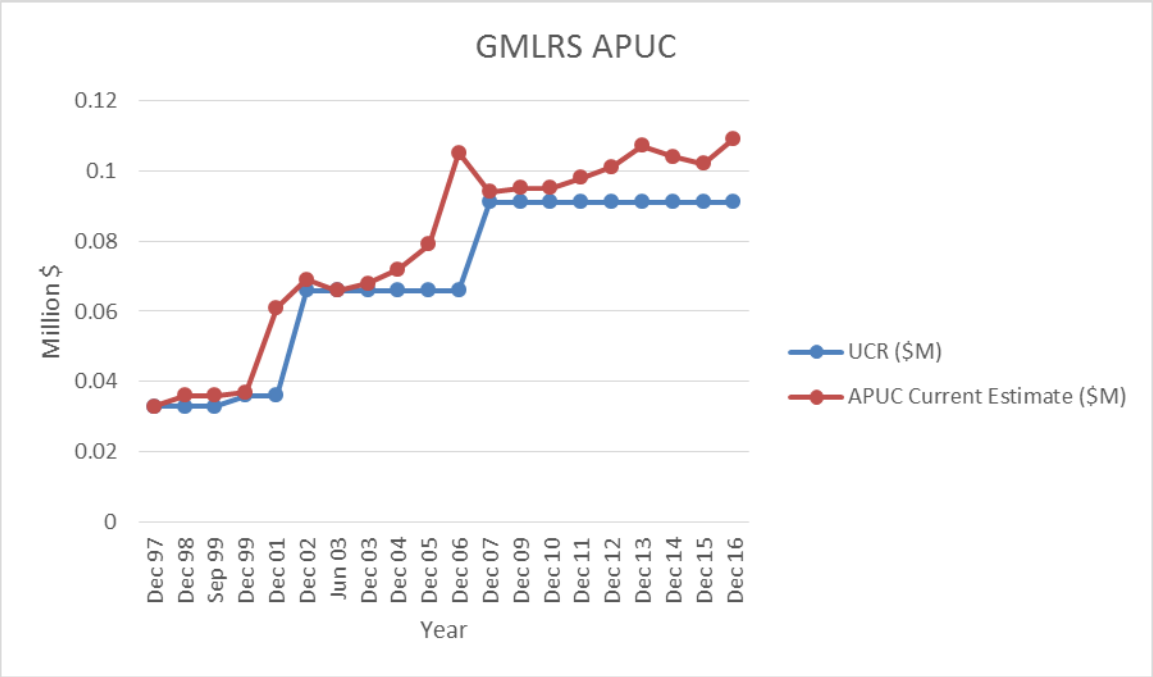
5. In non-compliance of Better Buying Power, the cost analysis requirements description indicates that a sole source contract for EMD will be pursued negating any benefits from competition (DOD, 2014c).

The May 20, 2015, Acquisition Decision Memorandum establishes affordability caps in compliance with Better Buying Power 3.0 (DOD, 2015a).

3. APUC and Expenditures

Selected Acquisition Reports for the GMLRS AW program reports expenditures each year and acquisition program baseline unit cost history among its substantial reporting metrics. Converting all current APUC estimates to same year dollars and graphing over time reveals the graph in Figure 11. As the graph indicates, the average

program unit cost has increased steadily since the original estimate in 1997. GMLRS AW is a variation of the current DPICM missile, as a result the program office had substantial cost data available to support the Alternative Warhead cost estimate. The graph also includes the unit cost report (UCR) as a baseline to compare APUC changes through time. This line is valuable because programs that exceed their original APUC baseline by 30% or 15% of their current baseline are subject to a Nunn–McCurdy breach. The UCR baseline is a constant figure that only changes in the event of a program re-baseline.

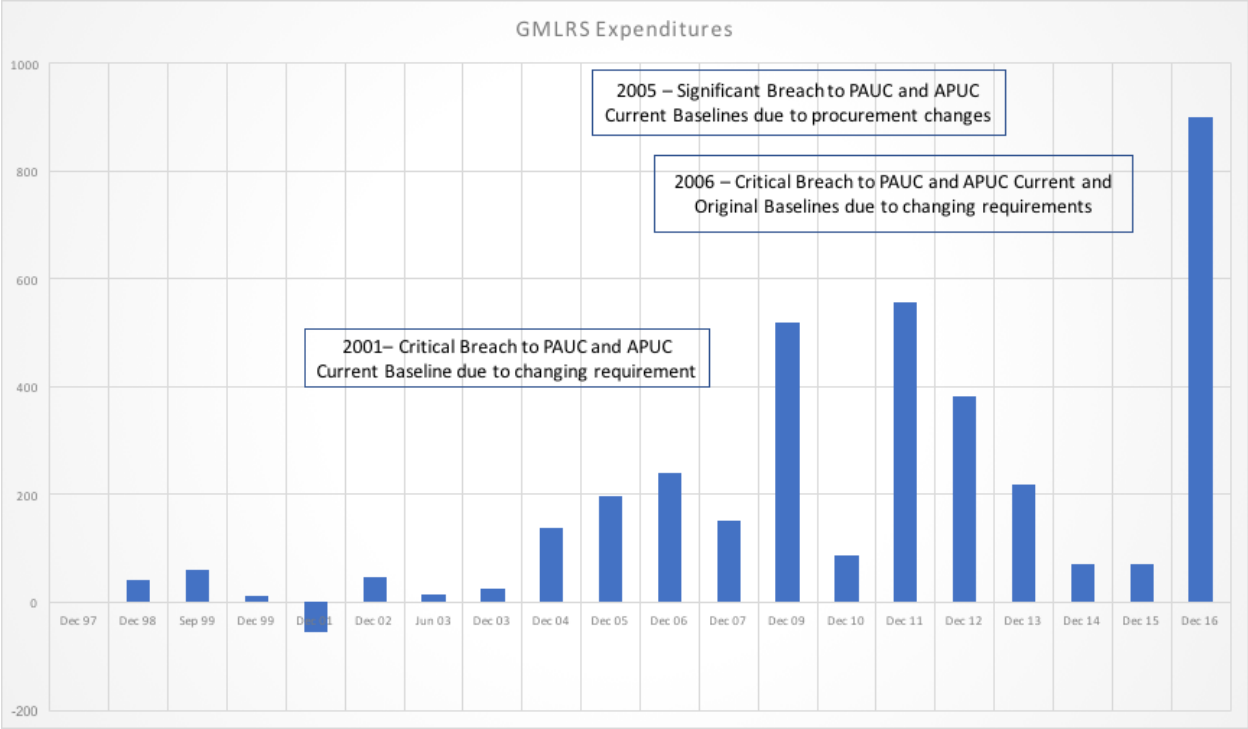


Adapted from DOD (1997, 1998, 1999b, 2001, 2002, 2003a, 2003b, 2004a, 2005a, 2006a, 2007a, 2009a, 2010b, 2011c, 2012c, 2013b, 2014e, 2015e, 2016a).

Figure 11. GMLRS APUC over Time

Furthermore, graphing expenditures over time results in a wildly variable graph with a generally positive trend. In Figure 12, the planned funding profiles for each SAR year can be used as a yearly affordability measure. The bars are the actual expenditures for the program since MS B. Yearly affordability goals are not placed on programs as there would be far too many data points and become an overly complicated measure for senior acquisition leaders to decipher. We have overlaid any instances of Nunn–McCurdy

breaches on the figure. From first glance, it does not appear that any patterns exist in terms of expenditures and breaches. Again, this is expected because the DOD does not establish yearly expenditure caps.



Adapted from DOD (1997, 1998, 1999b, 2001, 2002, 2003a, 2003b, 2004a, 2005a, 2006a, 2007a, 2009a, 2010b, 2011c, 2012c, 2013b, 2014e, 2015e, 2016a).

Figure 12. GMLRS Expenditures and Nunn–McCurdy Breaches

4. Analysis

The GMLRS program is particularly difficult to analyze in terms compliance with GAO best practices because of program restructuring and lack of inclusion in GAO annual reports. However, the technology readiness assessment in May 2011 found that the latest increment, Alternative Warhead, included no new critical technologies and shared over 90% commonality with previous increments. Therefore, the GMLRS AW program benefited from the previous increments by having all critical technologies fully mature and a stable design. Based on data that we were able to retrieve from the Alternative Warhead program, our overall assessment of the GMLRS program at

knowledge point 1 and 2 is green. Unfortunately, compliance with GAO best practices at knowledge point 3 is un-assessable due to lack of documentation on the program.

In terms of BBP initiatives, the program shows some compliance but one clear violation. The violation displayed was a lack of competition. The program utilized sole source contracts for both EMD and procurement. While the program has a long history beginning with the MLRS, the GMLRS program did not benefit from any competition effects to minimize costs or achieve higher performance. The program did employ one should cost initiative. The initiative focused on achieving manufacturing readiness level (MRL) 9 prior to MS C. According to the Manufacturing Readiness Level (MRL) Deskbook (2011), MRL 9 is "Low rate production demonstrated; capability in place to begin Full Rate Production" (OSD Manufacturing Technology Program, 2011). While this goal does achieve a readiness level prior to the necessary event of full rate production, it is an action that must be achieved anyway. This will serve as a measure to achieve schedule goals; it is hard to foresee how this will save money on its own. The one area that the program does comply with is establishing affordability caps. These caps will set hard limits on cost, forcing the program manager to limit cost growth or risk additional reporting requirements to the Defense Acquisition Executive (DAE). Overall however, the program displays a relatively low level of compliance with BBP initiatives and receives an overall score of red.

The program goes through two separate Nunn–McCurdy breaches, one critical breach in 2001 and a significant breach in 2005 that devolves into a critical breach in 2006. While all of these breaches occur prior to BBP, they are all in the era of GAO best practices. Again, we do not have the data stating that best practice compliance was achieved in the years prior to the BBP era. Regardless, all of the Nunn–McCurdy breaches occur in the GAO knowledge point era prior to BBP. The program data collected does not indicate strict adherence to BBP initiatives, but the cost growth post 2009 is significantly lower than prior to 2009. The environment surrounding the program makes it more difficult to identify correlation between lower cost growth and any one factor. The cause of the critical breach in 2001 was attributed to funding decrements as well as design changes. A second breach in 2005 was attributed to cost growth as well as

funding reductions, schedule stretch, and changing requirements. A third and fourth missile variant was added to the program in 2009 and 2016.

