THWARTING ANTIQUATION

Efficient Decisions and Effective Systems for the US Air Force

Tristan A. Caruso

WRIGHT FLYER PAPERS

Air Command and Staff College

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Foreword

It is my great pleasure to present another issue of The Wright Flyer Papers. Through this series, Air Command and Staff College presents a sampling of exemplary research produced by our resident and distance-learning students. This series has long showcased the kind of visionary thinking that drove the aspirations and activities of the earliest aviation pioneers. This year's selection of essays admirably extends that tradition. As the series title indicates, these papers aim to present cutting-edge, actionable knowledge—research that addresses some of the most complex security and defense challenges facing us today.

Recently, The Wright Flyer Papers transitioned to an exclusively electronic publication format. It is our hope that our migration from print editions to an electronic-only format will foster even greater intellectual debate among Airmen and fellow members of the profession of arms as the series reaches a growing global audience. By publishing these papers via the Air University Press website, ACSC hopes not only to reach more readers, but also to support Air Force–wide efforts to conserve resources. In this spirit, we invite you to peruse past and current issues of The Wright Flyer Papers at https://www.airuniversity.af.edu/AUPress/Wright-Flyers/.

Thank you for supporting The Wright Flyer Papers and our efforts to disseminate outstanding ACSC student research for the benefit of our Air Force and war fighters everywhere. We trust that what follows will stimulate thinking, invite debate, and further encourage today's air, space, and cyber war fighters in their continuing search for innovative and improved ways to defend our nation and way of life.

EVAN L. PETTUS
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Acknowledgements

After working in Electronic Warfare for over ten years and seeing how slow we have progressed in this important area of interest since the first Gulf War, I decided to investigate why many of our weapon systems maintain the same capability they were originally fielded with decades earlier. I found that a combination of our current acquisition process, financial management regulation, and several Air Force Instructions or directives prevented our ability to get capability out to the warfighter quickly. In essence, we have let ourselves become incapacitated by many unnecessary rules, regulations, and processes, and somehow seemed to have forgotten about what is important, the mission. I want our senior leaders to understand that our adversaries are not playing by the same rules. They are inserting advanced capabilities into their weapon systems at a far greater pace than us. The threats are real and our national security interests are at stake. We need to take risks. I would rather take a risk and fail than not take a risk and fail. I want to win the next conflict. I want to change the way we think in the Air Force. Let's make smart decisions and eliminate the unnecessary bureaucracy.

I would like to thank several individuals who have not only encouraged me throughout the years, but have peer reviewed certain sections of this paper for technical accuracy. I would like to thank my course instructors Dr. Steven Shirley and Dr. Fred Stone for their guidance during the research process. After many debates with both of them, I have to concede that their ideas greatly improved the final outcome of my research paper. I would like to thank the Section 809 Panel team for answering my financial questions and for their brilliant and comprehensive study which was used extensively throughout my paper. I would like to thank Matt Moorman for reviewing the supply chain sections, Dell Norris for reviewing the financial / appropriation sections, and Matthew Bryant for reviewing my recommendations for improvement. I would also like to thank Danette Lister for years of unwavering support, Remon Bradley for teaching me how to become a true leader with integrity, and Don Foran for training me to become one of the best electronic warfare engineers in the Air Force. Most importantly, I would like to thank my wife for her patience. There were many nights and weekends of sacrifice and yet she patiently endured.

Abstract

Using the problem solution framework, this research paper examined how United States weapon systems can end up in a continuous cycle of antiquation and stagnation during the Operations and Support phase of the acquisition lifecycle and offers solutions to address such scenarios. Several United States weapon systems maintain the same capability they were originally fielded with decades earlier. Key findings, such as a risk averse culture, system requirements falling below the Program Objective Memorandum cut line, misinterpretations of financial guidance, strict sustainment regulations, a cumbersome acquisition processes, and higher than necessary decision-making, were found to contribute to the underlying problem. This research paper presented several solutions that resolve a segment of the inclusive problem. Solutions were weighed against overall feasibility, the benefit to the warfighter, and any potential risks associated with implementation. The final recommendation includes consolidating and exploiting financial regulations to the warfighters advantage, allowing increased flexibility with Operations and Maintenance funding, allowing additional flexibility and performance increases in F3I redesigns, leveraging leading-edge commercial technology wherever possible, and changing the mentality of sustainment from maintaining readiness to maintaining relevance. The conclusion emphasizes the United States Air Force is technologically falling behind near-peer adversaries and senior leaders must think like the adversary to ensure US regulations do not inhibit the Air Force's ability to traverse through the OODA loop faster than the enemy.

Introduction

The United States has held air superiority in every engagement since the Korean War; however, several indicators suggest air superiority may no longer be guaranteed in future conflicts.[1] US adversaries may bridge the technological disparity within the next several years.[2] In some instances, such as hypersonics and electronic warfare, they are potentially ahead of the US.[3] Russia has extensively increased its surface-to-air missile (SAM) capabilities over the last several decades. Their latest S-500 SAM system was reported to successfully hit a target nearly 300 miles out.[4] China has heavily invested in its military over the last decade and has now reached a critical point of confidence where it is actively challenging US forces in the South China Sea.[5] They have claimed large swaths of the sea and built and militarized artificial islands within the Spratly and Paracel archipelagos, threatening the sovereignty and stability of several Southeast Asian nations. The US appears powerless to stop this newfound Chinese aggression.

The problem may stem from how the US operates and funds its military programs. The US Air Force defines sustainment as maintaining the existing baseline capability of a weapon system. Any means to improve a weapon system beyond its existing performance threshold is considered a development engineering effort and requires funds from the research development test and evaluation (RDT&E) appropriation.[6] Many systems do not obtain RDT&E funding once fielded and are usually funded with the operations and maintenance (O&M) appropriation for the remainder of their life cycles. Creative efforts to use O&M funding to advance system capability and counter evolving threats are usually denied by financial managers due to the strict interpretations of current financial regulations in place.[7] This leaves integrated product teams (IPTs) with little choice but to make less meaningful changes to their weapon systems to keep them operationally relevant.[8] The outcome is the systems often become ill-matched shortly after being fielded.

