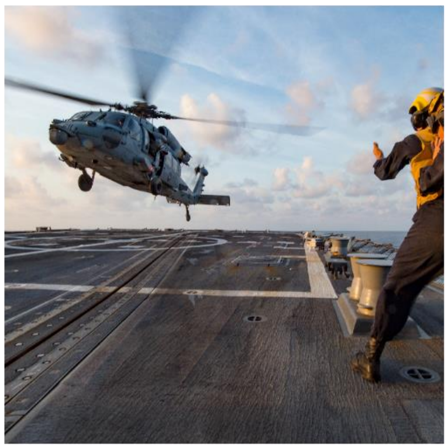
Competitive Strategies for Systems Acquisition & Life Cycle Management



A Practical Guide for Program Managers

2017

DAYTON AEROSPACE

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Preface

Competitive Strategies for Systems Acquisition and Life Cycle Management: A Practical Guide for Program Managers provides both industry and government program and product support managers (PM/PSMs), staffs, and other acquisition officials with a systematic guide to assess, implement, and execute successful competition strategies for government programs. This guide contains chapters on all phases of the weapon system's life cycle including technology maturation and risk reduction (TMRR); engineering and manufacturing development (EMD); production and deployment; and operations and support (O&S). Numerous acquisition program case studies and examples are included to illustrate various competitive strategies. Finally, this guide draws upon relevant competition studies and literature to develop a decision framework for use in evaluating programs for competition.

The competition decision framework (CDF) proposed in this guide has not been endorsed or approved by the US Air Force (USAF) or the Department of Defense (DOD).

Acknowledgements

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ABOUT THE AUTHORS

Dr. Bill Stockman is a PhD economist who led, researched, developed, and taught many of the graduate acquisition programs at AFIT, including the cost estimating graduate program which covers the majority of topics in this guide. While on active duty, he developed and led the cost teams' research and evaluations for the three largest depot competitions in USAF history. He has authored over 75 major study reports, books, and guidebooks—most notably, based on his research for a major USAF effort, a textbook on commercial derivative systems and how they play a major role in weapon system competitions.

Mr. Tom Wells possesses an extensive background in government contracting and acquisition theory in the USAF's largest acquisition and sustainment organizations, including as director, 711th Human Performance Wing, AFRL; director of contracting, Headquarters Air Force Materiel Command (AFMC); and director of contracting and competition advocate, USAF Electronic Systems Center (ESC) (now part of AFLCMC). As a highly-experienced procurement analyst, he has researched and published several USAF guides, handbooks, and templates on acquisition planning and competition strategies. During his multiple director-level assignments, he developed and/or executed many of the current competition strategies used today in the DOD, including authoring or approving hundreds of source selection documents, plans, and procurement policies/regulations.

ABOUT DAYTON AEROSPACE

Dayton Aerospace is a veteran-owned small business providing senior-level, hands-on support to both government and industry customers since 1984. All key personnel are retired senior military or US Government civilians, averaging over 30 years of experience in all technical and management disciplines essential to weapon system acquisition and sustainment. Our experts have held important government positions such as center/laboratory commander, system program director, chief engineer, program executive officer (PEO), AFIT department head, and director of various functional home offices such as contracting and financial management. Our team uses this experience to develop tightly focused products to support all phases of the DOD acquisition life cycle—for customers working programs for all military services in the US and internationally.

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Purpose and Organization

Dayton Aerospace authored this competition guide to provide industry and government acquisition workforces with information and practical support for planning and effectively implementing competitive acquisition strategies throughout the systems acquisition life cycle. While this guide is meant to be a first stop for program managers and teams concerning competition, it is not designed to serve as the single source for all relevant acquisition knowledge and supporting tools. Readers should take advantage of the numerous footnotes and extensive bibliography contained within to research supporting topics, as needed, to effectively implement competition for their acquisition program.

Government and industry program offices with potential competition opportunities are the primary audiences for this guide. The guide is written for mid- to senior-level professionals with some experience in acquisition and sustainment. Its intent is to help readers think through a wide range of competition strategies, rather than to dictate "schoolhouse" solutions.

This guide relies heavily on current guidance and regulation, but the authors are well aware that DOD policies adapt on a regular basis to changes in the political, economic, and defense environments. Therefore, this guide presents strategies intended to cover a broad scope of policy alternatives, as appropriate. The acquisition team should not rely on this guide as an authoritative source for the most current regulation and policy.

The guide is organized as follows:

Chapter 1 – Competition Environment: The first chapter discusses unique attributes of the DOD acquisition and product support marketplace. While providing some general theory, this chapter's purpose is to identify benefits of competition, potential barriers to competition, and methods to overcome these barriers. An overview of competition planning for the defense systems life cycle is presented along with an introduction to the competition decision framework (CDF) which is discussed in detail in later Chapters. Chapter 1 also summarizes major laws and regulations relating to competition for defense programs.

Chapters 2-5 – Acquisition Process: The next four chapters provide insight into how competition can be introduced and/or maintained during each of the major acquisition phases defined by DODI 5000.02, *Operation of the Defense Acquisition System*. This guide distinguishes between competition ***for*** award of a contract (i.e., competition is used to select a single contractor to perform the effort required during the phase) and competition ***during*** the phase (i.e., more than one contractor receives a contract to perform the required effort). Maintaining competition during an acquisition phase can be used as a strategy to ensure that competition for subsequent phases is viable (i.e., avoiding a sole source situation for subsequent phases). Each chapter follows a similar outline intended to help the program manager assess their program, develop a competitive strategy, and then execute that strategy. Each chapter includes the following:

- Short introduction and description of the phase as it applies to competition strategies.
- Brief review of applicable regulations directly related to the phase.

- Detailed discussion of general and specific competition strategies, methods, and techniques applicable to that phase, and insight regarding the application of the discussed strategies.
- Discussion of current phase actions necessary to enable competition in future phases.
- Review of best practices and lessons learned applicable to the phase.
- Numerous case studies to demonstrate how competition strategies have been used on current and past programs—from brief examples to detailed descriptions of the competitive strategy, its execution, and the outcome.

Chapter 6 – Competition Decision Framework: The final chapter presents a competition decision framework (CDF) which guides the evaluation of competition opportunities at each program phase. This evaluation is required at program inception and must be reviewed and updated at each milestone or major program change. The decision framework process has four parts that are detailed in this chapter:

- Assess competition considerations (technical, program, and market situations)
- Evaluate competitive strategy alternatives
- Conduct a cost benefit analysis
- Document the analysis and decision

Appendices: The guide includes two appendices which serve as helpful references:

- List of Acronyms
- Bibliography, which can be used to find additional guidance and information

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1. Competition Environment

THE LAW OF THE LAND

"The price of monopoly is upon every occasion the highest which can be got. The natural price, or the price of free competition, on the contrary, is the lowest which can be taken, not upon every occasion indeed, but for any considerable time altogether. The one is upon every occasion the highest which can be squeezed out of the buyers, or which, it is supposed, they will consent to give: The other is the lowest which the sellers can commonly afford to take, and at the same time continue their business."[1]

Adam Smith

[1] An Inquiry into the Nature and Causes of the Wealth of Nations, Chapter VII, Adam Smith, 1776.

WHY IS COMPETITION IMPORTANT?

Why is competition important? The textbook answer is "because it is the law of the land." The Competition in Contracting Act (CICA) was enacted in 1984 to promote competition in order to reduce costs and improve performance. CICA established full and open competition as the standard for most procurement actions, while at the same time allowing for a number of exceptions—most of which require that agencies request offers from as many potential sources as is practicable under the circumstances.[2]

Why Competition?

Beyond the legislative mandate, competition is important for many reasons. Competition:

- Creates an incentive for contractors to provide goods and services at a lower cost (economic efficiency).
- Spurs innovation and development of transformational technologies which allows the Department of Defense (DOD) to field the best weapon systems for our warfighters quickly.
- Yields improvements in the quality of products delivered and services rendered (firms that turn out low quality are driven out of the market and are unable to effectively compete).
- Affords the DOD the opportunity to acquire performance improvements (e.g., faster, lighter, and more sustainable) by using "best value" source selection criteria.
- Provides opportunities for capable small businesses to enter new markets.
- Enhances (or maintains) a strong defense industrial base which provides an operational surge capability to handle demand spikes.
- Curbs fraud by creating opportunities to re-assess sources of goods and services reinforcing the public trust and confidence in the transparency of the Defense Acquisition System.

In a purely theoretical world, competition is a wonderful thing. Economists paint pictures of free markets where consumers and suppliers meet to buy and sell products resulting in an economically efficient allocation of goods and services. In this world, there are numerous buyers and suppliers who all share total market information. Market forces cause suppliers to reduce prices, resulting in low economic profit and allocation schemes that best support the market. Poor performing suppliers are eliminated and new suppliers enter the market as needed. This is a great theory, but unfortunately the DOD rarely exhibits these market traits or outcomes. Rather, much of DOD acquisition and sustainment resembles monopoly suppliers and buyers attempting to optimize their own market position at the expense of the other. The DOD

[2] "Contracts: Competition Requirements," Title 10 USC, Section 2304, as of Public Law 133-88, March 21, 2014.

must still pursue competitive strategies and policies, but should do so in an informed and careful manner. Competition—when applied correctly—can lower cost, improve performance, reduce risk, and encourage innovation that otherwise might not occur. Likewise, pursuing competition when it doesn't fit the acquisition environment wastes time, money, and other resources. Analysis and judgment are required.

Will to Compete

Because the DOD market typically lacks the characteristics of a truly open and effective market, implementing competition can present challenges for the government acquisition professional. It is easy to continue sole source strategies while pointing out impediments and constraints to implementing competition, for example:

- Too much effort and financial investment are required to develop another source.
- The program schedule doesn't allow enough time to compete.
- Technical expertise and data are required to enable another source.
- Program staffing and funding are limited.
- Reluctance to accept risk of integrating multiple contractor efforts.