While no program is immune to requirements and funding volatility, there appears to be a significant amount of change in the GMLRS program. Much of the data collected for the program is during the BBP era. And it is during the BBP era that cost growth seems to be lower than previous time periods. While this is merely a qualitative observation, it is significant that even with the requirements and funding volatility, the program was still able to achieve lower cost growth relative to increments developed prior to the BBP era. The expenditure data on its own is not especially useful. As discussed in the methodology section, there is no convenient method to create an artificial affordability cap using planned funding profiles versus the expenditures. Another qualitative observation is that the expenditures do not appear have a pattern or typical behavior based on prior to or post Nunn–McCurdy breaches. Unfortunately, there is no conclusive causation that we can identify in analyzing the GMLRs program.

B. INTEGRATED AIR AND MISSILE DEFENSE

The Army's Integrated Air and Missile Defense (IAMD) program is a networked air defense system. The purpose is to integrate sensors and weapon systems into a battle command system. The end system will provide a fire control system to defeat enemy air threats (DOD, 2016b).

The program experienced a RDT&E APB breach in FY 2010 due to increased funding for additional requirements. The program also realized an $85 million decrement of FY 2011 funding, increasing program risks (DOD, 2010c). Requirements however have not been stable throughout the life cycle thus far. In addition to requirements additions in FY 2010, more requirements were placed on the program in FY 2011 (DOD, 2011d). The program was realigned in 2014 due to a schedule slip caused by an Army budget reduction in FY 2014 (DOD, 2014f). Quantities were stable for the program through the first six SARs, but increased by more than 50% in FY 2015. The quantity increase then caused an O&S APB breach in FY 2016. There was also an RDT&E APB breach in FY 2016 to extend the EMD phase for further risk reduction measures

necessary as identified from the limited user test held in 2016 (DOD, 2016b). Despite these changes and realignments APUC remains well below the baseline set in 2009. The expenditures also mirror the program execution with increases in 2010 due to additional requirements and subsequent budget reduction in 2013. Both measures indicate the program is executing within the constraints of its plan and environment.

1. Compliance with GAO Best Practices

Program technology development started in February 2006 and crossed Milestone B in December 2009. It began development in 2009 with all critical technologies nearing Technology Readiness Level (TRL) 6. However, the program did not demonstrate all critical technologies in a realistic environment, as recommended by GAO best practices. The IAMD program failed to implement several other best practices recommended by the GAO prior beginning system development, including holding a Preliminary Design Review (PDR) and constraining development time to less than six years. The program did hold several systems engineering reviews to include a system requirements review and a system functional review. DOD policy further states that a system or increment should be developed within a short time frame, normally less than five years. The emphasis behind the short timeframe is to increase funding predictability and ultimately the probability of program success. Unfortunately, the IAMD program did not comply with best practices or DOD policy because system development was originally scheduled to take almost seven years. Figure 13 shows in table format the level of adherence to GAO best practices within the IAMD program at Milestone B (GAO, 2011).

		IAMD
KP1	**Knowledge Based Practices at Development Start**	**Dec-09**
	All Critical Technologies TRL 6 (DOD Requirement)	
	All Critical Technologies TRL7 (Fully Mature)	
	Hold system requirements review	
	Hold preliminary design review	
	Constrain development phase to 6 years or less	
KP2	**Knowledge Based Practices at Design Review**	**May-12**
	All Critical Technologies TRL7 (Fully Mature)	
	Release at least 90 percent of design drawings	
	Test a system-level integrated prototype	
	Establish a reliability growth curve	
KP3	**Knowledge Based Practices at Production Start**	**Sep-20**
	All Critical Technologies TRL7 (Fully Mature)	
	Release at least 90 percent of design drawings	
	Identify critical manufacturing processes	
	Demonstrate critical processes are in statistical control	
	Demonstrate critical processes on a pilot production line	
	Test a production-representitive prototype	
	No data available / not applicable	
	Practice Implemented by Program	
	Practice Not Implemented by Program	

Adapted from GAO (2009, 2010, 2011, 2012a, 2013, 2014, 2015, 2016).

Figure 13. IAMD Compliance with GAO Best Practices

More than six years post Milestone B, IAMD announced that it had achieved full maturity in all critical technologies (GAO, 2016). According to the GAO, "IAMD completed its critical design review in May 2012 with a stable design and technologies nearing full maturity" (GAO, 2013, p.77). Although the program had released at least 90% of engineering drawings and held a system-level design review in May 2012, the DOD delayed completion of the design review until November 2012 due to interoperability issues with other programs such as the Patriot launcher. Unfortunately, due to the interoperability issues, the system could not test a fully integrated system-level prototype. A fully integrated system-level prototype was not tested until early 2014 (GAO, 2013). IAMD has not yet progressed through knowledge point 3 because the

Milestone C production decision has been delayed until September 2020 due to unsatisfactory results from the limited user test (DOD, 2016b).

2. Compliance with Better Buying Power Initiatives

IAMD conducted the following actions during program execution that demonstrated compliance with Better Buying Power 1.0 initiatives:

1. The 2009 Selected Acquisition Report stated that the program would use competitive prototyping (DOD, 2009b).

2. The 2010 Selected Acquisition Report stated that the program developed a data rights strategy to ensure open systems architectures and make acquisition of technical data rights more standardized (DOD, 2010c).

3. The 2011 through 2016 Selected Acquisition Reports indicated a stable production rate (DOD, 2011–2016).

4. The 2012 Acquisition Strategy incorporated many Better Buying Power initiatives including the following:

    - Market research to identify small businesses
    - FFP or FPIF contract type planned for production
    - Early focus on payload, protection, and performance
    - Early emphasis on achieving Reliability, Availability, Maintainability (RAM)
    - Roll down select strategy
    - Level III Technical Data Package (TDP) sought
    - Producibility and design for manufacturing
    - Maintainability to develop additional sources of hardware and software
    - Modular and open software architecture
    - Cost as an independent variable
    - (DOD, 2012a)

IAMD conducted the following actions during program execution that demonstrated compliance with Better Buying Power 2.0 initiatives:

1. The 2012 Acquisition Strategy incorporated collaboration through Integrated Product Teams (IPTs) as a method to control costs and build stronger partnerships in the requirements community (DOD, 2012a).

2. The 2012 and 2013 Selected Acquisition Reports indicated an increased emphasis on incorporating defense exportability features in initial designs by conducting foreign military sales feasibility studies (DOD, 2012–2013).

3. The 2013 and 2014 Selected Acquisition Reports indicated an increased use of performance based logistics (DOD, 2013–2014).

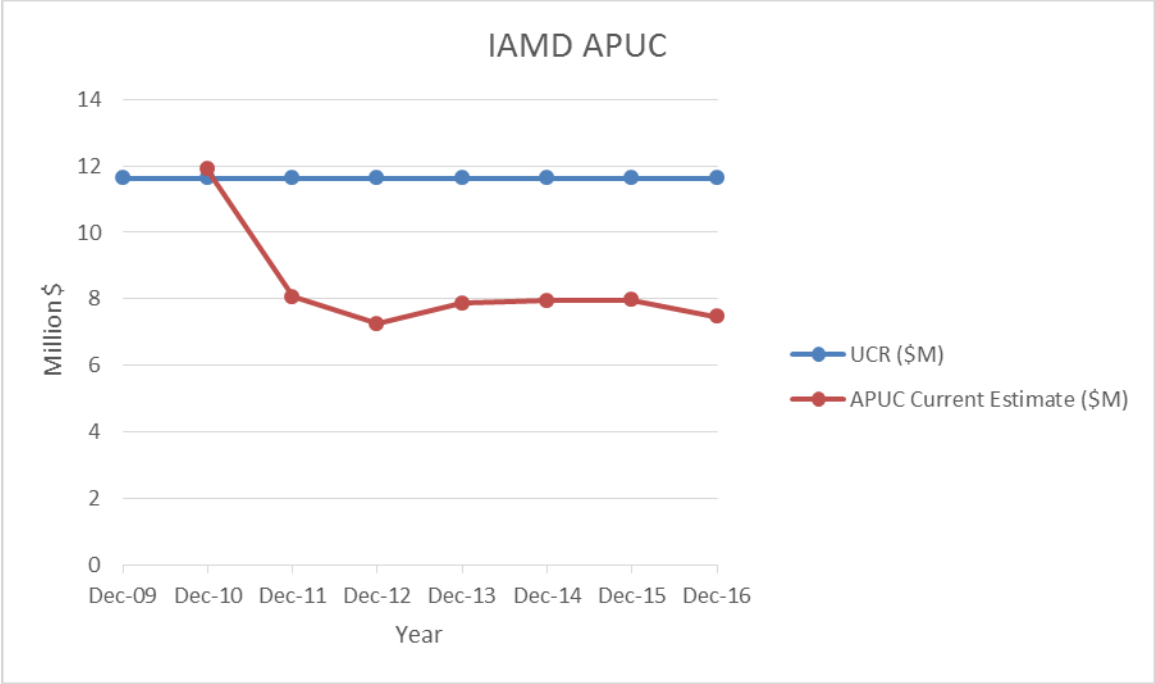
IAMD conducted the following actions during program execution that demonstrated compliance with Better Buying Power 3.0 initiatives:

1. Selected Acquisition Reports from 2009 to 2013 indicate that the program emphasized technology insertion and refresh in program planning (DOD, 2009–2013).