Not only is the US making bad financial decisions, but it's also slow at making them. Acquisition time cycles have increased over the last several decades. Current estimates from senior leaders in the USAF place the time from awarding a contract to fielding a system in excess of 10 years.[9] US adversaries function on acquisition cycles that are at least twice as fast.[10] Several major defense acquisition programs (MDAP) have been canceled over the last two decades. In fact, the Department of Defense (DOD) has spent over $46 billion on programs that will never be fielded.[11]

To solve this problem, new initiatives such as Section 804 Rapid Acquisition and Hack the DOD 5000 are receiving considerable attention. While they

do not solve appropriation issues, they seek to shorten the acquisition time cycles. Speed is now being emphasized as the principal consideration, after decades of cost being the primary factor in acquisition decision-making. Using the problem/solution framework, this paper will examine how US weapon systems end up in a cycle of antiquation and stagnation and what solutions can be implemented to effectively sustain US weapon systems.

This paper will first articulate the problem, describing several inefficient supply chain policies within the Consolidated Sustainment Activity Group (CSAG) and Air Force Sustainment Center (AFSC). It will then discuss system obsolescence and reliance on commercial technology, followed by the DOD's slow acquisition process. The problem section will conclude with a detailed analysis of current appropriation restrictions along with several USAF culture issues.

The solution section will begin by defining specific evaluation criteria. The paper will present several potential solutions, along with recommended actions. Each solution will then be evaluated in detail against the prescribed criteria, including any potential risks in implementation. Other solutions that were considered but not recommended will also be discussed. Finally, the paper will conclude with a quick summary of the problem, final recommendation, and why this research is relevant to the USAF.

The Problem, Background, and Significance

The CSAG was forecasted to spend approximately $12.5 billion on sustaining reparable and consumable assets for the USAF in FY18.[12] While these efforts were essential for getting warfighters back into the field, they provide the warfighter with no additional capability to do so. The average USAF aircraft is now more than 28 years old, and in many instances, the components being repaired are well over 30 years old.[13] In essence, the CSAG is spending billions to maintain the same capability that weapon systems had 30 years ago.[14]

The AFSC has the ability to redesign components to address maintainability, reliability, or obsolescence issues using sustaining engineering funds, but 448 Supply Chain Management Wing (SCMW) Instruction 63-118 states that sustaining engineering funds cannot be used for modifications that change the form, fit, function, interface (F3I) or increase the performance of a system.[15] The AFSC has also begun some initiatives like the improved item replacement program (IIRP) to redesign shop replaceable units (SRUs) and line replaceable units (LRUs) in which some capability improvements may be achieved; however, these initiatives are rare. In addition, the redesign is almost solely focused on reliability and maintainability improvements.[16] The

IIRP regulation explicitly states, "added performance or capability enhancements must be incidental and not intentional."[17] The IIRP requires the item to be a form, fit, function replacement, which severely prohibits the USAF's ability to move toward newer technology.

The vendors who developed or designed these outdated parts are moving away from the military sector and are focusing their efforts on the more lucrative commercial sector, a problem known as "vanishing vendors."[18] Between 2011 and 2015, roughly 17,000 companies that supply the US military have left the defense market.[19] Besides shrinking budgets, one of the largest causes of this exodus is the nature of AFSC operations. The problem usually begins when a part used in an active weapon system experiences diminishing manufacturing sources and material shortages/obsolescence (DMSMS/OB) issues. If the part has any sort of demand, this drives IPTs to condemn failed assets that cannot be repaired. This instigates a buy to replenish spare assets. However, since there is DMSMS/OB on the part, additional spares cannot be procured. At this point, a redesign is sought out. Vendors sought for repair provide little to no response because there is minimal incentive for companies to establish a production or repair line for low-demand items, usually fewer than 10 per year.[20] The process described above usually takes several years. Often by the time a redesign is pursued, the part is either on backorder or is causing a mission-impaired capability awaiting parts (MICAP). A MICAP indicates that the weapon system is now out of service awaiting material on a particular end item.[21] MICAPs lower the overall fully mission capable rate of systems and can cause mission degradation at the operational level.[22]

The AFSC redesign process for a single part normally spans several years as well. The part being redesigned is typically over 30 years old and leverages technology prevalent at that time. Attempts to leverage current technology generally change the F3I of a system or provide a significant performance benefit. F3I requirements are levied to reduce risk and to prevent the redesign from becoming unmanageable, a phenomenon known as "requirements creep." Unfortunately, these stringent regulations have negative effects which can stifle creativity.

For example, voltage-controlled oscillators (VCOs) were at one time the primary means for generating frequencies in analog systems. Unfortunately, VCOs had poor frequency range coverage, set-on accuracy, and warm-up times.[23] Direct digital synthesis is the digital replacement for an analog VCO and resolves many of its performance limitations at the expense of increased complexity.[24] This redesign would be disallowed, as it changes the interface and provides a performance benefit. In essence, the final outcome of an AFSC redesign would end up reproducing the same analog technology the system

was initially fielded with, in this case, a "new" VCO. However, the redesigned part is now only produced by a few select vendors since a majority of the industrial base has now shifted efforts to focus on emerging commercial technologies.

F3I requirements continue to limit meaningful redesigns. 448 SCMW Instruction 63-118 explains what constitutes an F3I replacement. For instance, form encapsulates the "dimensions, shape, size, mass, appreciable weight and other visual parameters that uniquely distinguish a part of an asset which negatively impacts adjacent components, requiring modification or reconfiguration for installation."[25] Fit is the how the part "physically attaches to, or integrates with an adjacent component or higher level assembly."[26] Function is how the part performs its designated capability. Interface is how the part interacts with adjacent parts or the system as a whole. Despite these definitions, it could be said that F3I is a matter of perspective. For example, redesigning components within an SRU can affect F3I at the SRU level, but viewing the redesign at the next higher assembly or from the LRU's perspective, the changes can prove to be inconsequential. Likewise, altering SRUs within an LRU can impact F3I at the LRU level but can be negligible at the system level.

Imagine that an aircraft cockpit is still using a cathode ray tube (CRT) display, which is now obsolete. A CRT's obsolescence can be addressed by replacing it with a liquid-crystal display or light-emitting diode (LED) display, but this would drive a change in the input connector and cable as well. The new input connector and cable would drive a change to the interface. Therefore, the redesign does not conform to F3I requirements, and the only remaining option besides obtaining RDT&E funding would be to find a vendor who can still produce a "new" CRT display to uphold F3I requirements. The more practical solution would be to view the redesign at the next higher assembly, which would include the cable and connector. However, based on existing regulations, the redesign project would typically not be sanctioned since the SRU itself does not conform to F3I requirements.

Obsolescence and Reliance on Commercial Technology

The USAF primarily considers obsolescence as a problem that arises due to the lack of availability, but obsolescence can also be examined as a part, LRU, or system that can no longer meet its applicability, otherwise known as "functional obsolescence."[27] Although the system is still available and in good working order, it is unable to effectively perform its intended function.