Leaders at all levels must exercise the will to compete and take on the kinds of impediments listed above. Executive-level commitment is essential to foster an environment where competition is highly valued. When leaders decide to compete, inertia and built-in resistance to compete are overcome. Great leaders are champions for competition and understand that fulfilling mission requirements and applying the competitive process are not mutually exclusive. Leaders with strategic vision recognize that the effects of competition can be achieved indirectly, even in the absence of conventional head-to-head competitors. The threat of competition, particularly if a program's performance and cost are not improving, may be sufficient to keep an incumbent provider on edge and effectively incentivized to drive down costs and increase quality.

Leaders that demonstrate a will to compete recognize the need to invest in the up-front costs to enable competition, whether that is by qualifying a second source or by recognizing seeing the value of dedicating a team of experts to participate in the critical, but time-consuming function of evaluating offerors' proposals in competitive source selections. Leaders that possess the will to compete recognize and articulate to their teams the long-term savings that will be realized as a result of competition.

Leaders with the will to compete seize on the fleeting window of opportunity that presents itself in a competitive source selection. They leverage that moment to ask for and acquire something of value that could not likely be attained outside of a competitive environment. Within the bounds of the law and regulations (of course), leaders use this leverage to optimize performance, delivery schedules, and affordability in the near term, while securing an agreement from offerors to do or provide what is necessary to enable the DOD to re-compete the effort (or related support and training service) in the future.

Competition and Innovation

Research indicates that maximum innovation occurs in an oligopolistic competition, which means a few firms compete for the market.[3] In this case, firms can charge a higher price, which in turn funds their research and development (R&D) for new technologies. Further, research shows that the most significant innovation occurs outside the current industry by firms that are willing to take large risks to break into the competition. That is a critical point—innovation tends to occur in businesses that are not currently DOD incumbents or primes. At the same time, the incumbent firms desire to erect barriers to entry to maintain their oligopolies. The challenge to DOD program managers (PMs) is finding and inviting these new, innovative businesses into their programs.

RAND Corporation completed a study[4] on competition and innovation specifically as it relates to the aerospace industry, an industry characterized as having few suppliers (i.e., an oligopolistic market) within the DOD. The RAND analysis (among others) demonstrated that competition is the most important driver of innovation in this industry and that most significant innovation occurs *outside* the industry by firms willing to take large risks to break into the competition. Innovation cannot be specified in a request for proposal (RFP) and ordered like a pizza. Rather, it is the result of industry visionaries who understand the DOD's needs and have a business sense about potential future revenue streams. Most importantly, firms must believe they can defend their new technology or capability's property rights in order to secure a future profit stream. The relationship between competition and innovation is not unique to the aerospace industry; it applies across the full range of products being sold in the marketplace.

Innovation may also be stifled if an industry has too few or too many competitors. In basic economic theory, when one firm has a monopoly, it will maximize profit, minimize investment, and only provide enough innovation to thwart competition. If there are too many competitors in a declining budget environment, profits are reduced to a minimum and firms will have little capital to invest in new technologies. While the firms may remain in business, there is little benefit to investing in new technologies because it raises costs which cannot be recouped in a low-price market with declining opportunities.[5]

The applicability of this concept can be seen in the commercial derivative aircraft (CDA) market. If one looks at the long history of the military's use of CDA—

[3] "Competition and Product Innovation in Dynamic Oligopoly," Goettler, Ronald L. and Brett R. Gordon, Quantitative Marketing and Economics, November 2013.
[4] "Competition and Innovation in the US Fixed Wing Military Aircraft Industry," Birkler, et al, RAND National Defense Research Institute, 2003.
[5] The Rand Study also mentions the spillover effect during periods of excess competition. This describes the effect of employees moving from firm to firm and taking information with them—which tends to level the playing field between competitors (both the level of innovation and price).

especially in the 1930s and 1940s—the military held competitions for a wide variety of aircraft and bought a significant number from new-start companies. Many of these innovative firms became the aerospace giants of today. The lesson learned is that the DOD should encourage competition from all sources and not just the established companies.

USAF Light Air Support (LAS) Aircraft

The LAS acquisition offered opportunities for new entrants into the DOD market.

A prime example of attracting new providers to the industrial base was the July 2009 Request for Information (RFI) issued by the Aeronautical Systems Center (ASC, now Air Force Life Cycle Management Center (AFLCMC)) Capabilities Integration Directorate (CID). The directorate was conducting a market research assessment of fixed-wing platforms available for performing strike, armed reconnaissance, and advanced aircraft training in support of irregular warfare (IW) operations. The Light Air Support (LAS) aircraft RFI implied a quick acquisition cycle with the first aircraft deliveries in two years. While the RFI attracted existing airframes—Raytheon's Joint Primary Aircraft Training System (JPATS) and the Embraer Super Tucano—it also attracted attention from new firms with fresh designs and capabilities. The winner of the ultimate competition was Sierra Nevada Corporation (SNC) who teamed with Embraer to build the Super Tucano in the US. This provided SNC, a relative newcomer to the DOD, an opportunity to grow its business and become a major DOD supplier.[6]

[6] "Super Tucano Wins Afghanistan Light Air Support Bid," Aaron Mehta, Defense News, 27 February 2013.

COMPETITION THEORY

Perfect Market versus the DOD

Most economists discuss perfect competition in order to have a baseline for theoretical discussions. From a DOD viewpoint, perfect competition (along with perfect market conditions) provides a means to compare theory with actual program conditions. Perfect competition exists in free markets with the following characteristics:

- There are a large number of buyers and sellers in the market so that no individual buyer or seller action will have any significant impact on the market.
- All buyers and sellers must offer and accept the equilibrium market price.
- Both buyers and sellers have perfect market information.
- The goods and services produced are substitutable.
- The market determines the introduction of new products.
- All producers have equal access to technology.
- All buyers and sellers are able to enter and leave the market at any time to pursue other economic activity.
- Firms only receive the minimum economic profit.

None of these absolute conditions exist in the normal commercial market, nor the DOD market—so why should a PM care? The reason is relatively simple—if the PM can nudge the military market toward these absolutes, the benefits that competition can deliver increase. For instance, if the PM can provide equal access to technology (either through data rights or funding two or more contractors during technology demonstration or licensing), then that may allow for competition during production and sustainment. To make goods and services substitutable, the program strategy must consider a statement of work (SOW) that is relatively open to allow for a variety of solutions. The net result can be a significant lowering of costs, introduction of new technology, reduction in program risk, and achievement of shorter schedules.

The DOD and Competition

In a pure theoretical market, the value of competition is that it forces suppliers to provide the best product, at the best price, and deliver it on time. Any deviations will result in the customer choosing another supplier who can provide these services. This is a good theory for acquiring traditional consumer goods in a normal commercial market with a reasonable number of suppliers providing similar goods to a large buyer base. Most weapon systems, however, have no similar commercial product. While there might be similar subsystems, most large DOD weapon systems are unique and complicated with only a small number of potential manufacturers.

The defense industry is closer to a monopsony-duopoly—the DOD is the primary customer (if not the sole customer), as well as the regulator of the market. There are few sellers due to the unique nature of the products. The federal government (President, Executive Departments, and Congress) sets the rules, regulates the prices through auditing of incurred cost, and controls who can and can't buy the products. Unlike the theoretical movement of prices due to the rise and fall of supply and demand, the prices for weapon systems are typically tied to audited cost information and quantities purchased are more a function of budget levels than reductions in price.

The defense market is best described as an imperfect market. Market demand is determined by a complicated requirements process that combines analytical studies, world threats, political needs, and congressional budget activity. Demand changes constantly and provides little warning or insight to the supplier base. This lack of clear information to industry serves as a deterrent to industry investment.

Costs of Maintaining Competition

In the perfect market, there are always suppliers waiting to provide products for the large number of potential buyers in a free market—not so with the DOD. There is a long list of costs involved with developing, implementing, and preserving competition that a PM must consider. These costs represent the effort and resources that must be expended to replicate the theoretical competitive marketplace for the DOD. A few examples are:

- Market research to identify and recruit suppliers
- Analysis efforts to identify and develop the acquisition strategy
- Cost of developing and maintaining additional sources
- Source selection costs
- Technical data
- Communication with offerors
- Increased schedule time to qualify competitors

Program Office Cost Benefit Analysis

Major programs require the PM to complete a cost benefit analysis (CBA) that evaluates potential competition strategies over the program's life cycle. This analysis provides significant insight into potential savings of competitive strategies. That means the study contains estimates about what a competitor may propose for cost, technical, and schedule elements—estimates which may have little resemblance to the ultimate prices proposed. This type of detailed study can be resource intensive and outside of the normal program office capability.

Competition versus Long-term Agreements

PMs should not assume that if a little competition is good, a lot of competition is even better. There are significant costs to both the government and the contractor when a system is competed. These non-trivial costs are only justified if the resulting new contract savings (or performance enhancements) exceed these costs. Commercial industry often balances long-term contracts with suppliers against potential savings from re-competitions. With long-term agreements, a supplier may invest in technical and manufacturing upgrades that produce savings and performance improvements that can be shared with the buyers. Short-term contracts can be especially problematic for performance-based logistics (PBL) efforts since a major objective is for the contractor to make process and product improvements that lead to lower cost, increased performance, and greater availability. The PM must compare the pros and cons of a short-term contract period versus a longer-term period when deciding the optimal time to re-compete an effort.

Competition during Life Cycle Phases

A PM's goal is to retain the option for competition at each phase if it makes sense in light of the total program goals. A PM's key challenge is how to develop and leverage competition in the current phase, while preserving the option to compete in the later phases. This involves decisions about maintaining multiple contractors, acquiring technical data rights, and developing/maintaining industrial base capability.

The timing of competition as it relates to a typical weapon system's life cycle is very important. Too-frequent competition to merely lower the contract price may harm the long-term program in these ways:

- Contractors will reduce program investment if they are not provided sufficient time (contract term) to recoup their investment.
- Contractors will reduce or eliminate R&D investments if the payback period is too short.
- Short-term contract periods will deter entry by outside firms since short-term contracts will not provide a sufficient return on investment (ROI).
- Short-term contracts will deter sub-tier contractors and their product enhancing investments.

The following sections summarize and define the program periods (detailed in Chapters 2-5) during which the PM will typically insert competition into their program.[7] Notice there is a distinction between competition ***for*** each phase (two or more sources compete to perform the work but only one wins a contract) and competition ***during*** the phase (two or more contractors are awarded contracts to

[7]"Eight Actions to Improve Defense Acquisition," Jacques Gansler and William Lucyshyn, University of Maryland, IBM Acquisition Series, 2013.

perform the work required during the phase). Each phase will be covered in detail in following chapters.