2. Selected Acquisition Reports from 2015 to 2016 report planned use of performance based logistics (DOD, 2015–2016).

3. APUC and Expenditures

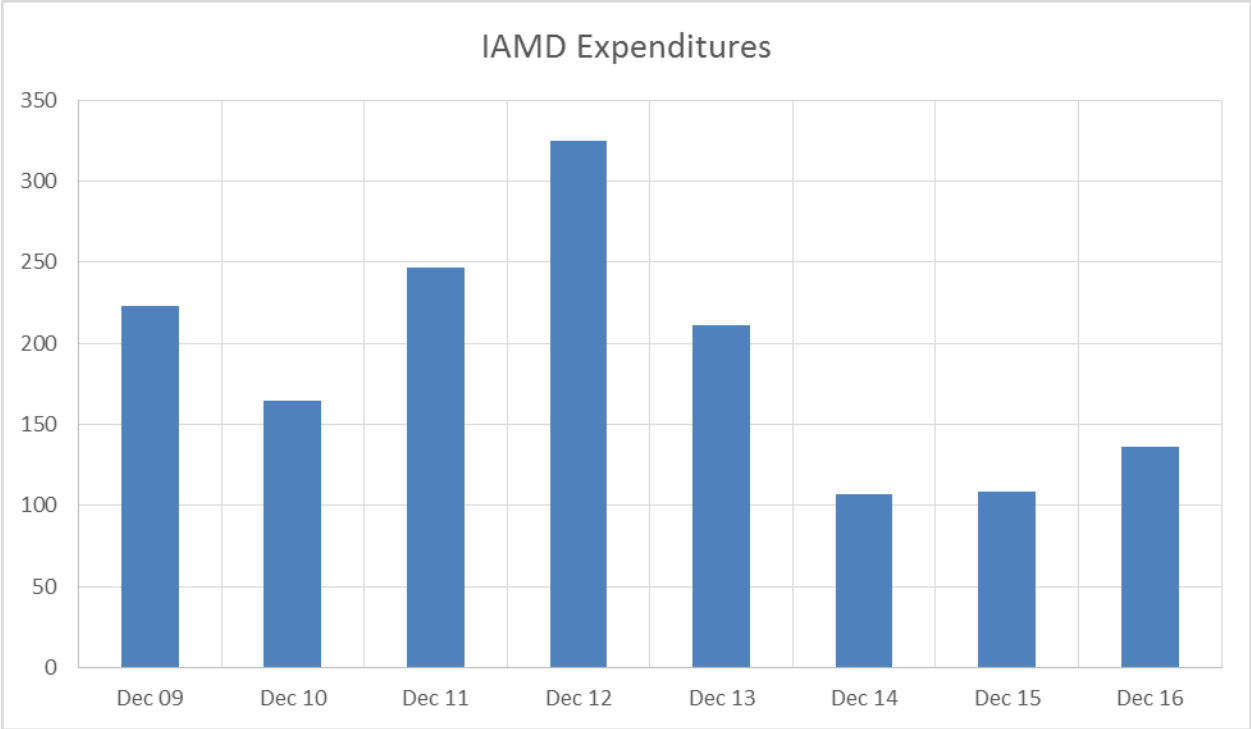
Selected Acquisition Reports for the IAMD program report deliveries and expenditures each year as well as the acquisition program baseline unit cost history. Converting all current estimates to same year dollars and graphing over time reveals the graph in Figure 14. As the graph indicates, the average program unit costs decreased from the original estimate in 2010 and remained consistently lower thereafter.



Adapted from DOD (2009b, 2010c, 2011d, 2012d, 2013c, 2014f, 2015f, 2016b).

Figure 14. IAMD APUC over Time

Further, graphing expenditures over time, as depicted in Figure 15, shows a random distribution of expenditures. There were no Nunn–McCurdy breaches in the time frame, again showing no pattern or relationship between expenditures and Nunn–McCurdy breaches.



Adapted from DOD (2009b, 2010c, 2011d, 2012d, 2013c, 2014f, 2015f, 2016b).

Figure 15. IAMD Expenditures and no Nunn–McCurdy Breaches

4. Analysis

At development start in 2009, the IAMD program had all of its critical technologies nearing maturity but they had not been demonstrated in a realistic environment as recommended by GAO best practices. Technology maturity is the number one factor mentioned by the GAO in determining if resources and requirements match. After factoring in the other elements of GAO best practices and the IAMD level of compliance, the overall qualitative score at knowledge point 1 is amber. The overall score at knowledge point 2 is also amber because the IAMD program did release approximately 90% of design drawings by the critical design review but failed to test a system-level prototype. The release of engineering drawings is considered the biggest factor in determining whether or not a product design is stable. Finally, the qualitative score at knowledge point 3 is un-assessable because production start is scheduled in September 2020 and the program has yet to identify critical manufacturing processes or demonstrate critical processes are in statistical control.

Our overall assessment of the IAMD program with regard to compliance with Better Buying Power initiatives is amber. In our research of program documents, we found a relatively high amount of information regarding efforts to employ initiatives corresponding to the topics and timeframes associated with Better Buying Power. Unlike the GMLRS program, we found no topic areas where the IAMD program was operating in opposition to Better Buying Power initiatives. Unfortunately, the IAMD program had a dramatic change in production quantities in FY 2015. The quantities prior to the dramatic change were stable, and since the change the quantities have remained stable through the most recent SAR in 2016. The 2012 Acquisition Strategy indicated that small businesses would not be capable of functioning as a prime contractor but could successfully perform as a subcontractor. In an effort to show compliance with BBP initiatives and comply with DOD policy, all contracts contained clauses to encourage small business opportunities in subcontracting. The program office also indicated a moderate level of compliance with BBP initiatives by reaching out to Army specialty programs to share program information with tier 1 and tier 2 countries in support of future Foreign Military Sales (FMS).

Requirement changes and production quantity changes have historically been very common reasons why programs incur Nunn–McCurdy breaches. Although the IAMD has experienced a significant amount of requirement additions through the years since development start, as well as a procurement quantity change in FY 2015, the program has remained below the original APUC estimate in 2010. Although there are significant externalities to any program that can cause unit cost to increase or decrease despite program initiatives, it certainly does not hurt the case for the IAMD program that it incorporated a relatively high level of compliance with GAO best practices and Better Buying Power initiatives from nearly program start.

Again, we are not able to establish causation stability of the APUC metric through the years. The program is subject to the same acquisition environment as the other programs but has found a way to stay below its APUC threshold. It is very convenient that the program established MS B during the most recent acquisition reforms. Its moderate compliance to BBP and GAO best practices may be a result of the continuous

focus on the initiatives since 2010. This is a strong qualitative relationship between BBP initiatives and lower cost growth.

C. PATRIOT ADVANCED CAPABILITY–3 MISSLE SEGMENT ENHANCEMENT

Patriot Advanced Capability–3 Missile Segment Enhancement (PAC-3 MSE) is an Army surface to air missile program designed to intercept and destroy tactical ballistic missiles and air-breathing threats. It is a follow-on variant of the PAC-3 missile and it began as a subprogram under the Patriot/Medium Extended Air Defense System Combined Aggregate Program (Patriot/MEADS CAP). On March 27, 2014, the DAE signed the Milestone C Acquisition Decision Memorandum (ADM) authorizing PAC-3 MSE to begin LRIP. The ADM also directed PAC-3 MSE be established as a separate ACAT 1D program because PATRIOT/MEADS CAP program was cancelled (DOD, 2015g).

The PAC-3 MSE started as a subprogram under the Patriot/Medium Extended Air Defense System Combined Aggregate Program (Patriot/MEADS CAP). Patriot/MEADS CAP stopped reporting in 2013 and as a result the PAC-3 MSE program was chartered in 2013 as an ACAT ID program (DOD, 2013e). In its time as a part of the Patriot/MEADS CAP program the missile program initially advanced as planned. Unsuccessful testing in FY 2009 caused a schedule and RDT&E APB breach as additional development and flight testing was deemed necessary (DOD, 2010d). The program did re-baseline, to include the APUC, in 2014 when the program began reporting separately from the Patriot/MEADS CAP program. The APUC number topped out in 2011, and since has continued to move lower. The program has consistently stayed below the re-baselined number and is now within 1% of the original APUC number (DOD, 2016c). During this era of the program, many Better Buying Power best practices are being implemented to include should cost management, increased competition, and achieving economies of scale (DOD, 2013a). Some of the APUC improvements could also be due to a streamlining of the product office through de-scoping the original Patriot/MEADS CAP and a maturing technology entering the latter testing phase of development.

1. Compliance with GAO Best Practices

The GAO did not collect data specifically on the PAC-3 MSE while it was a subsystem under PATRIOT/MEADS CAP. As a result, the GAO does not have any records indicating the missile program's technology maturity for PAC-3 MSE at development start in August 2004 or the critical design review in April 2006. Unfortunately, the only data specific to the PAC-3 MSE program was after it was designated as a separate ACAT 1D program.

Despite not having much data on the program prior to becoming an ACAT 1D program, there is a lot of data available for this system beginning in 2014. The program passed Milestone C in March 2014 with a stable design and mature technologies. The program also demonstrated critical process on a pilot production line but did not bring manufacturing processes under statistical control (GAO, 2016).

According to the GAO in 2016, "The Patriot Advanced Capability-3 Missile Segment Enhancement is leveraging the resources and development conducted by the Patriot/Medium Extended Air Defense System Combined Aggregate Program's Missile Unit sub-element" (GAO, 2016, p. 8). Figure 16 shows in table format the level of adherence to GAO best practices within the PAC-3 MSE program.

		PAC-3
KP1	**Knowledge Based Practices at Development Start**	Aug-04
	All Critical Technologies TRL 6 (DOD Requirement)	
	All Critical Technologies TRL7 (Fully Mature)	
	Hold system requirements review	
	Hold preliminary design review	
	Constrain development phase to 6 years or less	
KP2	**Knowledge Based Practices at Design Review**	Apr-06
	All Critical Technologies TRL7 (Fully Mature)	
	Release at least 90 percent of design drawings	
	Test a system-level integrated prototype	
	Establish a reliability growth curve	
KP3	**Knowledge Based Practices at Production Start**	Mar-14
	All Critical Technologies TRL7 (Fully Mature)	
	Release at least 90 percent of design drawings	
	Identify critical manufacturing processes	
	Demonstrate critical processes are in statistical control	
	Demonstrate critical processes on a pilot production line	
	Test a production-representitive prototype	
	No data available / not applicable	
	Practice Implemented by Program	
	Practice Not Implemented by Program	

Figure 16. PAC-3 MSE Compliance with GAO Best Practices. Adapted from GAO (2015, 2016).

2. Compliance with Better Buying Power Initiatives

PAC-3 MSE conducted the following actions during program execution that demonstrated compliance with Better Buying Power 1.0 initiatives through maintaining stable production quantities from 2004–2016 (DOD, 2004–2016).