Today, the DOD is almost solely reliant on leveraging technological advancements within the commercial sector; however, this was not always the case.[28] Radar, global positioning system, and the internet were all originally

US military innovations.[29] In 1960, United States defense-related research and development (R&D) accounted for 65 percent of the total US R&D; however, by 2016, it only accounted for 24 percent of the total.[30] In fact, the US share of global R&D had decreased from 69 to 28 percent during the same period.[31] With the end of the Cold War and the decisive victory of the first Gulf War, US policymakers saw large investments in the military as unnecessary. Hundreds of military installations and facilities were closed under the Base Realignment and Closure Act.[32] The number of B-2 bombers was reduced from a planned total of 132 to just 21 aircraft.[33] The F-22, once touted as a marvel of American ingenuity, was now labeled as a Cold War relic.[34] In 2019, the US military was in a very different situation. US adversaries did not share this post-Cold War mindset and heavily invested in emerging technologies such as hypersonics, electronic warfare, and artificial intelligence.[35] They were on track to level the playing field and diminish the asymmetrical advantage the USAF has become accustomed to. Several Russian and Chinese weapon systems are already in parity with the US.[36] China has been able to accelerate its military modernization through acquiring advanced foreign weapon systems and reverse engineering them at a fraction of the original R&D cost.[37]

Technology has increased in sophistication since the advent of World War II. Practically all aircraft weapon systems today rely on some form of computer technology to accomplish their intended mission. Thirty years ago, computers that displayed color were just emerging, and the typical computer processor contained a single core which ran at a 10–16 MHz clock speed.[38] Today's processors contain up to 18 cores at 4.50 GHz, a potential increase of 8,000 times the computing power. By limiting weapon systems to technology that was prevalent 30 years ago, the USAF is providing its adversaries with a considerable advantage. Analog electronic warfare systems are still prevalent within fourth-generation fighters, which contain physical limitations on the type of technique responses that can be produced.[39] US adversaries are incorporating newer technologies into their aircraft, such as digital radio frequency memory (DRFM) jammers,[40] which can overcome these physical limitations through advanced digital processing techniques.[41] A DRFM jammer can digitize incoming signals, manipulate them, and retransmit them back to deceive enemy radars without any loss of quality within the original signal, whereas an analog memory loop causes signal degradation over time. Incorporating DRFM jammers in legacy aircraft gives the USAF more advanced capabilities within the highly contested radio frequency spectrum.[42]

The Slow, Inefficient Acquisition Process and Why Speed Matters

Since World War II, acquisition programs have also experienced a considerable increase in developmental timeframes. For instance, the B-17 Flying Fortress progressed from design to flight test in 12 months.[43] During World War II, the US procured over 60 different light, medium, and heavy bombers, many of which flew in combat.[44] On the other hand, present-day estimates place the timeline from development to first flight at about 10 years to procure new missile-warning replacement architecture.[45] Granted, US weapon systems today are considerably more sophisticated and expensive than those utilized during World War II. However, according to Maj Gen David Thompson, then-vice commander of the Air Force Space Command, US adversaries currently have development cycles that are at least twice as fast.[46] By the time the USAF fields a new capability, it is potentially a generation behind the adversaries'. A large part of the issue is the bureaucracy involved in the decision-making process. Major acquisition programs have approximately 50 layers of activities that must be accomplished before a program manager engages with a decision maker.[47] Many of these layers require some form of transitional approval before moving to the next layer. These intermediate decision points can add months or years to the decision-making cycle, delaying critical capabilities from reaching the warfighter.[48]

Speed is a primary factor considered in almost every Air Force decision. In an acquisition program, it determines when a capability will be delivered or when a gap in capability will be met. How fast US adversaries deliver their capabilities matters as well. Their decisions will affect US decisions, and US decisions will drive theirs. These are the fundamental principles behind Col John Boyd's decision-making theory, the Observe, Orient, Decide, Act (OODA) loop. Colonel Boyd stated that military leaders must transcend through the OODA loop faster than their enemy to achieve victory.[49] Not only is reducing friction within the friendly OODA loop necessary, one must generate friction within the adversary's OODA loop. The ultimate goal is strategic paralysis of the enemy. For instance, economic sanctions on Iran have slowed down their nuclear development.[50] The Stuxnet cyberwarfare operation targeted and destroyed hundreds of Iranian centrifuges, severely crippling their nuclear program. This operation set back their nuclear program by at least two years.[51]

DOD Directive 5000.01, DOD Instruction 5000.02, and Federal Acquisition Regulation (FAR) are comprehensive regulations that govern the acquisition and sustainment of weapon systems, services, and automated information systems.[52] The current method for modification of weapon systems

dictates that permanent modifications must be treated as an acquisition program.[53] This is a significant hindrance in rapidly fielding capability because of the unwieldy acquisition process.[54] The modification process begins through AF Form 1067, which seeks approval for the modification,[55] then follows a 60-step process that seeks approval from decision makers at numerous milestones and requires the generation of copious documentation.[56] In some instances, the government will spend more money on managing the modification than the actual cost of the modification itself.

One asset in navigating the cumbersome acquisitions process is Dr. William Roper's (assistant secretary of the Air Force for acquisition, technology, and logistics) rapid acquisition memorandum, which allows IPTs to take risks and skip unnecessary steps within the process. Although this memorandum greatly speeds up the acquisition process, it does not address the numerous appropriations issues IPTs face. In addition, the longevity of the memorandum is still in question since a determination of its permanence has not been made.[57]

Recently, other transactions (OTs) have gained increased prominence in the acquisition community; they allow IPTs greater speed and flexibility in awarding, executing, and conducting research, development, and prototyping activities not typically afforded in traditional FAR-based contracts. OTs do not have to be funded by the RDT&E appropriation; they are meant to expand the industrial base of contractors available to the US government, hasten the acquisition process during award and execution, and leverage emerging commercial technology to meet the DOD's needs.[58] Three types of OTs are authorized under Title 10 US Code: research, prototype, and production.[59] Each OT activity contains specific provisions. For instance, the research OT cannot duplicate research being conducted among other DOD programs, while the prototyping OT must utilize at least one nontraditional defense contractor.[60] OTs are mentioned in Dr. Roper's rapid acquisition memorandum as a viable means to expedite the acquisition and contracting process, which aligns with his overall vision of achieving greater speed and flexibility in acquisition decision-making.[61]

Appropriation Restrictions

Another substantial restriction facing IPTs are the different types of appropriations, and the constraints that accompany them. The three primary appropriations used in the acquisition and sustainment of weapon systems are RDT&E, procurement, and O&M.