Competition during the Technology Maturation and Risk Reduction Phase

In the technology maturation and risk reduction (TMRR) phase, critical technologies are matured to meet specific military mission requirements. Contracts are typically awarded to multiple contractors for system and subsystem technology development that may offer different solutions to meet mission requirements. Typical program length is two to four years. Recent programs have required contractors to develop a prototype system often used in a "fly-off" against competing products. These initial prototypes normally do not meet the final mission requirements and a full development program is required. Depending on the strategy, at the end of the phase, the PM will hold a competition to select a single winner to continue to the engineering and manufacturing development (EMD) phase or carries two or more sources into EMD.

Research indicates that this competition normally produces one or more feasible solutions; however, there is little research to indicate that a winner's initial low prices and/or superior technical performance continue into all future phases. If there is a down select to a single source, there is little incentive for future cost reduction, performance increases, or schedule improvement. Rather, many of the major systems developed post-2000 experienced major cost increases and schedule slips. However, thanks to recent emphasis by the DOD on reducing program risk before proceeding to production and greater diligence managing changing requirements, the frequency and magnitude of cost and schedule growth on major programs are seeing improvement.[8]

Competition during Engineering and Manufacturing Development

Competitive development programs designed to meet stringent mission requirements typically involve only two contractors. These programs may look similar to technology development (to include prototypes), but the end result is a final design that is fully engineered and ready for manufacture and production. This form of competition is quite expensive since it can last three to eight years and, for major systems, requires two development programs that can cost 100s of millions or even billions of dollars each during this phase.

The benefit of competition in this phase is that it increases the probability that the program will produce a satisfactory weapon system that meets requirements and will be ready for production on schedule. In theory, this can lead to a less expensive final solution that is more technologically innovative, better integrated, and delivered in a shorter timeframe. However, the cost of this option is significant and must be evaluated against the potential life cycle savings and predicted performance and schedule improvements.

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[8] "Performance of the Defense Acquisition System: 2016 Annual Report," OUSD(AT&L), October 24, 2016.

Competition for or during Production

Competition for weapon system production can only occur if: 1) there is a set of solid requirements supported by two or more producers coming out of the development phase, or 2) the requirements are sufficiently open to allow outside producers to compete. Several potential competitive scenarios may be available in this phase:

- After the development phase, there may be a limited competition followed by an award to a single contractor. In this case, future production quantities may have to be acquired on a sole source basis. Where feasible, the contractor can be encouraged or incentivized to award subcontracts competitively.
- If multiple sources are coming out of the development phase, the program may award production lots to each using a variety of allocation schemes. The desired result is production unit prices (and planned savings) will offset the additional costs of managing and sustaining multiple configurations.
- If the system requirements are open, there may be an opportunity to attract new competitors who did not previously win a development contract or did not previously compete, but who have developed a suitable solution on their own.
- While unlikely, updated market research may discover a newly developed commercial solution that can enter the competition. If the program is a commercial or military off-the-shelf acquisition, market research should identify all eligible systems and manufacturers who may compete.
- If the program began as a non-developmental acquisition, it may be advantageous to consider changes to the strategy to allow a new competitor that must accomplish a development program (at their cost)—if their solution offers long-term performance, cost, and schedule benefits.

Once the initial production lots are competed and manufacturing begins, the PM must prepare for the follow-on lots.

- If sole source, the lot negotiation should focus on cost improvement and continued manufacturer investment. This should include evidence of lower-tier competitions to reduce cost.
- If the program desires to reintroduce competition after the initial production lots are awarded (assuming a single contractor was initially awarded a contract), several approaches may be used. Depending on requirements, the PM may consider: 1) acquiring technical data to allow a new producer to build the product, 2) allowing a new source to reverse engineer the product, or 3) soliciting proposals to design/submit a different product that meets the system requirements. Typically, the most likely competitors are those who participated in the development program, but the following options exist:
  - Allow the losing development contractor to compete for the new lots
  - Allow the losing development contractor to compete for a split buy

– Develop an outside source to build the system

Competition during the Operation and Support Phase

Sustainment of weapon systems absorbs more budget dollars than development and acquisition combined, yet sustainment often suffers from a lack of planning or attention early in the program. It is crucial that sustainment planning begin at program inception. Sustainment competition has undergone some of the most significant changes over recent decades in comparison to competition in the development and production phases. Major changes in laws and regulations, as well as dramatic changes in the sustainment industrial base, have impacted sustainment competitions. The biggest change has been the transformation from reactive and time-based sustainment to strategic, performance-based logistics support.

The single most important PM sustainment competition strategy is to acquire needed technical data rights early in the program. Without data rights, the PM is totally at the mercy of the manufacturer (or data rights owner). Modern weapon systems are often too complex to reverse engineer or allow third-party maintenance providers to conduct major repairs, overhauls, or upgrades. With data rights ownership, the PM will have future competitive options for executing all levels of maintenance, major repair, parts manufacture, and system upgrades.

DOD programs are required to complete a product support business case analysis (PS BCA) at the Milestone (MS) C decision and the analysis must be re-validated/updated every five years.[9] The PS BCA provides an opportunity to evaluate or re-evaluate competition opportunities and off-ramps.

Competition and the Defense Industrial Base

Defense Industrial Base

In traditional competitive market theory, cost, performance, and schedule benefits are all driven by the existence of a large group of suppliers—all with the ability to provide needed products and services. While the US defense industry was never a true competitive market as described in economic texts, there were a significant number of suppliers by the middle of the Vietnam War. The US defense industrial base has experienced a long period of decline since the end of the Cold War with all major consolidations tacitly approved by the DOD.[10] The impact on the PM is often a limited number of suppliers for their weapon systems and thus reduced competition opportunities. This declining industrial base presents a barrier to competition, but a far worse problem is a lack of industrial capability as the DOD buys fewer systems and traditional industry partners disappear.

[9] "Product Support Business Case Analysis Guidebook," Department of Defense, April 2011.
[10] The Defense Monopoly, Sapolsky, H. and E. Gohlz, The CATO Institute, Regulation, Vol. 22, No. 3, Winter 2009-2010.

The Defense Industry

"The fundamental starting point is the understanding that we in DOD do not make our weapons systems. They come from our defense industry. And these weapons systems are, second only to our superb men and women in uniform, what makes our military power unrivaled and what provides the buttress of national and international security. A strong, technologically vibrant and financially successful defense industry is therefore in the national interest."[11]

Ashton Carter, Former Secretary of Defense

While defending the entire defense industrial base is beyond the responsibility of a typical PM, it is not unreasonable to be concerned when the program is confronted with limited or diminishing sources for a key technology, critical subsystem, or technical service. In this case, it is the PM's responsibility to identify qualified suppliers and determine the ability of the industrial base to support their program.

When industrial base firms are discussed in this context, what is the focus? First, these firms possess design, engineering, and production capabilities for advanced systems whose only customers are the US military and its foreign allies. Second, the top-tier or integrating contractors have complex, multi-tier supply chains for technical services and subsystems (parts). This may extend several levels below the prime contractor. A recent report to Congress by the Under Secretary of Defense for Military Industrial Base Policy stated:[12]

> *Some defense-unique parts of the base develop brand-new, emerging technologies, while others manufacture and update very mature products; some products and services incorporated into the defense supply chain are widely available in commercial markets, while others are uniquely useful to the military; some niches have significant backlogs of work and reservoirs of capital earned in a recent production surge, while others currently operate at or below their minimum sustaining rate and are financially fragile. In some parts of the defense industry, all of the intellectual capital resides in a few key companies that interact directly with the Department and rely on build-to-print subcontractors, while in other areas the key design capability and production skills are diffused through the extensive layers of the supply chain.*

The companies in the defense industrial base are often diversified into commercial markets which provide significant portions of their revenues. Major changes in either the defense or commercial market can force a firm to leave that market—and thus deny the PM of a source of supply. While this guide assumes there is always a source(s) of

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[11] "The Defense Industry Enters a New Era," Prepared Remarks at Cowen Investment Conference, New York, NY, February 9, 2011.

[12] "Annual Industrial Capabilities Report to Congress," Under Secretary of Defense for Military Industrial Base Policy, 2012, p.9.

supply, the PM must ensure that there is at least one willing supplier for all elements of his/her program. In the DOD, every sourcing decision has the potential to cause a unique military supplier to leave the market or merge with another firm.

COMPETITION IN THE DEFENSE MARKET

There are several barriers to the use of competition for DOD systems. Fortunately, not all barriers are insurmountable. PMs and their teams have several tools at their disposal to encourage competition and reduce or remove barriers to competition.

Unique DOD Barriers to Competition

A major element of the program strategy must be to reduce or eliminate barriers to competition—a challenge for any DOD PM—and encourage competition during all phases, wherever it makes sense. Typical "tools" to encourage competition include additional up-front investments, schedule extensions, relaxed performance requirements, and/or balancing industrial base requirements.

How Does the Defense Market Compare to the Open Commercial Market?

There are many differences between the defense market and the traditional commercial sector that are theorized in economic texts. The biggest difference is that the DOD is usually the only buyer for a product and defines many, if not all, requirements associated with that product. This means providers have few other outlets to sell these products and few outside sources to guide product development. The more the DOD market (buyer and sellers) resembles a traditional commercial market, the more applicable are traditional competitive strategies.

Table 1[13] compares traditional competitive and defense market characteristics. The commercial market theoretically contains multiple buyers and sellers with significant market information readily available for buyers, sellers, and products. These commercial buyers and sellers normally do not dominate the market. The defense market, on the other hand, is closer to a monopoly buyer with limited sellers—and once a source is selected, the market often becomes a single-buyer/single-seller market for that product. The key point for the PM is that the further away your market is from a commercial competitive market, the harder it becomes to gain the benefits of competition. In a single-buyer/single-seller market, the DOD is committed to a long-term, sole source relationship and ensuring the single source remains viable with its motivations in line with the DOD program's motivations.

[13] "The Mechanism and Value of Competition for Major Weapon Systems," James Dominy, et al, Institute for Defense Analysis, April 2011.