PAC-3 MSE conducted the following actions during program execution that demonstrated compliance with Better Buying Power 2.0 initiatives:

1. Selected Acquisitions Reports from 2004 to 2016 show the use of FPIF contract types showing appropriate contract types (DOD, 2004–2016).

2. The April 25, 2013, Acquisition Strategy highlights the following initiatives:

- Enforce affordability caps with a 10% threshold.
- Implement should cost–based management by leveraging foreign military sales to gain economies of scale, working with the prime contractor to identify reductions, using FPIF contract types.
- Increase the use of fixed price incentive type contracts in LRIP.
- Performance-based logistics will be investigated as an option.
- Encourage competing break outs in order to improve competition and maintain a competitive environment.
- Implement and control open systems architectures and effectively use a data rights strategy to manage data rights (DOD, 2013a).

3. The January 24, 2014, Defense Acquisition Board shows the following initiatives:

- Reduce frequency of higher headquarters review with a request for delegation to an ACAT IC program.
- Utilize modification for system conversion in order to provide incentives for productivity and innovation within industry.
- Increase the level of tradecraft in acquisition of services by finding synergies with ongoing contracts to achieve economies of scale.
- Control costs throughout the product life cycle by decreasing test target cost with alternate targets (DOD, 2014b).

4. The Low Rate Initial Production Acquisition Decision Memorandum from March 27, 2014, establishes affordability caps (DOD, 2014d).

5. The January 16, 2015, Acquisition Program Baseline established affordability caps (DOD, 2015b).

6. The 2016 Selected Acquisition Report shows the following:

- Incorporate more defense exportability features in preliminary designs by approving foreign military sales.
- Reduce frequency of higher headquarters level review by delegating the program as an ACAT IC program (DOD, 2016c).

7. The April, 25,2013, Acquisition Strategy shows the following non-compliance of initiatives:

- Does not emphasize competition because the prime owns key data rights and no effective competition is anticipated
- Does not increase small business roles and opportunities because market research shows no feasible small business participation (DOD, 2013a)

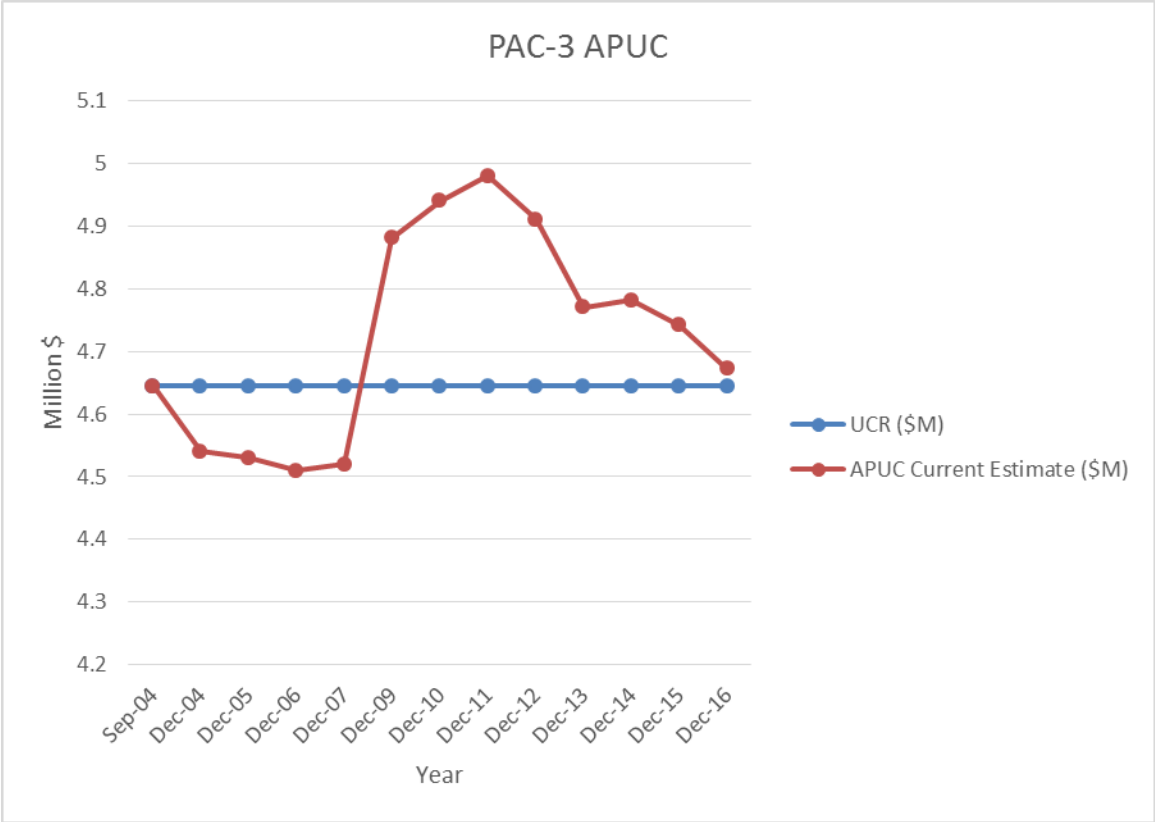
PAC-3 MSE conducted the following actions during program execution that demonstrated compliance with Better Buying Power 3.0 initiatives:

1. The April 25, 2013 Acquisition Strategy shows a tech refresh in incremental development (DOD, 2013a).

2. The 2015 and 2016 Selected Acquisition Report also shows a tech refresh strategy in place (DOD, 2015g, 2016c).

3. APUC and Expenditures

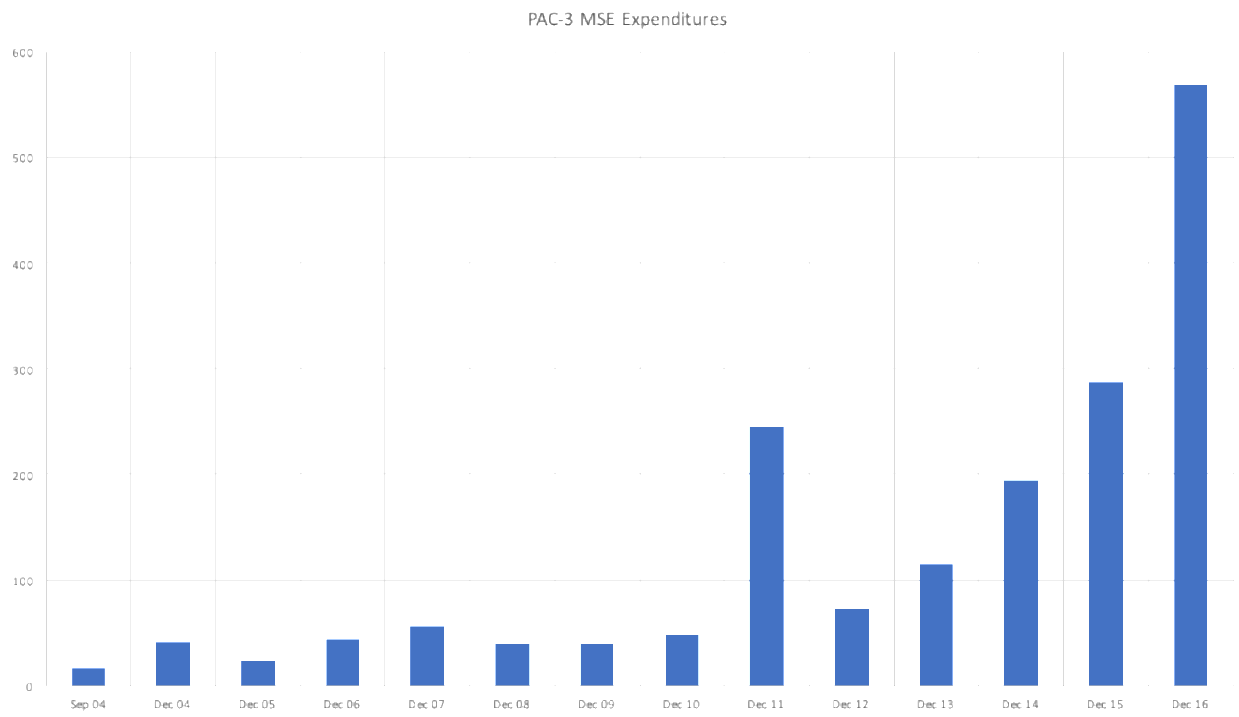
Selected Acquisition Reports for the PAC-3 MSE program report deliveries and expenditures each year as well as the Acquisition Program baseline unit cost history. Converting all current estimates to same year dollars and graphing over time reveals the graph in Figure 17. As the graph indicates, the average program unit cost has decreased steadily since the original estimate in 2014. PAC-3 MSE is a variation of the current PAC-3 missile, as a result the program office had substantial cost data available to support the PAC-3 MSE cost estimate but there were several design changes to the missile that made the confidence level in the cost estimate slightly lower. (SAR, 2015, 10).



Adapted from DOD (2004b, 2005b, 2006b, 2007b, 2009c, 2010d, 2011e, 2012e, 2013d, 2013e, 2014g, 2015g, 2016c).

Figure 17. PAC-3 MSE APUC over Time

Further, graphing expenditures over time, as shown in Figure 18, results in a generally positive linear trend. PAC-3 MSE did not commit any Nunn–McCurdy breaches.



Adapted from DOD (2004b, 2005b, 2006b, 2007b, 2009c, 2010d, 2011e, 2012e, 2013d, 2013e, 2014g, 2015g, 2016c).

Figure 18. PAC-3 MSE Expenditures and No Nunn–McCurdy Breaches

4. Analysis

The overall assessment of PAC-3 MSE for knowledge point 1 and knowledge point 2 is un-assessable due to a lack of data prior to being designated as an ACAT 1D program in 2014. The overall assessment at knowledge point 3 is amber because the PAC-3 MSE program incorporated mature technology, a stable design, and identified critical manufacturing processes prior to production decision. Although, according to the GAO, the program did not demonstrate that critical production processes were in statistical control prior to production decision.