Many weapon systems do not receive RDT&E or procurement dollars after fielding and typically are funded with O&M funding for the remainder of

their life cycle. O&M funding has severe restrictions on the type of work that can be accomplished, which are defined in the DOD Financial Management Regulation (FMR) 7000.14-R Volume 2A, Air Force Instruction (AFI) 65-601, and Air Force Manual (AFMAN) 63-143.[62] Contracting officers and financial managers often flag O&M-funded efforts that attempt to insert additional capability into weapon systems and require IPTs to treat the change as a development engineering effort rather than a maintenance engineering effort. This drives IPTs down an extensive modification process.

But first, IPTs must first obtain RDT&E and procurement funding through the program objective memorandum (POM) process. The POM process is typically projected two years out. For instance, if an IPT initiated a POM for requirements in FY19, they would receive their funding in FY21 if their request was deemed a priority. POMs are reviewed and prioritized among all Air Force weapon systems by the Office of the Secretary of Defense and Joint Staff.[63] In essence, a 30-year-old weapon system will have to compete for funding against the joint strike fighter (JSF) program, greatly diminishing the likelihood of obtaining modification funds. The JSF program was recently estimated to consume approximately 41 percent of the USAF's procurement budget,[64] forcing other programs to delay purchases due to a lack of remaining procurement funding.[65]

Currently, IPTs are required to use RDT&E appropriations for all developmental activities defined as bringing a program to its objective requirements.[66] This may sometimes be a moving target. Imagine a US weapon system—System A—which was originally required/designed to defeat an enemy weapon system: Threat X. System A performed this task effectively for several years. However, over time Threat X was modified and its key system attributes were improved. System A is now unable to defeat the improved Threat X. It no longer meets its original objective requirement; System A is now functionally obsolete. An IPT attempts to use O&M funding to conduct a hardware modification to System A to keep pace with Threat X's advancements. When conducting their early strategies and issues session (ESIS) or acquisition strategy panel (ASP), IPTs are denied the use of O&M funding to modify System A, since the hardware modification would increase the system performance beyond its original baseline specifications. At this point, the IPT has no choice but to wait for RDT&E funding, which may never arrive, leaving System A operationally irrelevant for the remainder of its life.

Many weapon systems today are sustained using centralized asset management (CAM) associated funding. Under CAM, O&M dollars are further separated into different subactivity groups (SAGs) and Air Force element of expense/investment codes (EEIC). These budget codes further segregate Air

Force funding based on the type of work defined in a SAG or EEIC. For instance, EEIC 56000 is utilized for contract software maintenance, while EEIC 583 is used for deficiency investigations.[67] Currently, program managers, financial managers, material leaders, and senior material leaders do not have the flexibility to reprogram funds across the different appropriations, nor do they have the ability to reprogram funds across the different SAGs within a single appropriation. Program executive officers have some flexibility in moving funds within an appropriation using below threshold reprogramming (BTR); however, there are restrictions associated with this process.[68] BTRs have severe threshold limits and cannot be used to change the congressional intent of the original funding.[69] None of the parties above have the authority to realign 56000 funds to 583—even though both funding streams are aligned under the O&M appropriation—since this reprogramming action could change congressional intent. Both 56000 and 583 are considered maintenance engineering activities, so reprogramming funds from one to another could still potentially meet congressional intent. However, because of strict regulations, financial managers view the two appropriations as software maintenance versus sustaining engineering and will prohibit the realignment.

There is little guidance on how to reprogram from one EEIC to another, as it is not explicitly mentioned in the FMR. Instead, each year Congress releases additional CAM guidance that further restricts the movement of funding. For instance, in FY19 organic software maintenance funding (540) cannot be realigned to contract software maintenance (560) to satisfy the "50/50 rule" which stipulates that at least 50 percent of the workload must be accomplished by an organic entity.[70] Sustaining engineering (583) and contractor software maintenance (56000) are in different SAGs entirely and cannot be realigned.[71] Rules like these make it difficult to manage programs effectively. In some instances, the organic depot no longer has the technical ability to sustain the weapon system due to the senior technical workforce leaving or retiring; therefore, the government is more reliant on contractor support.[72] Other cases where the organic depot preferred to realign their limited manpower to support newer weapon systems have left legacy weapon systems with little to no engineering support. All these scenarios are common, and each of them would drive the IPT to realign funds appropriately.[73] Unfortunately, the congressional CAM rules prevent the realignment of funds from organic to contractor sustainment and can eventually drive the weapon system toward a gap in supportability.

Moving money from one EEIC to another can be vital to program success. O&M funding is initiated through the POM process two years in advance, during which numerous changes can take place. Enemy threats can evolve

through hardware or software upgrades, driving IPTs to implement appropriate weapon system countermeasures to continue to be effective against objective threats. Major commands (MAJCOMs) might reactivate parts of a weapon system or resurrect entire weapon systems. In addition, entire areas of responsibility can shift, driving the need to counter developing threats. For example, in 2011 the Obama Administration announced that the US would be increasing its role in the Asia-Pacific region, specifically targeting China.[74] This pivot was geared toward protecting US interests, securing peace, and ensuring that maritime freedom of navigation was upheld in the region.[75] Similarly, a weapon system in sustainment requires the flexibility to utilize one or more EEICs necessary to counter unforeseen developments.

Air Force Culture Issues

For many, sustainment typically refers to "the process of keeping a weapons system or other technology in good working condition," also known as maintaining readiness.[76] In reality, it necessitates keeping the weapon system operationally relevant through technology improvements, modifications, and upgrades and addressing factors such as obsolescence, reliability, and maintainability.[77] All these activities ensure weapon systems perform their intended function.

A common misconception within the defense acquisition community is that operations and support (O&S) and O&M are identical.[78] O&S is a phase in the acquisition life cycle that sustains the weapon system through a variety of activities such as unit operations, maintenance and repairs, training, and continuing system improvements.[79] O&M is an appropriation used for some O&S activities. O&M activities can include maintenance, repair, overhaul, and technology refreshes (the intentional insertion of newer technology into end items that increases reliability, availability, maintainability and can even include minor performance benefits).[80] In FY18, O&M accounted for over 42 percent of the DOD's discretionary budget—a substantial amount of resources expended simply to maintain readiness.[81] However, financial managers assert that modifications that increase performance are considered investments rather than expenses because of strict interpretations of Section 010201 of FMR DOD 7000.14-R Volume 2A.[82] Many weapon systems do not keep pace with the adversary due to these misconceptions.