Table 1 Comparison of Traditional Competitive & Defense Market Characteristics

COMPETITIVE MARKET CHARACTERISTICS	DEFENSE MARKET CHARACTERISTICS
Price determined by supply and demand	Price is based on costs and determined through negotiations
Buyers and sellers act independently	High levels of cooperation between buyers and sellers
Individual producers decide what to produce and finance the development	Buyer determines the requirements of the product and provides most of the development financing
Many suppliers and buyers	One buyer and few sellers; frequently only one seller at the production stage
Demand is relatively stable as a function of consumer income	Demand is less stable and is a function of available technology, estimates of potential enemies' capabilities, and political environment
Product is standardized and there are many choices within a category	Typically, one product, which is new and subject to design changes
Price is the dominant factor in production choice (multiple substitutes)	Other factors, such as schedule and quality, are dominant in choosing the product producer
Purchasing a product is a simple, one-step process	Purchasing a weapon system is a multi-stage, multi-year process
Firms normally bear risk	Risk is often shared or covered by the government
Supplier typically finances development and production costs, which are recouped upon sale of product	Government usually provides progress or cost-incurred payments during development and production
Profit is controlled by the market.	Profit is regulated by the government

DOD Market Barriers to Entry

Barriers to entry are extremely high for most portions of the defense industry. Traditional contracting market surveys to identify and generate sources of supply are almost meaningless for major systems because the few qualified sources are well-known. Typical barriers include:

- Successful competition requires knowledge and experience with the Federal Acquisition Regulations (FAR). This is a major barrier for large and small firms and can add significant cost to traditional commercial operations and production. The government can impose licensing requirements for key technologies, limit access to raw materials, require security clearances for employees, and prescribe socioeconomic mandates and environmental performance conditions.
- Since many weapon systems have no commercial counterpart, the entrant is often required to create and build unique research, development, production,

and test facilities—which must be amortized over the life of the program. A newcomer to the industry must also establish supply chains for key materials and sources for technical support, which may be different from its commercial customers. New entrants must compete against incumbents who often have low capital costs and years of experience along with product and environmental knowledge.

- In most industries, newcomers face a disadvantage due to economies of scale. Scale economies in research, development, production, test, distribution, and sustainment are very difficult to overcome unless the instant contract is large enough to quickly reverse the situation or the challenger is providing a unique solution/technology that overcomes the incumbent's process and cost advantage.
- New entrants must develop or acquire the skilled workforce and management required to execute a successful DOD program.
- Many commercial system/service providers have well-established products that meet many, but not all, government requirements—with modification either impossible or uneconomical.

Barriers to Exit

Primarily due to the large capital investment, firms are not willing to exit the DOD market as quickly as their commercial competitors. There are few alternative markets outside of the DOD to sell defense-related products or research, so these firms are dependent on the DOD for their long-term survival. Often federal regulations prevent the sale of military items/services to the public or foreign nations.

Bargaining Power of Suppliers

In the theoretically perfect market, both buyer and supplier share all information which drives the price down to a minimum, while providing a maximum product or service. Initially defense suppliers do compete against each other, but many DOD programs are so complicated that the final decision does not totally rely on cost or price. Often there are few suppliers qualified to compete, so they have some bargaining power with the government (such as the terms of the solicitation or work requirements) that might impact the source selection. If the source selection decision results in the losers leaving the industry, the winner then becomes a monopoly supplier with significant bargaining power once the program matures.

Bargaining Power of Buyers

While the government may often enter the competition as a monopoly buyer, this is not always absolute. Because the government is so large and organizationally fragmented, it often does not act as a single buyer. Some competitors sell their products to multiple government program offices and multiple departments or agencies. Depending on the product or service, firms may have commercial opportunities and foreign government sale opportunities—all of which lessen the power of the individual buyer. Despite this, the DOD buyer typically has significant buying power, including:

- Regulating and setting the rules of the market.
- Specifying the product characteristics, schedule, and budget.
- Possessing detailed information and insight into suppliers' costs, processes, and capabilities.
- Often controlling the number of suppliers who can compete.

Export/Import Controls

Most commercial products can be sold worldwide with few restrictions. DOD products are highly regulated and are often limited to the US Government. On the other hand, there are also restrictions on suppliers and raw materials (Buy American Act, Berry Amendment, Textile and Specialty Metal Domestic Source Preferences, and International Traffic in Arms Regulations (ITAR)).[14] Thus, a DOD supplier frequently has few options to increase sales or to search worldwide for lower cost material providers.

Other Impediments to Competition

PMs must be aware that their actions or lack of action may deter current or future competition opportunities.[15] Detrimental government actions include:

- Program staffs often grow comfortable with the incumbent and fail to even consider the benefits of competition or re-competition.
- PMs are often pressured to deliver capability early—and assume competition will take too long.
- PMs fail to acquire all data needed to allow for competition.
- PMs allow programs to grow (scope creep) with multiple changes to the SOW instead of competing new work.
- Program staffs often over-specify the SOW and performance requirements in order to deter competition.
- PMs often bundle requirements which limit the number of competitors that can propose on the project.
- PMs are often reluctant to break out subcomponents or major subsystems for competition due to integration risk concerns.
- Unique DOD contract terms and conditions may cause commercial suppliers to avoid entering into contracts with the government.

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[14] Subchapter M—International Traffic in Arms Regulations

[15] "Guidelines for Creating and Maintaining a Competitive Environment for Supplies and Services in the DOD," OUSD(AT&L) White Paper, August 2014.

Removing Competition Barriers

Given the unique challenges of implementing competition in the defense market, what can a PM do? Some top-level actions include:

- Support industry days and opportunities to educate new industry competitors on how to work within the government environment.
- Consider stretching the schedule to allow new competitors time to develop their product or processes (usually at their expense). This can be justified through an analysis of alternatives (AOA).
- Consider waivers to regulations within DOD control that are restricting entry into the market.
- Fund technology development programs that support new innovations in production/manufacturing technologies that exceed typical progress curve improvements.
- Adjust the system requirements downward to allow more competition and consideration of commercial solutions.

The following sections discuss many of these concepts in greater detail.

Early and Effective Market Research

The program staff must begin market research early to understand the industrial base, weapon system being procured, applicable regulatory environment, political environment, budget situation, and ultimately, available competitors. This results in a program acquisition strategy that leads to the definition of work requirements and RFP specification and provisions. Determining which sources can provide the product/services and whether non-developmental items (NDI) can be used is the initial focus. This can be accomplished through RFIs, industry day meetings, in-depth web research, discussions with other government contracting and program offices, trade show attendance, and eventually one-on-one discussions with potential suppliers.

Requirements

PMs often eliminate competition possibilities early in the program's life cycle by making the requirements too detailed and too restrictive. The program office should initially release top-level requirements to industry that can be discussed during industry days and individual meetings. These discussions allow the program office to discuss and trade-off requirements in order to arrive at a healthy level of competition with a sufficient number of offerors. Overly restrictive requirements provided in the SOW or performance work statement (PWS) reduce the number of offerors and may prevent government access to proposals with superior performance and technology. For most programs, an AOA is developed to evaluate the alternative solutions that provide the required capabilities. A major challenge to recent programs is the insistence on high levels of technology and performance that result in major cost and schedule increases—as well as fewer potential competitors. A significant part of the program office evaluation should be tradeoffs between performance, schedule risk, and cost risk in the early phases of the program.

Communication between Competitors and the Government

As with all procurements, the PM should strive for maximum communication with competitors—early and often. The program office staff should take every opportunity to communicate their acquisition strategy plans—to include soliciting support and information up front on how to develop that strategy. Such interactions include:

- Frequent discussions and meetings during the development of the acquisition strategy, RFP, SOW, statements of objectives (SOO), etc.
- One-on-one meetings prior to the issuance of the RFP.
- Clear and meaningful discussions at the down-select and final decision.
- Industry days, as well as pre-solicitation and pre-proposal conferences, directly benefit the government by promoting a common understanding of the procurement requirements, constraints introduced by available technology, solicitation terms and conditions, and evaluation criteria.

These events also benefit industry—especially small businesses—by providing prime contractors and subcontractors an opportunity to meet and develop relationships or teaming agreements that benefit contract performance. However, the value of these events derives from the government providing the maximum information to potential offerors on its requirements, as well as answering questions and improving the solicitation based on potential offerors' feedback. The government also learns a great deal about the "art of the possible" through one-on-one discussions. In that way, the requirements can be made as clear as possible to assist potential offerors in providing the best solution to the government.

As long as the program office structures and executes an effective communications plan (i.e., shares all information in a timely fashion and keeps the competitors informed of key program issues), the majority of competitions will proceed on schedule with a lowered risk of protest.[16]

Clear RFIs and DRFPs to Solicit Information

Preparing a high-quality solicitation requires engaging with industry on issues that go beyond the government's technical requirements. In order to appropriately price proposals and reduce the number of potential contract changes, industry needs information about any unique terms and conditions, small business set-aside requirements, subcontracting goals, and other matters about which the contracting officer is the expert. As early as possible, the PM must be engaged with industry's best technical representatives and the contracting officer must ensure industry has as much information as possible about the government's business and source selection needs.

[16] "Myth Busting" Addressing Misconceptions to Improve Communication with Industry during the Acquisition Process, OMB Administrator for Federal Procurement Policy, 2 February, 2011.

As a result of early communication, the program team may learn that an approach somewhat different than originally planned may increase competition, enable more small business participation, lower prices, and/or provide a better definition to the government's technical requirements.

The program office should issue RFIs. Industry responses will provide key market capability information and also suggest potential acquisition strategy improvements to the program office. Draft requests for proposals (DRFPs) with near-final Section L, *Instructions to Offerors*, and Section M, *Evaluation Factors for Award*, should be used for major acquisitions. DRFPs permit detailed competitor feedback and allow industry to begin drafting proposals, both of which help the government to identify problems early.