After designation as an ACAT 1D program in 2014, the PAC-3 MSE Acquisition Strategy shows a great deal of effort toward incorporating nearly all elements of Better Buying Power initiatives with the exception of a few crucial areas. The biggest BBP initiative violation was with regards to the acquisition of technical data rights. The government did not possess the necessary data rights in order to support a competitive

acquisition strategy without the prime contractor's prior written approval. Additionally, much like the IAMD program, small businesses were not deemed capable of meeting acquisition requirements as a prime contractor and were not considered in competition. In order to show basic compliance with BBP initiatives and DOD policy, verbiage was written into contracts to encourage subcontracting opportunities for small businesses. As a result, the overall assessment of the PAC-3 MSE program with regards to Better Buying Power compliance is amber.

PAC-3 MSE did not incur any Nunn–McCurdy breaches since program restructure and designation as an ACAT 1D program in 2014. The program has shown a very high level of compliance with both GAO best practices and Better Buying Power initiatives. Despite having significant setback with restrictions in operational testing due to the deployment of a test battalion as well as further schedule delays from asset reallocation with the IAMD program, the program has maintained relatively stable. The prime contract also remained undefinitized during production start to allow a change in contract type from firm-fixed price to a fixed price incentive (firm target) but resulted in no significant increase to unit cost (GAO, 2016). Although there are numerous externalities that could account for overall success in reduction of cost growth since program restructure in 2013, there is certainly some degree of correlation between the level of GAO and BBP compliance and the reduction in cost growth despite significant setbacks in the program environment.

Patriot Advanced Capability-3 Missile Segment Enhancement is another example of a program's cost declining. While the program did re-baseline in 2014, declining APUC since a high in 2011 has the program back to the original APUC baseline. All of the decrease in APUC has occurred in the BBP era. Another example of a strong correlation between BBP and cost growth control. The program breached its APB for RDT&E cost and schedule in 2009, the same year as recent acquisition reforms. Although the APUC continued to increase for a few years into the BBP era, once the program APUC peaked, it has decreased every year since. Compliance with many BBP initiatives and the APUC decline cannot be ignored. Once again, strong correlation is observed between the BBP era and stable and/or declining APUC data.

D. WARFIGHTER INFORMATION NETWORK-TACTICAL (WIN-T) INCREMENT 2

According to the GAO,

> WIN-T is the Army's high-speed and high-capacity backbone communications network. WIN-T connects Army units with higher levels of command and provides the Army's tactical portion of the Global Information Grid. WIN-T was restructured following a March 2007 Nunn-McCurdy unit-cost breach of the critical threshold, and will be fielded in four increments. The second increment will provide the Army with an initial networking on-the-move capability. (GAO, 2012a, p. 133)

The program went through a Nunn–McCurdy process, and in 2007 was restructured into four increments. WIN-T Increment 2 is the initial networking on the move for Army division and/or brigade headquarters. In June 2007, an ADM established the program as post-MS B (DOD, 2007c). The program was approved for MS C and entry into production and development in February 2010. The program experienced a significant quantity increase causing procurement and O&S cost APB breach (DOD, 2010e). In 2013, WIN-T Increment 3, a concurrent program providing full on-the-move capability, was significantly de-scoped and the hardware requirements shifted to the WIN-T Inc.2 program (DOD, 2014h). The program experienced an RDT&E APB breach in 2015 due to additional requirements placed on the program. As the APUC numbers shift through time, there is a clear upswing FY 2013 to FY 2014 due to the additional requirements placed on the program from the de-scoping of WIN-T Inc.3. The SARs in addition to the documents such as the Acquisition Strategy from April 2015 indicate that the program is implementing many of the Better Buying Power best practices, but the requirements instability make it especially difficult to identify whether the program is meeting its affordability goals.

1. Compliance with GAO Best Practices

The original WIN-T program started development in July 2003 with none of its critical technologies mature and only three of the 12 critical technologies were approaching maturity. This general lack of technology readiness was cited as a major

factor in the June 2007 Nunn–McCurdy breach that caused the program to be restructured and broken down into increments (GAO, 2009).

In June 2007, WIN-T Increment 2 began development with seven of the 15 critical technologies fully mature or nearing maturity (GAO, 2010). In March 2008, the Office of the Secretary of Defense's Director of Defense Research and Engineering (DDR&E) approved Increment 2's technology readiness assessment. At the time of the assessment, DDR&E determined that 14 out of 15 critical technologies were either mature or approaching maturity. In November 2009, the DDR&E found that all critical technologies were at TRL 7.

According to the GAO report in 2010, "WIN-T Increment 2 completed a successful critical design review in February 2008" (p. 138). However, the GAO could not assess the design maturity of the system because their analysis method (number of engineering drawings released) was not a meaningful metric for the WIN-T program. Increment 2 did test a system level integrated prototype but there was no information in the GAO or SAR reports to indicate that the program completed a failure mode effects analysis. The system failed to demonstrate required performance and reliability metrics during operational testing. As a result, full rate production was delayed several times until reliability and performance of the system improved. (GAO, 2015).

The level of production maturity could not be assessed by the GAO because the program is a mostly integration of commercially available products. As a result, the program office did not report any critical manufacturing processes. According to the GAO in 2012, "the WIN-T program began production in February 2010 with manufacturing processes that had been demonstrated on a pilot production line, but were not in control" (p. 134). Thirteen months after production began, Increment 2 began testing a production representative prototype. By 2013, an Army manufacturing readiness assessment concluded that the program was in statistical process control but had not been demonstrated at production start. Figure 19 shows in table format the level of adherence to GAO best practices within the WIN-T Inc.2 program (GAO, 2015, 132).

		WIN-T Inc 2
KP1	**Knowledge Based Practices at Development Start**	**Jun-07**
	All Critical Technologies TRL 6 (DOD Requirement)	
	All Critical Technologies TRL7 (Fully Mature)	
	Hold system requirements review	
	Hold preliminary design review	
	Constrain development phase to 6 years or less	
KP2	**Knowledge Based Practices at Design Review**	**Feb-08**
	All Critical Technologies TRL7 (Fully Mature)	
	Release at least 90 percent of design drawings	
	Test a system-level integrated prototype	
	Establish a reliability growth curve	
KP3	**Knowledge Based Practices at Production Start**	**Feb-10**
	All Critical Technologies TRL7 (Fully Mature)	
	Release at least 90 percent of design drawings	
	Identify critical manufacturing processes	
	Demonstrate critical processes are in statistical control	
	Demonstrate critical processes on a pilot production line	
	Test a production-representitive prototype	
	No data available / not applicable	
	Practice Implemented by Program	
	Practice Not Implemented by Program	

Adapted from GAO (2009, 2010, 2011, 2012a, 2013, 2014, 2015, 2016).

Figure 19. WIN-T Inc.2 Compliance with GAO Best Practices

2. Compliance with Better Buying Power Initiatives

WIN-T Inc.2 conducted the following actions during program execution that demonstrated compliance with Better Buying Power 1.0 initiatives:

1. The 2007–2016 Selected Acquisition Reports show high, economical production rates, but not at a stable quantity (DOD, 2007–2016).

2. The March 8, 2010, Acquisition Strategy Report Annex incorporated the following initiatives:

   - Encourage open systems architectures and develop a data rights strategy.
   - Where appropriate, use FPIF contract type by using a 50/50 share line and 120% ceiling (DOD, 2010a).

3. The 2011 Selected Acquisition Report also shows the program would use a FPIF contract type where appropriate using a 50/50 share line and 120% ceiling (DOD, 2011).

4. The September 2012 Acquisition Strategy incorporated the following initiatives:

   - Use will cost/should cost management with targets identified in order to drive productivity.
   - Require open systems architectures and use an open standard system software approach to set rules for data rights acquisition (DOD, 2012b).

5. The May 8, 2013, Acquisition Program Baseline established an Army cost position, meeting the affordability requirement (DOD, 2013h).

6. The March 8, 2010, Acquisition Strategy Annex Report shows non-compliance in presenting a competitive strategy at each milestone as a justification and approval citing one responsible source is requested (DOD, 2010a).

WIN-T Inc.2 conducted the following actions during program execution that demonstrated compliance with Better Buying Power 2.0 initiatives:

1. The 2014 Selected Acquisition Report highlights to following initiatives:

   - Implement should cost–based management by implementing BBP best practices.
   - Emphasize competition and maintain a competitive environment at the sub-system level (DOD, 2014h).

2. The September 11, 2015, Acquisition Decision Memorandum delegated the program to an ACAT IC program in line with the reduced frequency of higher headquarters level review (DOD, 2015j).

3. The 2014 Selected Acquisition Report shows a justification and approval was requested for production (DOD, 2014h).

WIN-T Inc.2 conducted the following actions during program execution that demonstrated compliance with Better Buying Power 3.0 initiatives:

1. The 2014–2016 Selected Acquisition Reports indicate that a technology insertion and refresh in program planning strategy is implemented (DOD, 2014–2016).

2. The April 2015 Acquisition Strategy highlights the following initiatives:

   - Business case analysis recommends against the use of performance-based logistics.
   - Stimulate motivation by using a modular, open systems architecture.
   - Strengthen program planning and emphasize technology.
   - More actively utilize should cost management.
   - The program does not have a strategy to create and maintain competitive environments.
   - Increase small business participation. Try new ways of conducting market research (DOD, 2015d).

3. The May 8, 2015, WIN-T Efficiency Initiatives highlight the following initiatives:

   - Continue to set and enforce affordability caps.
   - Increase small business participation. Try new ways of conducting market research.
   - Achieve dominant capabilities while controlling LCC (DOD, 2015k).