How the DOD measures success matters as well. The US spends more on the military than the next seven countries on the list combined, yet is still potentially falling behind in several key defense sectors, including hypersonics and the electromagnetic spectrum.[83] Today, the DOD measures success

using metrics such as budgeting dollars executed, mission capable rate, total flying hours, and maintenance hours, and overlooks factors such as technological and functional obsolescence prevalent in various DOD parts and weapon systems.[84] Obligating budgeted dollars and awarding contracts on time usually constitute program success; however, these metrics are inconsequential if the weapon system being sustained is operationally irrelevant.

The three primary measurement criteria for acquisition programs are cost, performance, and speed. Reducing cost has been the primary focus among acquisition activities for the last several years, but speed is now being emphasized as the primary driver.[85] Initiatives like Section 804 Rapid Acquisition seek to shorten developmental cycles by adopting modern processes such as agile software development, which breaks tradition with the waterfall method of software development found in many DOD acquisition programs.[86] Instead of achieving 100 percent of performance objectives at the end of extensive, drawn-out schedules, agile software development objectives are incrementally delivered, providing key opportunities for customer feedback.[87] This not only allows for evolving design changes later in the process, but it ultimately achieves a higher quality product in line with the customer's original vision. Section 804 seeks to achieve this through rapid prototyping of both hardware and software products.

Evaluation Criteria, Possible Solutions, Final Recommendation and Implementation

Each of the alternatives presented below addresses only a part of the overarching problem of weapon system sustainment versus innovation. For instance, the inclusive problem encompasses policies contained within the CSAG and the AFSC, the FAR, the FMR, and the Air Force's culture. Each individual solution seeks to address one or more of these subissues. Individual solutions are not mutually exclusive, and the final recommendations may encompass several individual solutions. Senior leaders may not agree with all solutions presented below or with the final recommendation; however, they may choose to implement one or more of the ensuing solutions they believe would be beneficial to the warfighter.

Evaluation Criteria

Each solution is evaluated on warfighter merit, the feasibility of implementation, and potential risk.

- Warfighter merit is the solution's overall benefit to the warfighter, including how the solution enables IPTs to keep weapon systems operationally relevant. Warfighter merit will be classified using three distinct categories: low, medium, high. For instance, if there is currently only one path that allows IPTs to insert new capability into a weapon system and a solution provides an additional path, the solution would have high warfighter merit.
- Feasibility is defined as the solution's overall practicality of implementation. Feasibility will also be classified using low-medium-high categories. For example, a solution that recommends rewriting all US Title 10 code would have low feasibility because Title 10 comprises more than 2,500 pages of law that governs the Armed Forces of the US and is only updated annually by Congress;[88] however, a solution that recommends changing a few paragraphs within an AFI would have high feasibility, since AFIs are updated frequently at the service level.
- Finally, any potential risks in a solution must be identified to reduce bias. These risks will not be categorized and will be discussed instead. Any potential mitigations to acknowledged risks will be identified.

Solution 1: Encourage IPTs to "Hack the FMR" in Favor of the Warfighter

AFMAN 63-143 regulates CAM funding, which is the centralized O&M process that sustains many Air Force weapon systems. This funding is broken out into several subcategories including sustaining engineering funding, or EEIC 58300. This EEIC is employed to investigate, address, and resolve system level technical or supportability deficiencies. It includes efforts such as "defining the characteristics and cause of such deficiencies; determining the impact on the affected system; identifying and evaluating alternative solutions; determining the preferred solution; and designing, integrating, and validating the solution."[89] This generically worded language can encompass a variety of technical efforts. Sustaining engineering falls under maintenance engineering, where "the general objective is to sustain the fielded system to the approved specification."[90] The CAM guidance indicates that efforts that substantially improve the performance of the system may be best funded under RDT&E.[91]

The keywords here are "substantially" and "may." Nowhere in the guidance is "substantially" defined, leaving the word open for interpretation. The word "may" indicates that RDT&E funding is usually the preferred method for funding performance improvements; however, it is not the only method explicitly allowed. Therefore, one could potentially exploit CAM and FMR guidance to the warfighter's advantage.

Recommended Action: With senior leader support, IPTs can take bolder risks and creatively develop solutions that address the growing functional obsolescence in weapon systems.

Evaluation: Since this solution would require no change in regulation but would involve a culture shift throughout the Air Force, the overall feasibility is considered high. The warfighter merit is considered medium since this would allow IPTs the decision-making authority to adjudicate FMR guidance to benefit the warfighter.

One clear risk is the potential for abuse. This risk can be alleviated through the effective use of the IPT structure and the chain of command. For instance, if someone within the IPT disagrees with a programmatic decision, the decision authority can be elevated to the next IPT level in the chain of command for arbitration.

Solution 2: Consolidate Financial Management Guidance and Allow Additional Flexibility with O&M Funding

Currently, there is conflicting guidance between when and where O&M funding can be utilized for sustainment activities. For instance, AFI 65-601V1 states that weapon system redesigns that improve system performance would be considered development engineering efforts and must be funded under the RDT&E appropriation.[92] However, FMR DOD 7000.14-R Chapter 1 allows the use of O&M funding for minor performance upgrades via technology refreshes.[93] Today, program managers and financial managers see O&M-funded efforts that increase performance as a misappropriation of funds and require IPTs to unnecessarily POM for RDT&E funds; this may be a misinterpretation of the FMR.[94] This conflicting guidance makes it difficult for IPTs to plan meaningful program sustainment activities. Essentially, as soon as IPTs obtain the proper funding, they are behind the curve and are attempting to catch up to the adversary.[95] Figure 1 depicts a typical decision loop IPTs encounter while sustaining weapon systems.