Evaluation Factors and Criteria

In order for the government to conduct current and future competitions, potential competitors must be convinced that the evaluation will be fair and balanced. A key element of this is that the evaluation criteria allow for a relatively wide variety of alternative solutions to be offered and potentially selected. The government often deters competition by setting performance requirements too high or requiring key operational parameters that only one system can meet. Meaningful and effective proposal evaluation factors:

- Do not unnecessarily restrict competition,
- Allow for differentiation between offerors,
- Are focused on important attributes that are supportable by the end-users, and
- Are communicated with enough detail to allow offerors to self-evaluate their proposals.

There is an old myth that sharing evaluation details with offerors allows them to "game" their proposals to appeal to evaluators. If the evaluation process focuses on the most important criteria—PMs should want competitors' proposals to track to that criteria.

Technical Data Rights

The acquisition of technical data and necessary data rights must be a major consideration in the program acquisition strategy from the very beginning. As part of the MS A requirements, the PM must establish and maintain an intellectual property (IP) strategy to identify and manage the full spectrum of IP and related issues.[17] The IP strategy will describe how program management will assess program needs for—and acquire competitively whenever possible—the IP deliverables and associated license rights necessary for competitive and affordable acquisition and sustainment

[17] "Operation of the Defense Acquisition System," DODI 5000.02, Change 2, February 2, 2017, Paragraph 6a(4).

over the entire product life cycle. Such technical data may enable build-to-print competitions in production and/or competitions for major subsystems, spare parts, major modification or overhauls, and/or system maintenance.

At the same time, government PMs and contracting officers must completely understand that technical data often does not transfer with the sale of a weapon system or its parts. The law is very clear that government data rights are very limited and that only in cases where the government funded total development does the government enjoy full data rights. Every program should do a full cradle-to-grave data rights analysis as part of their life cycle strategy. Even if purchased items were commercially developed with no government funding, the government does not always receive full data rights

The law recognizes rights in data developed at private expense and limits the government's demands for delivery of that data. When such data is delivered, the government will acquire only data rights essential to its needs. Contractors may have legitimate proprietary interests in data; and to prevent the compromise of these interests, agencies shall protect proprietary data from unauthorized use and disclosure. The government should not use competition as a method to strong arm businesses into giving up their legitimate data rights.

Effectively planning a program's IP strategy requires the acquisition team to possess a good understanding of the laws and regulations related to the purchase of data and computer software, and associated data rights. The primary regulatory reference related to contractually implementing the purchase of technical data and computer software is FAR Part 27 and Defense FAR Supplement (DFARS) Part 227.[18] Several other helpful guides are also available to assist the acquisition team in applying the regulations to their program.[19]

Open System Architecture

The DOD open systems initiative began on November 29, 1994 when the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics (OUSD(AT&L)) directed all DOD components and agencies to use open systems specifications and standards for weapon systems acquisition. OUSD(AT&L) also chartered the Open Systems Joint Task Force (OSJTF) as a jointly sponsored body to provide oversight of the new policy's implementation.[20] The OSJTF charter was extended several times during the last 10 years with its mission, functions, and

[18] FAR Part 27, "Patents, Data and Copyrights," DFARS Subpart 227.71, "Rights in Technical Data" and Subpart 227.72, "Rights in Computer Software and Computer Software Documentation."
[19] See: "Army Guide for the Preparation of a Program Product Data Management Strategy (DMS)," Army Materiel Command Product Data and Engineering Working Group, August 31, 2010 and "Acquiring and Enforcing the Government's Rights in Technical Data and Computer Software under Department of Defense Contracts: A Practical Handbook for Acquisition Professionals," 6th Edition, USAF Space and Missile Systems Center, Office of the Staff Judge Advocate, March 2014.
[20] Office of the Deputy Assistant Secretary of Defense, Systems Engineering webpage: http://www.acq.osd.mil/se/initiatives/init_osa.html.

responsibilities transferred to the System and Software Engineering Directorate – now the Office of the Assistant Secretary of Defense for Systems Engineering (DASD(SE)). DODD 5000.01 mandates the use of a modular open systems approach (MOSA) by all programs, where feasible.[21]

MOSA, also called open systems architecture (OSA), is both a business and technical strategy for developing a new system or modernizing an existing one. Through OSA, acquisition and engineering communities are able to design for affordable change, employ evolutionary acquisition and spiral development, and develop an integrated roadmap for system design and development. Basing design strategies on widely supported open standards increases the possibility that future changes to the system can be integrated in a cost-effective manner.

Open systems employ modular design, use widely supported and consensus-based standards for their key interfaces, and have been subjected to successful validation and verification (V&V) tests to ensure the openness of their key interfaces. Open systems characteristics and principles may be dealt with as:[22]

- Design requirements (e.g., mandated open standards and protocols)
- Derived requirements (e.g., need for open interfaces to enable interoperability)
- Design constraints (e.g., need to adhere to open interface specifications as system components are designed)
- Architectural attributes (e.g., need for an adaptable, upgradeable, and reconfigurable system architecture)
- Design considerations (e.g., taking into consideration modular and open systems design benefits and concerns)
- Business strategies to gain access to competitive sources of supply and effectively manage technological obsolescence

Subcontract Competition

Prime contractors focus primarily on system integration and often subcontract 60%-70% of the contract value. The PM has a responsibility to ensure that primes are awarding these contracts using competitive procedures, when possible.

Additionally, program acquisition strategies must ensure fair and objective ‘‘make or buy’’ decisions by prime contractors on major defense acquisition programs (MDAPs) by requiring prime contractors to give full and fair consideration to qualified sources other than the prime contractor for the development or production of major subsystems and components.

[21] “The Defense Acquisition System,” DODD 5000.01, Enclosure 1, Paragraph E1.1.27, November 2007.
[22] Office of the Deputy Assistant Secretary of Defense, Systems Engineering webpage: http://www.acq.osd.mil/se/initiatives/init_osa.html.

Provide Adequate Time to Develop Competition and Prepare Proposals

PMs may feel pressured to rapidly get on contract and start their programs, sometimes at the expense of taking the time necessary to develop a comprehensive competition strategy. PMs must appreciate that it is worth the time to accomplish market research and develop sources and then provide adequate time for industry proposal preparation and government source selection activities.

While the FAR does contain some requirements on the length of time between issuance of solicitations and proposal due dates, often task and delivery order competitions within indefinite delivery/indefinite quantity (IDIQ) multiple award contracts (MAC) do not have these requirements. Contracting officers in all environments should allow offerors the time required by the circumstances of the acquisition (requirement and evaluation criteria complexity) to prepare their proposals. This will likely yield better proposals and streamline evaluation, as well as reduce the need for (or scope of) discussions. While today's workforce may be stretched thin and requirements often arise unexpectedly, shortcutting the solicitation and proposal development processes often results in fewer proposals and/or proposals that are more difficult to evaluate. Rushing through an acquisition can lead to expensive outcomes. Providing adequate time for vendor communication throughout the procurement process indicates that the government is sincerely interested in obtaining the best outcomes.

Competition and Commercial/Military Derivatives

One way to reduce barriers and increase competition, while reducing risk, is to minimize requirements so that off-the-shelf systems can compete. The use of off-the-shelf systems, either as starting points or as final production systems, allows for maximum competition from existing firms with minimal investment by the DOD. To execute this strategy, the PM must convince stakeholders that the possibility of lower risk in cost and schedule outweighs potential compromises on technical and performance requirements.[23]

The DOD has a long history of using commercial derivatives or existing military systems as the starting point for new weapon systems. The current US Navy (USN) P-8 Poseidon (Boeing 737), USN Joint High Speed Vessel (JHSV) (Austal High Speed Ferry), and US Air Force (USAF) KC-46 Tanker (Boeing 767) programs are all examples of weapon systems that quickly went into production due to their commercial origins.

[23] Successful Integration of Commercial Systems, Stockman, et al, Dayton Aerospace, 2011.

While this approach can save significant time and money, the following are major considerations for the PM:

- Commercial systems are optimized for a single mission to produce revenue at the lowest possible cost—so they have little excess performance margins. This means systems do not have excess structure, redundancy, or capability beyond that needed for their intended mission, i.e., they are not overbuilt. Military requirements may be quite different and broad, thus requiring extensive modifications. The program must do a comprehensive analysis of total military requirements prior to choosing a commercial system. Requirements are often compromised to meet budget and schedule, so PMs can rarely have everything they want.
- The PM must perform market research to determine total system operation and system support costs and effectiveness. The PM must also determine OSA standards compliance and support available through commercial systems. A key consideration is whether the DOD system will be able to take advantage of enhancements and upgrades that are occurring in the commercial market.
- Where possible, candidate systems should be tested in the environment in which they will operate. Any performance claims for a system based on future modifications should be heavily discounted for risk. Commercial systems operate in a rather benign environment compared to the military mission environment.
- PMs must seriously consider the long-term impacts of not having full access to system data (design, production, or test) as it will impact maintenance, modification, and operational costs. Commercial providers rarely sell complete technical data packages (TDPs).
- PMs must appreciate that commercial derivative source selections can be fundamentally different and much more difficult than traditional clean-sheet development program source selections. PMs must fully understand the competitors' strategies prior to developing a detailed evaluation model, solicitation instructions and evaluation plan which will become Sections L and M of the RFP. Sections L and M should be thoroughly vetted and dry run, then shared with the offerors.
- Different source selection criteria are necessary for commercial derivative candidates versus the traditional developmental systems. Commercial derivative program evaluation criteria should be heavily weighted toward operational demonstrations to verify achievement of system requirements.[24]
- Program teams should re-evaluate their selected requirements if the requirements may limit competition to only one or two competitors or drive potentially viable competitors away. Broadening requirements can open and increase competition.

[24] "Lessons Learned Applying Commercial off the Shelf Products," by Lisa Brownsword and Patrick Place, COTS-Based Systems Initiative, CMU/SEI-99-TN-015, June 2000.

- Most commercial systems employing open architecture designs are updated on a regular basis. The DOD must consider how defense-unique modifications and use impact their ability to take advantage of these upgrades.
- Military modifications of a commercial derivative system will not automatically be easier than a full-up development program. Early on, a clean sheet system's design can be adjusted to meet mission or mission equipment requirements. With a commercial derivative, the baseline system configuration will always constrain the design.
- Users should develop requirements that take maximum advantage of commercial items with previous commercial and government testing, as allowed under current statutes and regulations.
- The RFP should require offerors to explain how their past test plans support the new program and what additional testing will be required. The government must share their test requirements and test plans with commercial offerors.
- Competing commercial derivative systems allows for in-depth analysis of prior operational metrics and cost data as part of the decision process.
- Commercial producers with a long system production history will often provide significant discounts during the competition that would not be offered if it were a new product entering development.
- Competing commercial systems allow the government to take advantage of commercial parts pooling, commercial maintenance centers, and commercial systems engineering support/data that normally would not apply to traditional DOD programs.