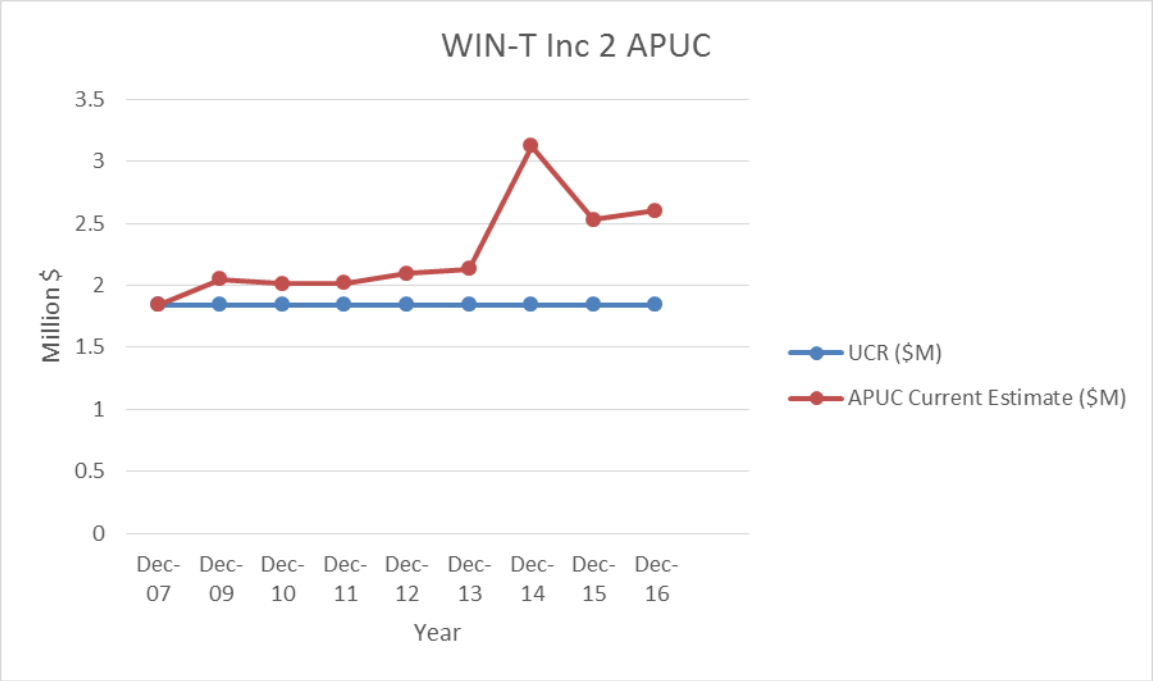
4. The June 3, 2015, Full Rate Production Acquisition Decision Memorandum highlights the affordability cap initiative by establishing caps (DOD, 2015j).

5. The 2015 Selected Acquisition Report highlights the following initiatives:

   - Continue to set and enforce affordability caps by updating cost thresholds.
   - Create and maintain competitive environments at the sub-system and below (DOD 2015d).

3. APUC and Expenditures

Selected Acquisition Reports for the WIN-T Increment 2 program report deliveries and expenditures each year as well as the acquisition program baseline unit cost history. Converting all current estimates to same year dollars and graphing over time reveals the graph in Figure 20. As the graph indicates, the average program unit costs increased from the original estimate in 2007 and remained consistently higher thereafter. According to the GAO in 2015, "The WIN-T Increment 2 program completed a restructure that increased procurement quantity by 3167 units resulting in a cost increase of more than $7.4 billion or 14 % over the past year" (p. 14).

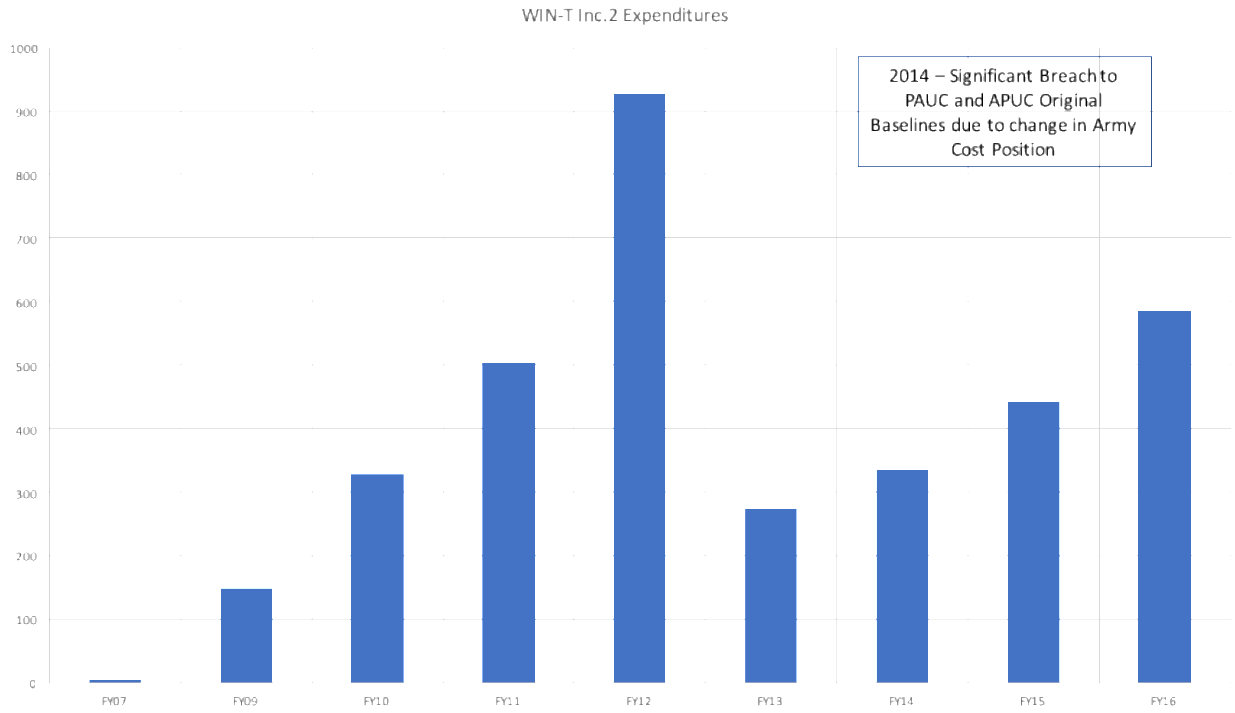


Adapted from DOD (2007c, 2009d, 2010e, 2011f, 2012f, 2013f, 2014h, 2015h, 2016d).

Figure 20. WINT-T Inc.2 APUC over Time

Further, graphing expenditures over time, as shown in Figure 21, results in two positive linear trends. The program experienced a significant Nunn–McCurdy breach to its original baseline PAUC and APUC. This is partly due to the incorporation of WIN-T Inc.3 requirements into the program. The factors leading up to the Nunn–McCurdy

breach can be explained through the requirements change and difficult to place on the execution of the program.



Adapted from DOD (2007c, 2009d, 2010e, 2011f, 2012f, 2013f, 2014h, 2015h, 2016d).

Figure 21. WIN-T Inc.2 Expenditures and Nunn–McCurdy Breaches

4. Analysis

The overall assessment of WIN-T Increment 2 at knowledge point 1 is red due to none of the critical technologies being fully mature at development start. We chose to qualitatively assess knowledge point 1 red rather than black for non-compliance because the GAO did note that the program held a preliminary design review and anticipated the development phase to be less than six years long. The overall assessment of the level of GAO compliance at knowledge point 2 is red due to critical technologies not being fully mature at the critical design review. Unfortunately, primary metric the GAO uses for determining design maturity was not a meaningful figure to a software intensive program such as WIN-T, therefore there was little other heavily weighted factors to consider in the

overall assessment at knowledge point 2. The overall assessment for WIN-T Increment 2 at knowledge point 3 is un-assessable due to a lack of reporting on critical manufacturing processes or statistical control.

The overall assessment for WIN-T Increment 2 with regards to compliance with Better Buying Power initiatives is amber. We found that the program attempted to incorporate a relatively high level of compliance with Better Buying Power initiatives with only a few notable exceptions. The most significant violation of Better Buying Power initiatives was during system development efforts when the program pursued a Justification and Approval (J&A) to issue a sole source Request for Proposal (RFP) for five years of RDT&E on a cost plus award fee contract with the prime contractor. Despite some variation in production rates and the sole source contract during development, the overall level of adhesion to BBP initiative is relatively high.

The program has incurred significant changes throughout its lifetime, and, even after the restructure in 2007, the program has suffered from dramatic changes and further restructuring. Changes and requirements and the elimination of Increment 3 as a hardware upgrade has caused huge changes in the unit cost since the beginning of acquisition reform. Software intensive programs such as WIN-T are particularly susceptible to cost growth as requirements for interoperability and the complexity of software continue to increase at nearly an exponential rate. APUC over time shows a steady increase during the acquisition reform era and expenditures provide relatively little insight into program efficiencies. Overall, there are too many externalities to draw a correlation between affordability and Better Buying Power implementation because any cost savings that may have resulted in reform initiatives were eclipsed by the variations in costs due to the nature of the program in the acquisition environment.

E. WARFIGHTER INFORMATION NETWORK-TACTICAL (WIN-T) INCREMENT 3

The WIN-T Increment 3 basic description is the same as Increment 2 however, the Army restructured the program again in 2014 by de-scoping all hardware

development in Increment 3. Currently, increment 3 provides software enhancements only to the existing WIN-T network to improve network capacity and robustness.

Warfighter Information Network-Tactical Increment 3 (WIN-T Inc.3) was established through an ADM in May 2009 (DOD, 2009e). The program continued in the EMD phase until October 2011 when an Army configuration steering board (CSB) de-scoped the program requirements and identify technology to insert into WIN-T Inc.2 (DID, 2011g). In 2012, a decrement to the FY 2014 President's budget caused a realized schedule APB breach (DOD, 2012g). Another CSB held in 2013 further de-scoped the program requirements and the FY 2014 Appropriations Act reduced RDT&E (DOD, 2013g). In 2014, the WIN-T Inc.2 program office proposed strategy called for re-structuring the program into a software only program and transfer any hardware requirements to the WIN-T Inc.2 program (DOD, 2014i). The program was further decremented the program causing further realignment of resources (DOD, 2015i). Testing activities continued until the final SAR submission in December 2016 (DOD, 2016e). As with WIN-T Inc.2 the APUC data is inconclusive. In 2014 with the removal of all hardware items, APUC was no longer reported as there were no longer units to assess an average cost against. The funding decrements and subsequent program restructuring make it difficult to determine the efficacy of program initiatives planned.