Recommended Action: The ideal solution would be to update FMR DOD 7000.14-R Chapter 1 and AFI 65-601V1 with clear guidance that allows IPTs to use O&M funds for minor, and even moderate, system redesigns or technology refreshes where some improvement in capability is achieved. This will not only address the underlying DMSMS/OB issues but also keep weapon systems operationally relevant. Major development activities or upgrades should continue to be funded using the RDT&E appropriation. Financial regulations can implement funding thresholds to clearly delineate what constitutes a minor/moderate upgrade versus a major upgrade. This may also re-

quire changing the current dollar thresholds between what comprises an investment versus an expense under FMR DOD 7000.14-R Chapter 1. The threshold for an expense is currently capped at $250,000.[96]

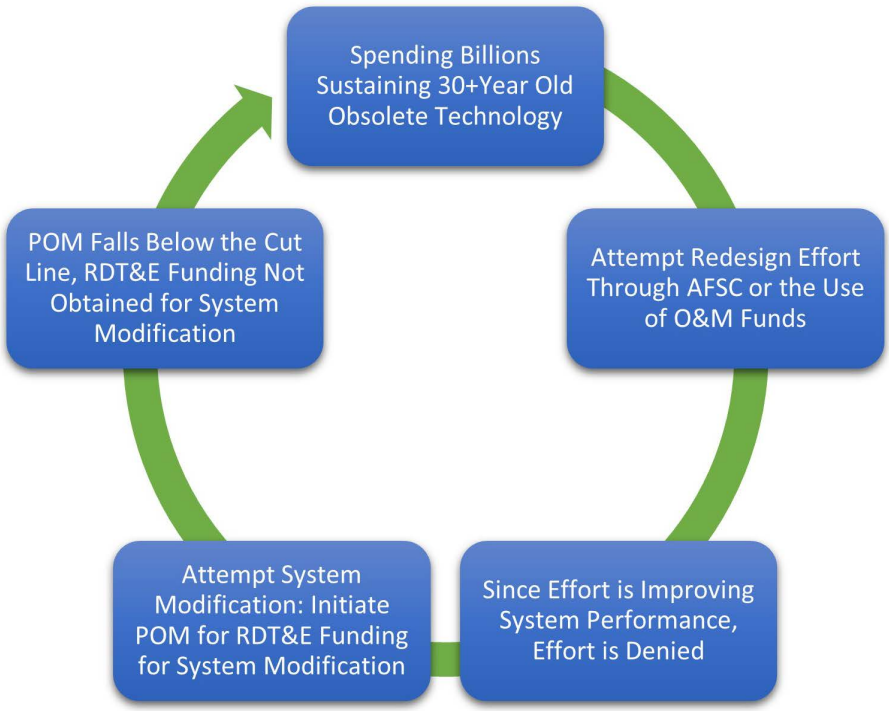

Figure 1. How Weapon Systems Become Stagnant

An ideal example of an RDT&E effort is the F-15 Eagle Passive Active Warning Survivability System program, which is a substantial upgrade/replacement of the legacy Tactical Electronic Warfare System.[97] Potential O&M efforts include replacing analog parts or LRUs with digital components or incorporating state-of-the-art central processing units and graphics processor units into weapon systems to address DMSMS/OB and leveraging the increased performance benefits associated with the effort.

Evaluation: Since this solution requires the consolidation and reevaluation of existing financial management guidance, including FMR DOD 7000.14-R Chapter 1 and AFI 65-601V1, the overall feasibility is considered medium. The warfighter merit would be considered high since this solution would provide IPTs with clear guidance that minor, or even moderate, system improvements are allowed utilizing O&M funding.

The potential for abuse may be mitigated by implementing funding thresholds to determine a minor/moderate improvement versus a major improvement. For instance, an O&M funding threshold of 20 percent of the original RDT&E costs could be considered the cutoff point for a redesign with minor/moderate performance increases.

Solution 3: Encourage and Allow Performance Increases with F3I CSAG Redesigns

Current CSAG regulations like 448 SCMW Instruction 63-118 do not allow performance increases associated with F3I redesigns.[98] These regulations make it fundamentally difficult to address DMSMS/OB issues by restricting the ability to move to modern technology. Addressing obsolescence and achieving performance increases are not mutually exclusive affairs; many redesigns are capable of achieving both. Vendors are typically contracted to redesign the old part or SRU to the same specification as the original end item.

Recommended Action: CSAG regulations should be updated to allow minor to moderate performance increases with F3I redesign efforts. This would not only open up the pool of vendors which can address the DMSMS/OB issue, it would also enable weapon systems to maintain operational relevance.

Evaluation: The goal of this solution is to address DMSMS/OB issues and simultaneously obtain capability increases. Since this solution would require the reexamination of current CSAG regulations at the group level, the overall feasibility of implementation is considered high. The warfighter merit would be considered high since this solution would provide IPTs with an additional path to achieving operational relevance besides trying to obtain RDT&E funding.

To alleviate risk, language can be leveraged from existing Air Force supply chain programs like the IIRP and applied to CSAG redesigns. For instance, the parts being redesigned must primarily address DMSMS/OB issues; however, if additional capability is inherent in the redesign, it should be allowed.[99] Using CSAG funding to redesign a part that has no DMSMS/OB issues or solely for a capability increase should continue to be prohibited.

Solution 4: Utilize CSAG Funding to Purchase Air Force Life Cycle Management Center (AFLCMC) Redesign Components

The current process dictates that if the AFSC redesigns an LRU which is self-managed, the AFSC has the responsibility to procure initial buys and spares and establish repair support for the LRU. However, if the AFLCMC redesigns an LRU which is AFSC-managed, the AFLCMC is held accountable to procure initial buys and spares along with establishing initial repair sup-

port for the LRU.[100] This is problematic because the AFLCMC does not traditionally obtain procurement or repair funding for legacy parts; these responsibilities typically fall under the AFSC's purview. In some instances, the redesigned LRU continues to use legacy SRUs along with new parts. In essence, although AFLCMC redesigns may resolve the underlying obsolescence issues contained within the LRU, the new LRUs are never procured due to management and responsibility issues.

Recommended Action: The AFSC and AFLCMC should work cooperatively and utilize each other's resources to redesign, procure, field, and support redesigned parts and LRUs for the warfighter. Without close cooperation between the two organizations, duplicative efforts can take place. Whether the AFSC or AFLCMC funds the redesign, the AFSC should have the ability to procure initial buys and spares along with establishing repair support for the redesigned part. The AFLCMC shall continue to maintain responsibility for ensuring the operational safety, suitability, and effectiveness of the system.

Evaluation: This solution would require a new memorandum of agreement between the two organizations, along with updated policy and AFIs that govern them. Because of these issues, the overall feasibility is considered low. The warfighter merit would be considered high since this solution would allow IPTs to tap into the AFSC's vast resources for procuring redesigned parts, providing an additional path to achieving weapons system operational relevance.

Unfortunately, there are several potential risks with this solution. One major downside is a likely increase in acquisition time cycles, as two organizations would now require leadership buy-in and agreeance on all cross-organizational acquisition activities. These factors could complicate the roles and responsibilities between the two organizations. However, this situation can be alleviated if organizational responsibilities are clearly specified beforehand. Regardless, this solution will require close coordination between the two organizations at various levels of command.