Statutory and Regulatory Environment

PMs must be aware of the many laws and regulations that define the trade space for their acquisition program with the goal of improving cost, schedule, and technical performance. Competition must be considered for all phases of the program.

Competition in Contracting Act – 10 USC 2304

CICA establishes full and open competition as the standard for government contracting unless the acquisition falls under one of seven authorized exceptions.[25] Full and open competition means that all responsible sources are permitted to compete for government contracts. The procedural requirements established by CICA help to ensure the opportunity to compete, as well as a fair and equitable evaluation of competitive proposals. This 1984 legislation made many other changes intended to

[25] See: Federal Acquisition Regulation (FAR) Subpart 6.3, "Other Than Full and Open Competition."

improve industry access to solicitations, the fairness of proposal evaluations, and public transparency of federal contracting.[26]

Rights in Technical Data – 10 USC 2320

This law, originally passed in 1984, sought to balance legitimate contractor rights to protect technical data developed at private expense with the DOD's interest in obtaining and using technical data related to acquiring and sustaining military systems and equipment. This law forms the basis for current regulations[27] related to the purchase of technical data and computer software and associated rights to use and permit others to use this information.[28]

The underlying principles set forth in the law are:[29]

- In the case of an item or process developed by a contractor (or subcontractor) exclusively at private expense, the contractor may restrict the rights of the government to release, disclose, or permit the use of technical data by others outside of the government. This limitation does not apply to technical data that:
  - Represents a correction or change to government-furnished data.
  - Relates to form, fit, or function.
  - Is necessary for item operation, maintenance, or training.
  - Is otherwise publicly available or has been released or disclosed by the contractor or subcontractor without restriction on further release or disclosure.
- The government also may not limit the rights of any contractor with regard to patents, copyrights, or any other rights in technical data provided for under the law; nor may the government restrict the contractor's right to charge a royalty or fee to any third party for use of technical data regarding an item or process developed at private expense.
- In the case of an item or process developed by a contractor exclusively using federal funds, the government shall have an unlimited right to release, disclose, use, or permit the use of the technical data by others outside of government.
- The law further specifies that the DOD cannot require a contractor, as a condition of being responsive to a solicitation or as a condition for contract award, to sell or otherwise relinquish any rights in technical data to which the contractor is entitled. Neither can a solicitation require a contractor to refrain

[26] "Contracts: Competition Requirements," 10 USC 2304, Public Law 98-369, July 18, 1984.
[27] Defense FAR Supplement Subpart 227.71 and 227.72, in particular.
[28] For detailed guidance regarding data rights, see: "Acquiring and Enforcing the Government's Rights in Technical Data and Computer Software under Department of Defense Contracts: A Practical Handbook for Acquisition Professionals," 6th Edition, March 2014.
[29] "Rights in Technical Data," 10 USC 2320, Public Law 98-525, October 19, 1984.

from using an item or process to which the contractor is entitled to restrict rights in technical data.

Weapon Systems Acquisition Reform Act of 2009

The Weapon Systems Acquisition Reform Act (WSARA) prescribed a broad series of reforms intended to improve the overall cost, schedule, and performance outcomes of major acquisition programs.[30] Section 202 of the law focuses on development of acquisition strategies to ensure competition, or the option of competition, at both the prime contract and subcontract level, throughout the life cycle of major defense acquisition programs. Section 203 mandates the use of competitive prototyping for major programs, unless waived by the Milestone Decision Authority (MDA).

Federal Acquisition Regulation

The FAR and DFARS incorporate the prescriptions directed by CICA, including the rules regarding the use of competition, establishment of agency competition advocates, publication of procurement information, and guidelines for defining acquisition requirements. The FAR and supplements also prescribe acquisition planning requirements, market research guidance, a preference for NDI or commercial items, source selection guidelines, and rules related to technical data and data rights. The requirements of 10 USC 2320, *Rights in Technical Data*, are also incorporated within the FAR and DFARS.

DODI 5000.02 Operation of the Defense Acquisition System

DODI 5000.02 is the guiding instruction for the systems acquisition process. The instruction stresses the PM's responsibility to develop acquisition strategies which create and sustain a competitive environment from program inception through sustainment. DODI 5000.02 details many strategies that should be considered to establish this competitive environment. The importance of planning a program's IP strategy and the use of open systems and architectures are emphasized as key enablers of competition throughout the system's life cycle.

[30] "Weapon Systems Acquisition Reform Act of 2009," Public Law 111-23, May 22, 2009.

COMPETITION STRATEGIES

On cultural changes in acquisition program leadership: "One (approach) is to get beyond the checklist mentality, to actually really understand the job that has to be done and how to do it. So that when people are managing these programs, they don't just look for the school solution and check off the things that are on that list. They really dig in and understand what it takes to get the job done, work with industry to get it done."[31]

Honorable Frank Kendall, Former USD(AT&L)

Impacts of Competition

Competition benefits the DOD in many ways beyond simply the promise of lower program cost. In fact, competition by itself may not always generate significant cost savings, especially at the system level; but it will encourage technology development, provide new weapon system approaches, strengthen the industrial base, reduce program and schedule risk, and enable better collaboration between the contractor and the government.

Major cost savings may be achieved at the lower-tier supplier levels where there is a sufficient industrial base and major markets beyond the current program office requirements. Where lower-tier products require specialized development, however, the same system-level prime ground rules apply: without an upfront investment to develop competition, it may not be feasible.

The majority of theoretical cost savings result from EMD competitions, but a winner-take-all (WTA) approach creates a "franchise" for the winner that often lasts for decades. Dual sourcing is possible, but only if there is a sizable production program and the second source can be brought on at a relatively low cost. Re-competition may generate savings if the outside sources can qualify themselves through similar program experience or privately-funded development. However, program offices must understand that new competitors will often out promise the incumbent, but then have a high risk of failing to deliver on cost, schedule, or quality. Existing research is unclear on whether re-competitions or dual sourcing actually reduces the total cost to the government. [32]

Program offices must be cognizant of impacts to teaming arrangements while at the same time conducting multiple competitions. Unless the team compositions remain the same, there is a high chance that changing teams will undermine the government desire

[31] "Interview: Frank Kendall, US Undersecretary for Acquisition, Technology and Logistics," Muradian, Vago, Defense News, August 5, 2013.
[32] "The Mechanisms and Value of Competition for Major Weapon Systems," Dominy, et al; Institute for Defense Analysis (IDA), April 2011.

for cooperation and sharing of data within a team. This contributes to program risk and reduces technical innovation.

Competition Advocates

The head of each federal executive agency is required by law[33] to designate, for the agency and for each procuring activity within the agency, individuals to serve as the Competition Advocate for the agency and each procurement activity. These advocates are responsible for promoting the acquisition of commercial items, promoting full and open competition, and challenging requirements that are not stated in terms of functions to be performed, performance required, or essential physical characteristics. The advocates are also tasked to identify and challenge barriers to commercial item acquisition and full and open competition such as unnecessarily restrictive SOWs, unnecessarily detailed specifications, and unnecessarily burdensome contract clauses.[34]

Competition Advocates annually review and report on competition implementation at the procurement activities which they oversee,[35] as well as review and approve certain justifications for other than full and open competition for certain acquisitions.[36]

PMs and contracting officers may find it helpful to consult with the procurement activity's Competition Advocate early during the acquisition process to help identify potential competition impediments and develop mitigation strategies. The Competition Advocate can be a convenient source of lessons learned about providing for full and open competition and/or acquisition of commercial products and services.

Competition Case Studies

Chapters 2-5 of this guide conclude with several in-depth case studies which provide insight into competitive strategies used for various DOD weapon system programs. Throughout each chapter, there are also brief summaries, presented in shaded boxes, which highlight competitive approaches used by other programs. These case studies are helpful examples for acquisition teams to consider as they develop strategies for their programs. Many of the case studies serve to highlight the complexities and challenges associated with successfully introducing competitive strategies.

While no program should ever simply and wholly adopt the approach used by another program, it can be useful to examine approaches used by other PMs and DOD organizations. The PM will undoubtedly find many other examples within their particular organization that may be more closely aligned to the nature of their program.

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[33] Title 41 United States Code, Section 1705, "Advocates for Competition," current as of Public Law 111-350, Section 3, January 4, 2011.
[34] FAR 6.502(a), "Duties and Responsibilities (of Competition Advocates)."
[35] FAR 6.502(b).
[36] FAR 6.304(a)(2) designates the procuring activity competition advocate as the approval authority for justifications over $650,000 but not exceeding $12.5M. Most agencies require competition advocate coordination on justifications exceeding $12.5M which require approval at higher levels.

COMPETITION DECISION FRAMEWORK

A detailed discussion of the competition decision framework (CDF) is presented in Chapter 6 of this guide. The framework includes four steps which are depicted in Figure 1. First, assess technical, programmatic, and market considerations to determine whether a competitive strategy is feasible. Second, determine the desired competition strategy for the program's life cycle. Third, complete a CBA to determine whether any added costs necessary to implement competition are greater or less than the estimated value of benefits. Finally, document the results of steps 1-3, which form the basis for the competition decision.