1. Compliance with GAO Best Practices

The nature of WIN-T changed dramatically since program start in July 2003. The restructure that occurred in 2007 created Increment 2 and Increment 3. For the purpose of this case study, we are most interested in compliance with GAO best practices before and after the implementation of Better Buying Power in 2010. Therefore, this case study is focused on WIN-T Increment 3 from June 2007 through 2017. As a result, our analysis includes compliance with GAO best practices before program restructure in 2014 as well as compliance with GAO best practices after the restructure in 2014.

When the WIN-T program was restructured in June 2007, WIN-T Increment 3 had 19 critical technologies and only three were mature. Eight of the 19 critical technologies were reported to be nearing maturity in 2007. In 2010, the program office

issued a statement to the GAO indicating that there were 20 critical technologies and none of them would be TRL 7 until production decision in May 2013 (GAO, 2010).

In 2014, the GAO reported that the program had 18 critical technologies, 12 of those technologies were mature and six were nearing maturity after the CDR in December 2013. However, the Army's configuration steering board in November 2013 resulted in another restructure of the WIN-T program. As a result, Increment 3 was de-scoped from 18 critical technologies to only nine. This decision eliminated all hardware technologies thus resulting in a software only program.

Much like Increment 2, the program office for Increment 3 did not track the metric that the GAO uses for determining design maturity. The GAO uses percentage of engineering drawings released as a foundation for determining design maturity but Increment 3 was never a manufacturing effort even before the 2014 restructure. As a result, the GAO could not produce estimates toward compliance with best practice recommendations. However, the GAO did note that WIN-T Inc.3 was delayed 22 months in testing a system level prototype. According to the GAO in 2014, "WIN-T Increment 3 reported use of other knowledge-based practices to increase confidence in the stability of their product's design. Those practices include the identifying key product characteristics; identifying critical manufacturing processes; conducting producibility assessments to identify manufacturing risks; and completing failure modes and effects analysis to identify potential failures and early design fixes" (GAO, 2014, p. 33). Figure 22 shows in table format the level of adherence to GAO best practices within the WIN-T Inc.3 program.

		WIN-T Inc 3
KP1	**Knowledge Based Practices at Development Start**	**Jun-07**
	All Critical Technologies TRL 6 (DOD Requirement)	
	All Critical Technologies TRL7 (Fully Mature)	
	Hold system requirements review	
	Hold preliminary design review	
	Constrain development phase to 6 years or less	
KP2	**Knowledge Based Practices at Design Review**	**Dec-13**
	All Critical Technologies TRL7 (Fully Mature)	
	Release at least 90 percent of design drawings	
	Test a system-level integrated prototype	
	Establish a reliability growth curve	
KP3	**Knowledge Based Practices at Production Start**	**N/A**
	All Critical Technologies TRL7 (Fully Mature)	
	Release at least 90 percent of design drawings	
	Identify critical manufacturing processes	
	Demonstrate critical processes are in statistical control	
	Demonstrate critical processes on a pilot production line	
	Test a production-representitive prototype	
	No data available / not applicable	
	Practice Implemented by Program	
	Practice Not Implemented by Program	

Adapted from GAO (2009, 2010, 2011, 2012s, 2013, 2014, 2015, 2016).

Figure 22. WIN-T Inc.3 Compliance with GAO Best Practices

2. Compliance with Better Buying Power Initiatives

WIN-T Inc.3 conducted the following actions during program execution that demonstrated compliance with Better Buying Power 1.0 initiatives:

1. The June 25, 2011, Acquisition Strategy highlight the following initiatives:

   - Where appropriate, utilize FPIF contract with a 50/50 share line and 120% ceiling. The strategy highlights multiple contract types as the program moves through the acquisition life cycle.
   - Set rules for data rights acquisition and encourage open systems architectures (DOD, 2011a).

2. The 2009 Selected Acquisition Report states an Army cost position is in review in compliance with setting affordability caps (DOD, 2009e).

3. The 2010 Selected Acquisition Report indicates an Independent Cost Estimate is generated in compliance with setting affordability caps (DOD, 2010f).

4. The 2012 Selected Acquisition Report indicates that will cost/should cost management measures are being used (DOD, 2012g).

5. The June 25, 2011, Acquisition Strategy and 2011 Selected Acquisition Report highlight the failure to incorporate competition at each milestone. The program utilizes a sole source contract citing one responsible source (DOD, 2011a).

WIN-T Inc.3 conducted the following actions during program execution that demonstrated compliance with Better Buying Power 2.0 initiatives:

1. The 2009–2016 Selected Acquisition Reports show the program transitioning from CPAF to CPIF contract types in line with employing appropriate contract types (DOD, 2009–2016).

2. The June 25, 2011, Acquisition Strategy states that performance-based logistics will be considered as part of the life cycle sustainment plan (DOD, 2011a).

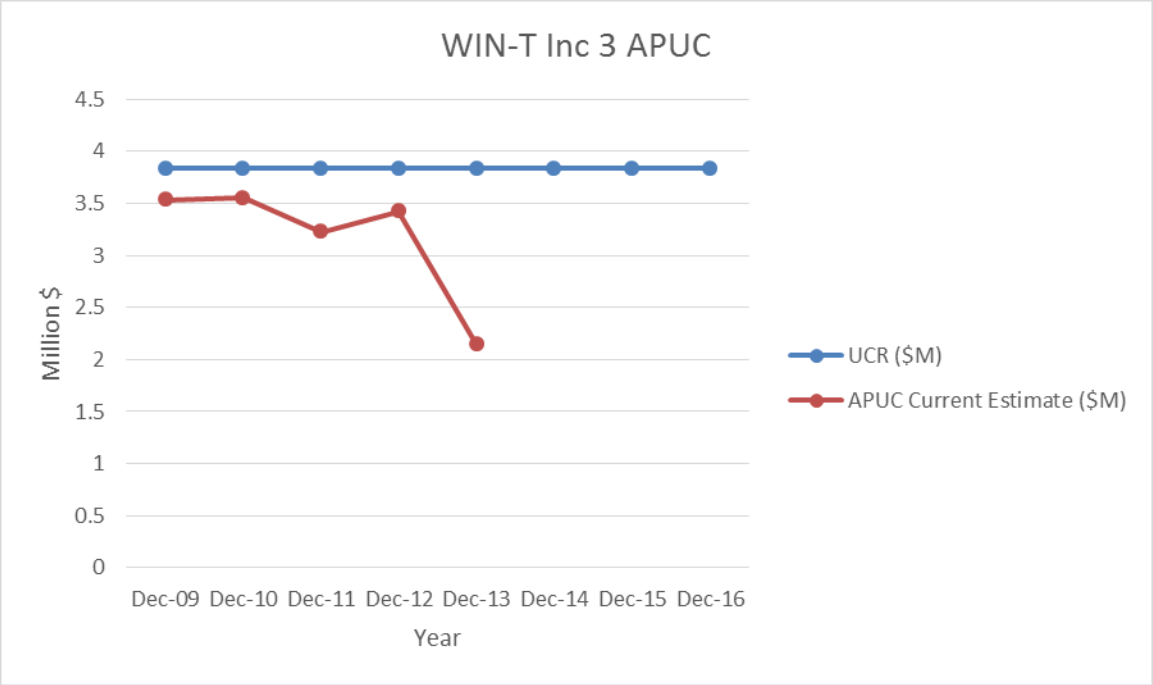
3. The 2011 Selected Acquisition Report indicates the program is attempting to control costs and build stronger partnerships in the requirement community (DOD, 2011g).

4. The September 15, 2014, Acquisition Program Baseline states an Army cost position is established in line with affordability caps (DOD, 2014a).

The June 25, 2011, Acquisition Strategy indicates the program is planning for technology insertion and refresh in compliance with Better Buying Power 3.0 initiatives (DOD, 2011a).

3. APUC and Expenditures

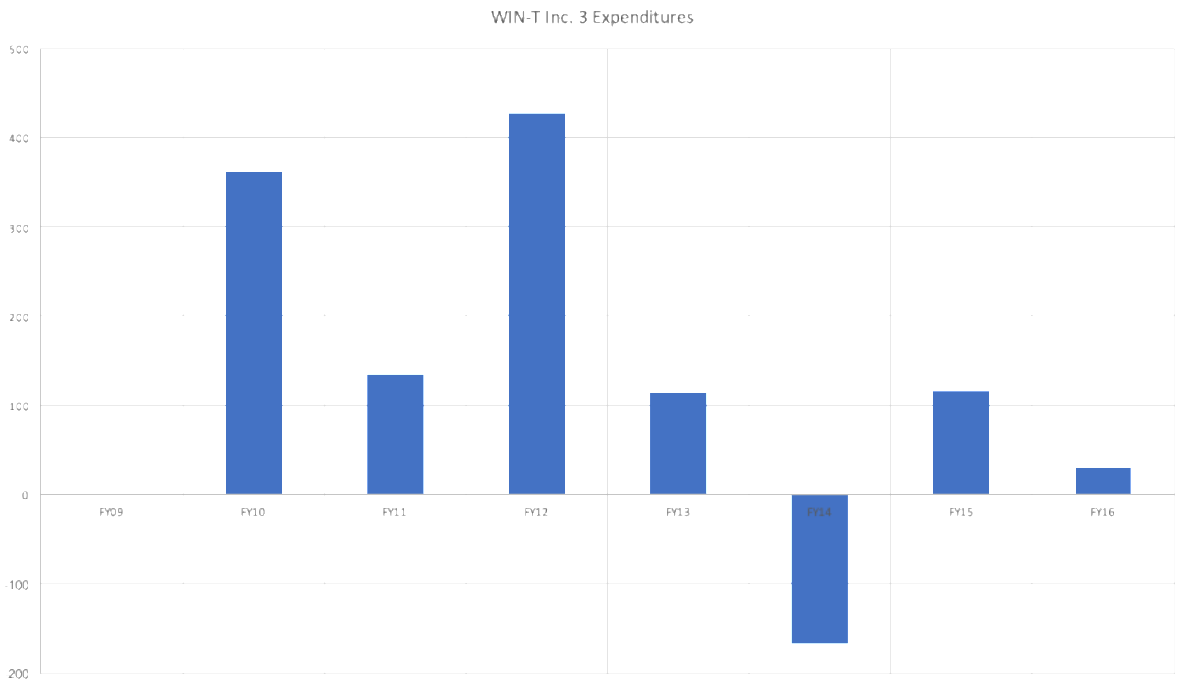
Selected Acquisition Reports for the WIN-T Increment 3 program report deliveries and expenditures each year as well as the Acquisition Program Baseline unit cost history. Converting all current estimates to same year dollars and graphing over time reveals the graph in Figure 23. As the graph indicates, the average program unit costs decreased from the original estimate in 2009 and remained consistently lower thereafter. WIN-T Increment 3 program completed a restructure in 2014 that made it a software only procurement. As a result, there APUC was no longer a meaningful unit of measure for the program.