Solution 5: Allow Additional Flexibility in F3I Redesigns

Redesigns are usually sought for individual parts or SRUs. If two or more parts are heavily coupled together, a CSAG redesign is practically impossible to accomplish since it usually involves redesigning more than one part to maintain coherent operation. From the SRU's perspective, the redesign does not meet F3I requirements since the redesign would impact other SRUs in the subassembly. However, viewing the problem at the next higher assembly, the redesign *would* meet F3I requirements since SRUs outside of the subassembly would be unaffected. In these scenarios, the responsibility would be placed

back on the system program office (SPO) to determine a viable solution.[101] Since the CSAG has been established as the responsible entity for maintaining reparable assets, the SPO would not typically have the appropriate moneys associated with SRU redesigns readily available and would have to POM for such funding. This negatively impacts the part or subassembly's supportability, creating a downward spiral in the system's mission capable rate. Requiring redesigns to strictly adhere to F3I requirements greatly stifles innovation and creativity in addressing DMSMS/OB issues and also limits the ability to leverage commercially available solutions.

Recommended Action: CSAG regulations such as AFI 23-101 and corresponding supplements should allow IPTs flexibility in F3I redesign requirements and to conduct the redesign at the next higher assembly or at system level if necessary.

Evaluation: Since this solution would require the reexamination of several Air Force regulations such as AFI 23-101 and 448 SCMW Instruction 63-118, the overall feasibility is considered medium. The warfighter merit would be considered medium since this solution would provide IPTs with the ability to redesign parts without strictly adhering to F3I requirements, allowing further opportunities to address DMSMS/OB issues in weapon systems. The amount of flexibility provided to IPTs would have to be carefully considered. Abuse can be minimized through the effective use of the IPT structure and the chain of command. IPTs will typically lay out their acquisition plan during an ESIS or ASP. Currently, cross-functional team members and management can broach any reservations or apprehension against the IPT's proposed strategy and discuss a way forward collectively.

Solution 6: Allow Material Leaders the Flexibility to Realign O&M Funding Across Different EEICs and SAGs

While projecting program funding needs for the future years' defense program is necessary, such forecasts should not be set in stone. Programmatic situations are an evolving affair. What was a viable plan two years ago may no longer be practical today. Material leaders require the ability to adapt to changing circumstances within their portfolios. The constraints associated with the different appropriations make adaptability practically impossible today. Currently, material leaders do not have the ability to reprogram funding across various Air Force EEICs and SAGs. This drives material leaders and IPTs to pursue alternative options, which ultimately results in less effective decisions for the warfighter. This situation could be reconciled if material leaders had greater flexibility in realigning funds across the various EEICs and SAGs.

Recommended Action: Material leaders should be allowed to realign funds across all O&M EEICs and SAGs for all weapon systems managed within their respective portfolios. Congressional intent can still be technically satisfied since the realignment would be limited to the SAG level and does not affect the overarching budget activity code or appropriation.

Evaluation: Since this solution would only require the reexamination of the language contained within each fiscal year's general execution procedures, which is updated and republished each year at the MAJCOM level, the overall feasibility of implementation is considered high. The warfighter merit would be considered high since program success is increased by eliminating the need to wait for future year funding to resolve pertinent weapon system issues. No potential risks could be identified for this solution.

Solution 7: Allow Small-Scale O&M Funded Rapid Prototyping Activities

All developmental activities, regardless of scale and including rapid acquisition, are funded with the RDT&E appropriation.[102] Many existing weapon systems are unable to obtain RDT&E funding because higher priority efforts occupy a majority of the limited resources available. This leaves many weapons systems incapable of keeping pace with the adversary, rendering them operationally irrelevant. CAM policy currently contains language that allows for rapid prototyping-like activities via sustaining engineering efforts. Based on the interpretation of current regulatory guidance, financial managers require IPTs to utilize the RDT&E appropriation for such activities. However, many small-scale efforts require little developmental engineering involvement, such as replacing a monochrome CRT screen with a LED display.

Recommended Action: Allow IPTs the ability to rapidly prototype proven commercial off-the-shelf (COTS) products and technologies through O&M funding or via OTs. If prototypes are successful, they can transition to official programs of record if necessary. This will reduce the risk for decision makers in determining what weapon system initiatives to invest in before they face scrutiny as official programs of record.

Evaluation: Since this solution would require careful reevaluation of existing CAM and FMR policy at the DOD level, the overall feasibility of implementation is considered medium. The warfighter merit would be considered high since this would reduce risk for decision makers and would incorporate proven COTS technologies into weapon systems more quickly, minimizing the technological gap between the commercial and defense sectors.

There are several risks associated with this solution. There is the likelihood that several rapid prototyping activities will never be fielded; however, it is

important to note that this is already taking place among MDAP.[103] Also, existing CAM funding levels may be insufficient to integrate some COTS technologies into weapon systems. This risk can be reduced by requiring the use of modular open systems architecture (OSA) solutions and commercial standards to minimize potential integration costs, although very few systems utilize OSA standards today. Finally, rapid prototyping efforts can encompass multiple years. This risk can be reduced by limiting the scope of the effort and specifying a maximum time frame for such activities. Any prototyping effort that has the potential to extend beyond the maximum predetermined time frame should be pushed toward an RDT&E-funded effort instead.

Additional Solutions Considered but Not Recommended

The request for additional funding and manpower resources are the traditional solutions sought by IPTs; however, many would argue that the US military has more resources than necessary. Instead, the solutions described above examine how the US can be creative with the existing resources it possesses.

Another possible solution is the creation of a new policy that allows IPTs to bypass the principles contained within the FMR, similar to how OTs bypass the rules in the FAR. However, this was deemed impractical, as it would greatly diminish congressional oversight.

Aligning appropriations with acquisition phases also proved impracticable. For instance, the RDT&E appropriation would fund the material solution analysis phase through the engineering and manufacturing development phase, the procurement appropriation would fund the production and deployment phase, and the O&M appropriation would fund the O&S phase. This would eliminate weapon systems in sustainment having to compete for RDT&E funds against newer systems in development. This solution would greatly impact the FMR, numerous AFIs and AFMANs, and possibly several additional Air Force documents and policies, and therefore was deemed impractical.