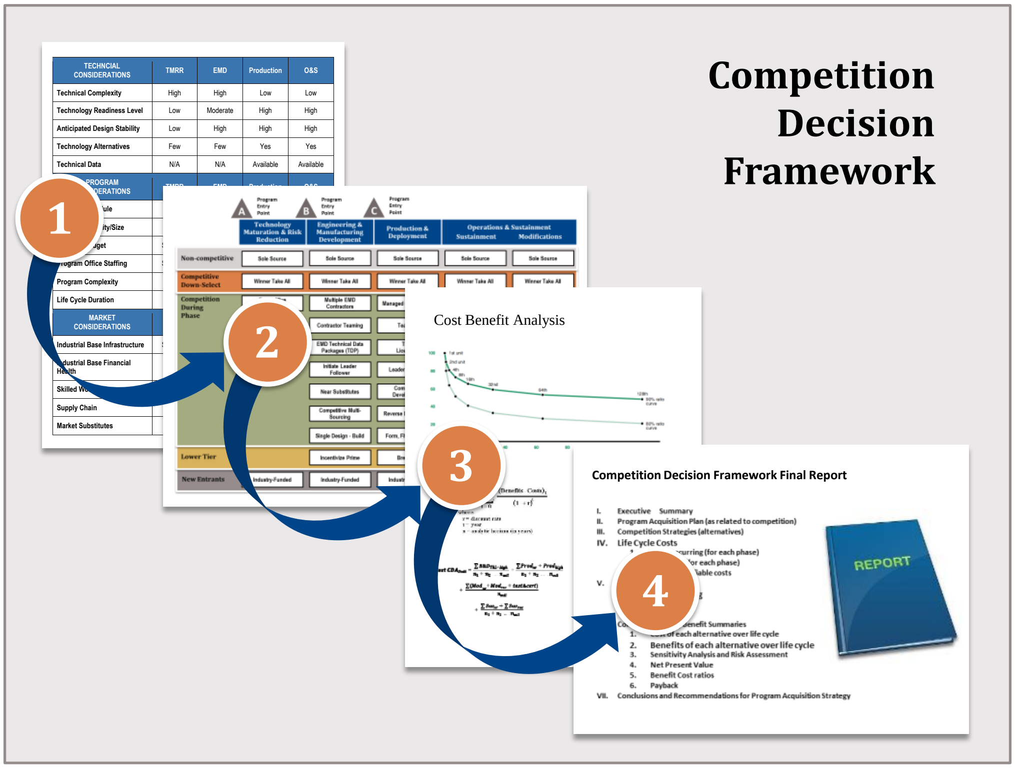

Figure 1 Competition Decision Framework

Competition Considerations

Table 2 shows a summary evaluation of competition considerations. These considerations are fully explained in Chapter 6. The complete evaluation looks at three major considerations through the entire life cycle of the program: technical, program, and market. The technical evaluation considers all elements that make up the program's technical risk and how that risk changes relative to competition. The program evaluation considers how the program structure impacts competition and government program office requirements. The final area, market considerations, evaluates the industrial base infrastructure and its ability to support a government competition. The outcome of this evaluation is a positive or negative recommendation to develop a detailed competitive strategy.

Table 2 Competition Decision Considerations

TECHNCIAL CONSIDERATIONS	TMRR	EMD	Production	O&S
Technical Complexity	High	High	Low	Low
Technology Readiness Level	Low	Moderate	High	High
Anticipated Design Stability	Low	High	High	High
Technology Alternatives	Few	Few	Yes	Yes
Technical Data	N/A	N/A	Available	Available
PROGRAM CONSIDERATIONS	**TMRR**	**EMD**	**Production**	**O&S**
Phase Schedule	Short	Long	Long	Long
Program Quantity/Size	Large	Large	Large	Large
Program Budget	Sufficient	Sufficient	Constrained	Constrained
Program Office Staffing	Sufficient	Sufficient	Sufficient	Sufficient
Program Complexity	High	Moderate	Low	Low
Life Cycle Duration	Long	Long	Long	Long
MARKET CONSIDERATIONS	**TMRR**	**EMD**	**Production**	**O&S**
Industrial Base Infrastructure	Sufficient	Sufficient	Sufficient	Sufficient
Industrial Base Financial Health	Good	Good	Good	Good
Skilled Workforce	Available	Available	Available	Available
Supply Chain	N/A	Good	Good	Good
Market Substitutes	No	Yes	Yes	Yes

Life Cycle Competition Strategies

The second step addresses the numerous potential competitive strategies which may be considered at each phase of the systems acquisition life cycle. Potential competitive strategies for each acquisition phase are presented in Chapters 2-5 and are summarized in Figure 2. As depicted, programs may enter the acquisition process following any one of three milestone decision points corresponding to the start of three different acquisition phases. The primary focus of this guide is on the strategies that enable competition ***during*** an acquisition phase or otherwise posture a program for competition for a future phase, as opposed to competition ***for*** a phase leading to a winner-take-all situation and potentially resulting in a non-competitive follow-on phase. When competition is not possible at the system level, programs may gain some benefits from competition at lower tiers and, in some cases, new industry sources may enter into competition due to privately funded development.

A Program Entry Point — B Program Entry Point — C Program Entry Point

	Technology Maturation & Risk Reduction	Engineering & Manufacturing Development	Production & Deployment	Operations & Sustainment: Sustainment	Operations & Sustainment: Modifications
Non-competitive	Sole Source	Sole Source	Sole Source	Sole Source	Sole Source
Competitive Down-Select	Winner Take All	Winner Take All	Winner Take All	Winner Take All	Winner Take All
Competition During Phase	Competitive Severable Tasks	Multiple EMD Contractors	Managed Competition	Competitive PSI	Performance-Based
	Competitive Similar Tasks	Contractor Teaming	Teaming	Competitive CLS	OSA Upgrades
	Competitive Prototypes	Acquire Technical Data Package (TDP)	TDP/ Licensing	TDP Spare Parts	TDP Enabled
		Initiate Leader Follower	Leader Follower	TDP Repair & Maintenance	Form, Fit, Function
		Near Substitutes	Commercial Development	Reverse Engineering	Substitution
		Competitive Multi-Sourcing	Reverse Engineering		Separate Production/Install
		Single Design - Build	Form, Fit, Function		Credible Threat
Lower Tier		Incentivize Prime	Breakout	Breakout	Breakout
New Entrants	Industry-Funded	Industry-Funded	Industry-Funded	Industry-Funded	Industry-Funded

Figure 2 Competitive Strategy Alternatives

During the operations and support (O&S) phase, developing and preserving options for competitive sustainment and/or modification of fielded systems is of primary concern. The feasibility of competition during the O&S phase is highly dependent on actions taken (or not taken) during the EMD and production and deployment phases.

Cost Benefit Analysis

The third step of the CDF is to complete a detailed CBA. This analysis should consider all life cycle phases to determine if the competitive savings in production and O&S recoup the investments made in earlier phases to establish the competition. In addition to the quantified costs and benefits, the program office must also evaluate the non-quantified cost, benefits, and risks of these competitive approaches.

Documentation

The final step is to document the evaluation and competition decision as part of the acquisition strategy. This analysis should be accomplished at program inception and updated when conditions impacting the strategy change.

2. Technology Maturation & Risk Reduction Phase

IMPLEMENTING COMPETITION

"Prototyping during the Technology Development (TD) Phase can be a valuable tool to reduce risk prior to entering Engineering and Manufacturing Development (EMD), but only if the prototyping is focused on reducing the specific technical risks in the design for the actual product that will be designed and tested in EMD. The data of the last several years of TD phase prototyping programs demonstrates that in many cases, the Government failed to require meaningful risk reduction during the TD phase. Industry is motivated primarily to win the follow-on EMD phase, and the Government has been permitting industry to conduct prototype TD programs designed to meet nominal Technology Readiness Level (TRL) 6 criteria, but without the needed connection to the risks in the product that will actually be built."[37]

Honorable Frank Kendall
Former Under Secretary of Defense
Acquisition Technology & Logistics

[37] "Implementing Directive for Better Buying Power 2.0 – Achieving Greater Efficiency and Productivity in Defense Spending," OUSD(AT&L) Memo, April 24, 2013.

INTRODUCTION

The TMRR phase was previously known as the technology development (TD) phase. This chapter's introductory quote provides the primary rationale for renaming and refocusing efforts accomplished during this phase.[38] TMRR follows a DOD decision to commit resources toward pursuing a specific product or design concept. In effect, this is the phase where most acquisition programs are "born." During this phase, the initial contracts to begin the process of designing, developing, producing, fielding, and sustaining major weapon systems are awarded.

Goal of the TMRR Phase

As the title suggests, the goal of this phase is to mature critical technologies and reduce risks associated with the selected product or design concept. More specifically, the purpose of the phase is to reduce technology, engineering, integration, and life cycle cost (LCC) risks to the point that a decision can be made to contract for EMD with confidence in successful program execution for development, production, and sustainment.[39] Depending on the specific program risk reduction requirements, a variety of contract efforts may be required during this phase including:

- Design or requirements trade studies to assess costs and risks of potential alternative technologies or designs necessary to develop the end product.
- Focused technology maturation efforts for technologies assessed at low maturity or technical readiness levels (TRLs).[40]
- Design and fabrication of prototypes or performance of demonstrations focused on identified technology, engineering, integration, and development risks.
- Development and assessment of risk reduction prototypes at the system, subsystem, and/or component levels.
- Demonstrations of technology capabilities in a relevant environment.
- System design activities up to and including a Preliminary Design Review (PDR).[41]
- Competitive system or subsystem-level prototypes.

Impact of Earlier Life Cycle Management Phases

While TMRR is the phase where major acquisition programs are "born," efforts to be accomplished during TMRR are definitively impacted by the prior phase, the materiel

[38] The name and guidance changes applicable to this phase were implemented by Interim DODI 5000.02, Operation of the Defense Acquisition System, 26 Nov 2013
[39] DODI 5000.02, paragraph 5.d(4)(a)
[40] Technology Readiness Level (TRL) is a nine-tier rating system used to assess technical maturity
[41] PDR is a technical assessment of the proposed design to ensure that each functional (performance) requirement is appropriately allocated to product specifications for one or more system configuration items in order to ensure a system will be operationally effective. PDR must be completed prior to Milestone B for all Major Defense Acquisition Programs; reference DODI 5000.02, para 5.d(7).

solutions analysis (MSA) phase. MSA begins with a decision that a new capability is required to satisfy a warfighter operational need. The MSA is primarily focused on analyzing alternative solutions to fulfill the operational need. A major end product is an AOA which documents the results and provides a recommended solution for satisfying the need. The AOA provides an important basis for the decision to proceed with an acquisition program and the determination of the appropriate phase for the program to begin.