Adapted from DOD (2009e, 2010f, 2011g, 2012g, 2013g, 2014i, 2015i, 2016e).

Figure 23. WIN-T Inc.3 APUC over Time

Further, graphing expenditures over time, as shown in Figure 24, results in a generally positive linear trend. WIN-T Inc.3 experienced a significant de-scoping of requirements in FY 2014.



Adapted from DOD (2009e, 2010f, 2011g, 2012g, 2013g, 2014i, 2015i, 2016e).

Figure 24. WIN-T Inc.3 Expenditures and No Nunn–McCurdy Breaches

4. Analysis

The overall assessment of WIN-T Increment 3 at knowledge points 1 and 2 are the same as Increment 2 for the same reasons. Increment 3 is also un-assessable at knowledge point 3 due to a lack of reporting on critical manufacturing processes or statistical control.

The overall assessment for WIN-T Increment 3 with regards to compliance with Better Buying Power initiatives is also very similar to WIN-T Increment 2 for nearly all the same reasons. Both programs shared the same prime contractor as well as the same acquisition environment from program initiation in 2007.

APUC and expenditures dramatically decreased over time in an opposite manner as WIN-T Increment 2 due to the way the programs were restructured. Unit costs for Increment 3 went down while Increment 2 increased due to project de-scoping for Increment 3 and the addition of hardware requirements for Increment 2. Overall, we

found it difficult to draw correlation between Better Buying Power reform efforts and actual cost savings using WIN-T as a case study.

A summary of the overall qualitative assessment at each knowledge point is depicted in Figure 25.

		GMLRS	IAMD	PAC-3	WIN-T Inc 2	WIN-T Inc 3
GAO	KP1					
	KP2					
	KP3					

Figure 25. Qualitative Assessment of Program Compliance with GAO Best Practices.

A summary of all the factors that contributed to the overall score is found in Figure 26.

Better Buying Power Initiative	GMLRS	IAMD	PAC-3	WIN-T Inc 2	WIN-T Inc 3
Better Buying Power 1.0: June 2010 - April 2013					
Mandate Affordability as a Requirement					
Drive Productivity growth through Will Cost/Should Cost management					
Make producition rates economical and hold them stable					
Increase the use of FPIF contract type where appropriate using a 50/50 share line and					
Present a competitive strategy at each program milestone					
Require open systems architectures and set rules for acquisition of techical data rights					
Increase dynamic small business role in defense marketplace competition					
Better Buying Power 2.0: April 2013 - April 2015					
Mandate Affordability as a requirement					
Enforce Affordability Caps					
Implement "should cost" based management					
Build stronger partnerships with the requirements community to control costs (CSBs)					
Increase incorporation of defense exportability features in initial designs					
Employ appropriate contract types					
Increase use of Fixed Price Incentive contracts in Low Rate Initial Production					
Increase effective use of Performance-Based Logistics					
Reduce Frequency of higher headquarters level review					
Emphasize competition strategies and create and maintain competitive environments					
Enforce open system architectures and effectively manage technical data rights					
Increase small business roles and opportunities					
Use the Technology Development phase for true risk reduction					
Better Buying Power 3.0: April 2015 - Present					
Continue to set and enforce affordability caps					
Strengthen and expand "should cost" based cost management					
Employ appropriate contract types, but increase the use of incentive contract types					
Ensure Effective use of Performance-Based Logistics					
Increase the use of prototyping and experimentation					
Emphasize technology insertion and refresh in program planning					
Use Modular Open Systems Architecture to stimulate innovation					
Create and maintain competitive environments					
Increase small business participation, including more effective use of market research					
Overall Average Level of BBP 1, 2, 3 Compliance					

	No data available / not applicable
	Complete Compliance
	Relatively High Compliance
	Relatively Low Compliance
	Non-Compliance

Figure 26. Qualitative Assessment of Program Compliance with Better Buying Power Initiatives

V. CONCLUSION AND AREAS FOR FURTHER RESEARCH

Better Buying Power has been a part of defense acquisitions since 2010. As of 2017, the initiatives are in their third iteration. While none of the initiatives are particularly unique or innovative, they were emphasized by two consecutive defense acquisition executives. Since the inception of BBP, data finds that cost is either growing at a slower rate or declining for most programs. In our analysis of a subset of five Army programs, we found this to be true. The acquisition environment, however, makes it difficult to attribute cause to any one factor. Requirements will change, budgets are not stable, and technology risk will never be completely mitigated, but it is significant that since the inception of BBP, cost growth does appear to be controlled relative to years prior. One constant in the acquisition environment since 2010 is the continued emphasis of BBP. This stability in an otherwise fluid environment leads us to correlate the decreased cost growth to BBP and its initiatives.

A. CONCLUSIONS TO THE RESEARCH QUESTIONS

(1) Is the affordability success in defense acquisition programs the product of the implementation of BBP?

We looked at affordability by analyzing how average procurement unit price estimates change over time. We selected five Army programs to examine. Data was collected from DAMIR and DAVE for analysis. The quantitative data came from Selected Acquisition Reports. These reports offer a yearly view of how programs are executed. The APUC data collected does show that cost growth is at a lower rate than prior to the implementation of BBP. Finding causation in a fluid environment is difficult. Isolating environmental effects and analyzing them individually is extremely challenging. In an unstable fiscal environment, it is now almost normal to begin each fiscal year under a continuing resolution (CR). The waterfall of effects on programs stemming from a CR can include programs forced to stretch their schedules, cut quantities to remain on schedule, or many other actions. This interaction between factors further complicates the ability to isolate any of the environmental effects in the acquisition system. Better Buying Power is yet another factor in the environment. It is a constant, however, making it

unique among the environment. This, however, is only enough to establish a correlation of Better Buying Power initiatives to reduced cost growth. This correlation is also based on a relatively small sample size. Even though BBP 1.0 was published in 2010, it is unreasonable to assume that it had immediate effects. The GAO began to highlight effects of BBP in its 2013 report, indicating that it took two years for the initiatives to begin being implemented by acquisition programs. In effect, the affordability success is based on four years of data. Further data will be needed to further establish this correlation, but current programs are seeing a positive trend in cost growth reductions.

(2) How well are programs implementing the Better Buying Power initiatives?

Of the five programs analyzed for this project all of them, to some degree, implemented initiatives identified in the Better Buying Power memos. Of the programs, GMLRS and PAC-3 MSE complied most extensively with the various BBP initiatives. These two programs also realized a decline in APUC in doing so. While this is not conclusive evidence that BBP is major reason for observed declines in cost growth, it is another positive correlative factor. The bigger take away, is that all five programs analyzed mentioned BBP initiatives in their acquisition documents and their reports. At the very least, the emphasis of BBP from senior acquisition officials is making its way throughout the Army acquisition community. This steady drumbeat of emphasis is a part of the acquisition environment. Whether this constitutes a change in the acquisition culture is up for debate, but at the very least BBP initiatives are a significant part of the acquisition climate.

(3) Does a review of cost data from Selected Acquisition Reports corroborate the cost savings being touted by the GAO and USD(AT&L)?

The APUC data, the most common metric for establishing affordability metrics, supports the GAO and USD(AT&L) findings that cost growth is declining. From our subset of programs, we are not able to assess whether or not the portfolio as a whole is less expensive. Considering the WIN-T programs as outliers due to the significant

reshaping of each program, GMLRS, IAMD, and PAC-3 MSE all saw the APUC either go down or grow at a slower rate.

B. AREAS OF FURTHER RESEARCH

(1) Look at Outlier Programs

The first area of recommended research is to examine programs identified by OUSD(AT&L) as outliers. The 2015 *Performance of the Defense Acquisition System* listed 27 DOD programs as outliers. That year, the GAO reported the DOD portfolio to include 78 MDAPs and MAIS programs (GAO, 2015). That is almost 35% of the portfolio experiencing cost growth between 153% as a low and 2197% on the high end. Our research purposefully left these programs out of the analysis, but the large number of outliers deserve a hard look at what is happening. With so many programs experiencing such significant cost growth, portfolio affordability will difficult to achieve.

(2) Is Affordability Good for Acquisitions?

As mentioned in both BBP and GAO reports, the technological edge the United States has is being tested by our enemies. The GAO further asserts that the DOD aversion to risky acquisition strategies is due to the emphasis on affordability. Performance is being traded for affordability by many programs (GAO, 2016). This may be an unintended consequence of achieving affordability, it must be further explored. Resources will continue to be limited, but if we are sacrificing our technological advantage for affordability, we must find ways to overcome.

(3) Affordability Metrics

As identified in this project, the most common measure of affordability is through APUC estimates. While this approach provides a single metric that is easy to understand and compare, it may not be the best metric for measuring affordability. The DOD maintains that programs are not stretching schedules or adjusting quantities to avoid growth in their APUC estimate. The fact remains however, that this type of gaming is possible and programs are able to adjust their data to maintain the appearance of affordability. Further research into a better method for establishing affordability caps is

needed to ensure that programs that are not affordable receive the scrutiny they deserve in an era where weapon systems are becoming much more complex and expensive. We must ensure that our resources are being by programs that are truly affordable.

(4) Lasting Effects of Better Buying Power

Will Better Buying Power continue to exist in a new administration? Has the work Ash Carter and Frank Kendall put forth changed the culture of the acquisition community? Many of the initiatives of Better Buying Power are not new and many have been in practice in some form or another in individual programs for years. The current defense acquisition executive (in December 2017) is the Honorable Ellen Lord. Will she continue to emphasize these best practices? And if she does not, will the initiatives continue to guide how program offices develop their acquisition strategies?

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