Final Recommendation and Guidance for Implementation

This paper recommends implementing these solutions (solutions 1 and 2 are prerequisites for solution 7):

- Solution 1: Encourage IPTs to "Hack the FMR" in Favor of the Warfighter
- Solution 2: Consolidate Financial Management Guidance and Allow Additional Flexibility with O&M Funding
- Solution 3: Encourage and Allow Performance Increases with F3I CSAG Redesigns

- Solution 5: Allow Additional Flexibility in F3I Redesigns
- Solution 6: Allow Material Leaders the Flexibility to Reprogram O&M Funding Across Different EEICs and SAGs
- Solution 7: Allow Small-Scale O&M-Funded Rapid Prototyping Activities

Solution 4, "Utilize CSAG Funding to Purchase AFLCMC Redesign Components," is not recommended because it is a much larger step than many may be willing to accept. This solution may be a possibility in the future.

Since the final recommendation would drive changes to various regulations such as AFIs, AFMANs, and the FMR, this may take time to coordinate and update among various stakeholders; therefore, a new Air Force Guidance Memorandum (AFGM) can be published which specifies the change in direction. Similar to Dr. Roper's rapid acquisition memorandum, the phrase "to the extent its directions are inconsistent with other Air Force publications, the information herein prevails in accordance with AFI 33-360" should be included to remove all doubt about possible conflicting policy.[104]

In addition, the new AFGM should underscore several important cultural shifts needed in the Air Force today:

- First, senior leaders must change the current sustainment mindset in the Air Force. Today's focus is primarily on maintaining readiness when it should be on keeping weapon systems operationally relevant against their respective threats.
- Second, senior leaders must emphasize metrics that matter. Awarding contracts on time is currently perceived as a programmatic success; however, rapidly fielding new capabilities should be commended instead. While there is a substantial amount of government work involved in awarding a contract, the warfighter has not technically received anything tangible at this point in time.
- Third, senior leaders should empower individuals to make decisions at the lowest level possible. Too many decisions are made at higher levels than necessary. In other instances, decisions at lower levels are discouraged due to the risk-averse culture pervasive throughout several Air Force organizations.[105] Instead, the ideology contained within the commander's intent should be practiced. Overall direction should be provided by senior leaders while the lower level decision-making and the "how" is left to the respective IPTs.
- Finally, the Air Force should continue to encourage airmen at all levels of command to take calculated necessary risks. There is a stark contrast be-

tween taking a calculated risk and taking an unnecessary risk. Attempting to integrate leading-edge commercial technology into a weapon may or may not succeed. If successful, the weapon system could potentially maintain its dominance against the adversary. If unsuccessful, the risk would be realized by wasting time and taxpayer money. In this case, the benefits would likely outweigh the consequences. However, sending a technologically inferior weapon system into battle which has proven to be ill-matched against its objective threats would be considered an unnecessary risk; there is relatively little to no chance for success, and the consequences, if unsuccessful, would result in a loss of life or aircraft.

Conclusion

The US must reconsider its position during the O&S phase to avoid sustaining antiquated capability throughout the life cycle of weapon systems. This paper recommends revising and streamlining financial management regulations while allowing increased flexibility with O&M funding. In the meantime, IPTs should creatively utilize O&M funding to the maximum extent allowed to deliver capability to the warfighter. This paper also recommends allowing additional flexibility and performance increases in F3I redesigns, leveraging leading-edge commercial technology wherever possible, and—most importantly—changing the mentality of sustainment from maintaining readiness to maintaining relevance. O&M funding must contribute to maintaining relevance since it consumes over 42 percent of the DODs discretionary budget.

The paper also recommends key cultural changes required in the Air Force, such as emphasizing metrics that matter, empowering individuals to make decisions at the lowest level possible, and transitioning from a risk-averse to a risk-taking culture. Military leaders must consider implementing solutions that remove the barriers that prevent capability from reaching the warfighter. They must consider whether the US should continue engaging in business-as-usual activities or should implement a different way of thinking. During the American Revolution, minutemen fired upon the British from protected perches, an unconventional tactic that was deemed "ungentlemanly" at the time.[106] As German Panzers rolled through the Ardennes during World War II, the Allies realized that large-scale trench warfare was now obsolete. The US must not concern itself with being proper or solely reliant on conventional methods. Rapidly delivering capability to the warfighter and winning the fight are paramount.[107] The US must continue to innovate and use any means

necessary to reduce friction within its own OODA loop and cause friction within the adversarial OODA loop.

With the growing threat of near-peer adversaries, the Air Force must move faster to keep pace. The US is currently at risk of being technologically surpassed by countries such as Russia and China, which are not playing by the same rules.[108] These countries do not have to abide by the DOD 5000, the FAR, or the constraints within the FMR. Some military leaders believe these countries are functioning on timeframes that deliver capabilities at twice the speed of US acquisition cycles, jeopardizing US national security in their respective regions.[109] Military leaders must strongly consider if the adversary undergoes a cumbersome acquisition process to insert new technologies into their aircraft, or if they spend billions in repairing and sustaining 30-plus-year-old components without creatively thinking of ways to move toward modern, sustainable, leading-edge technologies. The answer to these considerations may appear to be simple in nature, yet the ability to achieve the desired results proves otherwise. In a fiscally constrained environment, the US must actively seek creative ways to sustain and simultaneously insert new capabilities within its weapon systems.

Notes

(All notes appear in shortened form. For full details, see the appropriate entry in the bibliography.)

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Abbreviations

AFGM	Air Force Guidance Memorandum
AFI	Air Force Instruction
AFLCMC	Air Force Life Cycle Management Center
AFMAN	Air Force Manual
AFSC	Air Force Sustainment Center
ASP	Acquisition strategy panel
BTR	Below threshold reprogramming
CAM	Centralized asset management
COTS	Commercial off-the-shelf
CRT	Cathode ray tube
CSAG	Consolidated Sustainment Activity Group
DOD	Department of Defense
DRFM	Digital radio frequency memory
EEIC	Element of expense/investment codes
ESIS	Early strategies and issues session
FAR	Federal Acquisition Regulation
FMR	Financial Management Regulation
IIRP	Improved item replacement program
IPT	Integrated product teams
JSF	Joint strike fighter
LED	Light-emitting diode
LRU	Line replaceable units
MAJCOM	Major command
MDAP	Major defense acquisition programs
MICAP	Mission-impaired capability awaiting parts
O&M	Operations and maintenance
O&S	Operations and support
OODA	Observe, Orient, Decide, Act
OSA	Open systems architecture
OT	Other transactions

POM	Program objective memorandum
R&D	Research and development
RDT&E	Research development test and evaluation
SAG	Subactivity groups
SAM	Surface-to-air missile
SCMW	Supply Chain Management Wing
SPO	System program office
SRU	Shop replaceable units
VCO	Voltage-controlled oscillators

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