The next phase after MSA could be TMRR, EMD, or even production and deployment, depending on the actions necessary to mature or develop the product to be acquired. For example, the AOA might support a decision to acquire an existing system (either a system already in use by another military component or a commercially available product fully suitable for satisfying the need), which may allow the program to proceed directly to a MS C decision and the award of a contract or contracts for production of the end item. More commonly, the decision is made to begin a new program at either MS A (entry to TMRR) or MS B (entry to EMD) because design, development, and testing efforts are required before the product can be produced.

The opportunity to effectively leverage competition at the very initiation of a program is directly dependent on the results of the MSA and the point at which a new program will begin. Programs beginning at MS A or B usually offer a range of competitive alternative strategies. Programs that begin at MS C may offer only limited or no opportunities for competition.

In the last decade, several acquisition programs began as follow-on efforts to an Advanced Technology Demonstration (ATD), an Advanced Concept Technology Demonstration (ACTD),[42],or a Joint Capability Technology Demonstration (JCTD). These demonstrations are initiated independent of an established acquisition program and are normally led by one of the defense laboratories. Major programs that began as demonstrations include the Predator[43] and Global Hawk unmanned aerial vehicles (UAVs). Many other smaller programs resulted in the rapid production and fielding of required military capabilities, including: unattended ground sensors, combat identification, battlefield awareness and data dissemination, counter-proliferation technologies, navigation warfare, and human intelligence support tools.[44] ACTDs are intended to rapidly prototype and demonstrate improved military capabilities to the warfighter by leveraging advanced and innovative—but mature—technologies. The primary advantage over the traditional acquisition program is that these demonstrations are executed quickly, usually in two to four years.

[42] ACTDs are not acquisition programs and yet should not be science projects; they are intended to rapidly prototype and demonstrate emergent mature technologies with potential to meet critical warfighter requirements.
[43] "The Predator ACTD: A Case Study for Transition Planning to the Formal Acquisition Process," RAND, 2002.
[44] "Defense Acquisition: Factors Affecting the Outcomes of Advanced Concept Technology Demonstrations," GAO, December 2002.

Transitioning a successful technology demonstration to a formal acquisition program can present unique challenges for the PM because many of the deliberate steps in the early phases of the formal acquisition process intended to ensure supportability and enable future competition are potentially bypassed to achieve the desired rapid development and demonstration schedule.[45] Some ACTDs that become acquisition programs enter the acquisition process at MS C (entry to the production phase) and, in many cases, the system design is complete, or nearly complete, and the end item can only reasonably be acquired non-competitively from the contractor originally selected to participate in the demonstration program.

Competition Opportunities & Constraints

Competition ***for*** TMRR contracts is the norm during the TMRR phase because few, if any, impediments to competition exist at this point in the acquisition program's life cycle. Unless the AOA resulted in a decision to leverage an existing product (commercial or military) to meet warfighter needs, the phase begins with a near "blank slate." Competition ***during*** the TMRR phase (i.e., awarding more than one contract) is also fairly common because the phase is the most reasonable and effective point in the development of a new system to actually implement beneficial competition.

Competition Environment

Typically, no prior effort has been accomplished that creates restrictions limiting acquisition of TMRR efforts to a single source. Depending on the specific product being developed, however, it is possible that there will only be a limited number of contractors with the capabilities required to produce the end item. For example, if the end item is a ship, armored vehicle, missile, or aircraft, only a limited number of sources are capable of production due to the unique facilities and expertise necessary to develop and manufacture these products. Even in those situations, however, there may be the opportunities for broadly inclusive competitive procedures, since there are often many contractors, including small businesses, capable of conducting focused technology maturation efforts or performing design and requirements trade studies.

Due to the relatively low cost of many TMRR efforts, the PM may choose to award multiple contracts to different contractors performing similar efforts. This approach not only mitigates the risk that a single contractor may fail to accomplish the desired results, but also helps to posture multiple sources as potential competitors for follow-on development efforts.

Use of Government Sources

In addition to the availability of multiple contractors for TMRR, some work may also be suitable for performance by government research entities. The DOD enterprise

[45] "Defense Acquisition: Advanced Concept Technology Demonstration Program Can Be Improved," General Accountability Office (GAO), October 1998.

includes over 40 specialized laboratories, employing more than 38,000 scientists and engineers who perform more than $30B in R&D efforts annually.[46] Each laboratory maintains its own specialized core technical competencies and focus areas geared toward their military component's unique technology interest areas. The DOD labs perform a broad range of research up to and including the development of prototypes. A major advantage of using a DOD laboratory is, in most cases, any IP developed by the lab can be freely transitioned to industry which can increase competition for product development. Government labs may also partner with industry or academia, thereby bringing together the unique facilities and capabilities of both public and private sources.

Specialized Methods and Agreements

The TMRR phase offers opportunities to use several unique methods and agreements, beyond traditional contracts, to acquire technical development efforts. Some of these methods are specifically designed to enable industry partnerships with DOD laboratories. A detailed discussion of these instruments and programs is beyond the scope of this guide, but each approach offers certain advantages that may benefit individual acquisition programs. The PM and acquisition team should consider the applicability of these specialized authorities and instruments to the TMRR phase of their program. The following methods and instruments, all of which can be competitive, may be used:

- **Small Business Innovative Research (SBIR)**: This program was designed to strengthen the role of innovative small business concerns in federally-funded R&D.[47] A pool of centralized funding is available to support Phase I SBIR projects from which acquisition programs may benefit.
- **Small Business Technology Transfer (STTR)**: This program was designed to stimulate partnerships of ideas and technologies between innovative small businesses and government-funded research institutions.[48] This program is specifically intended to mature and commercially transition innovative technologies that may benefit the public and private sectors.
- **Cooperative Research and Development Agreements (CRDAs)**: This is a written agreement wherein a federal laboratory and a non-federal entity, or entities, enter into a partnership involving sharing resources (but not the transfer of funds) to develop and transition technology.[49] This form of agreement is also focused on technologies with potential dual use (public-private) applications.

[46] Office of the Assistant Secretary of Defense for Research and Engineering, Directorate of Research, Defense Laboratory Enterprise, January 2014, http://www.acq.osd.mil/rd/laboratories/labs/list.html
[47] Small Business Administration (SBA), Small Business Innovative Research Program Policy Directive, October 18, 2012
[48] SBA, Small Business Technology Transfer Program Policy Directive, October 18, 2012.
[49] CRADAs are authorized by 15 U.S.C. 3710a

- **Other Transactions (OTs)**: For the DOD, the term "other transactions" commonly refers to the 10 USC 2371b authority to enter into transactions other than contracts, grants, or cooperative agreements. Because OTs are not subject to federal laws applicable to traditional procurement contracts, they offer great flexibility and can encourage broad open-market competition, particularly for prototype development.[50] OTs are particularly useful for engaging commercial sources who do not regularly engage in government contracts due to the large number of mandatory terms and conditions applicable to most contracts.

Planning for Competition

Typically, the most significant impediment to competition during TMRR is the availability of resources. Available program funding may limit the PM's ability to engage multiple sources to mature technologies or develop prototypes. Limited program office manpower may also impede the implementation of desirable competitive initiatives, particularly the award and management of multiple, competitive prototype contracts. The PM must assess the costs and benefits of engaging multiple sources. The results of a CBA may be used to support a resource reallocation, if the potential benefits are deemed to be significant. The added resources required to contract with multiple contractors during the TMRR phase are relatively small compared to the resource demands associated with continuing competition during EMD; for this reason, any decision to award to only a single contractor should carefully consider competitive program benefits that may be sacrificed.

TMRR is the most important phase from the perspective of planning for and initiating actions intended to sustain competition across the system's life cycle. Decisions made and actions taken during this phase have the potential to create increased opportunities for future competition or cause significant competition impediments. This is why DODD 5000.01 mandates that acquisition managers take all necessary actions to promote a competitive environment, including the consideration of alternative systems to meet stated mission needs and structuring science and technology investments and acquisition strategies to ensure the availability of competitive suppliers throughout a program's life.[51]

The remainder of this chapter addresses general techniques and specific strategies that enable competition during the TMRR phase and posture the program for competition in subsequent phases.

[50] "Other Transactions (OT) Guide for Prototype Projects," OUSD(AT&L), January 2001.
[51] "The Defense Acquisition System," DODD 5000.01, Enclosure 1, paragraph E1.1.3, dated May 12, 2003 but certified current as of November 20, 2007.

Applicable Laws and Regulations

In addition to the general laws, policies and regulations related to applying competition discussed in Chapter 1, there are a few laws, regulations, and policies which are specifically focused on and impact acquisition planning for the TMRR phase.

Weapon System Acquisition Reform Act of 2009

Section 203 of WSARA mandated the use of competitive prototyping for MDAPs[52] prior to MS B, unless waived by the MDA. Waivers may only be approved if the cost of producing competitive prototypes is estimated to exceed the LCC benefits of producing the prototypes or if the waiver is required to meet critical national security objectives. Approved waivers must be submitted to the Congressional Defense Committees within 30 days of approval, along with supporting rationale, and are subject to a review and report to the defense committees by the Government Accountability Office (GAO), to be completed within 60 days of receipt.[53]

DODI 5000.02, Operation of Defense Acquisition System

In addition to incorporating the WSARA requirements related to competitive prototyping,[54] DODI 5000.02 emphasizes that decisions made during the early phases of an acquisition program (i.e., TMRR and EMD) can either improve or reduce program management's ability to maintain a competitive environment throughout the life cycle of a program.

DOD Better Buying Power 2.0 Policy Directive

The Better Buying Power (BBP) 2.0 memorandum highlights the importance of using the TMRR phase for true risk reduction, i.e., acquiring the "right" efforts to truly reduce the risk of successfully completing the EMD phase. BBP 2.0 also encourages increased opportunities for small businesses to participate and compete in defense acquisitions. TMRR typically affords many opportunities for small business participation because there can be many different types of effort acquired during this phase, many of which may be suitable for award to small businesses.

[52] MDAPs are ACAT I programs estimated to require an eventual total expenditure for research, development, test, and engineering (RDT&E) exceeding $480M or more than $2.79B for procurement (both amounts are in fiscal year 2014 constant dollars). Reference Interim DODI 5000.02, Enclosure I, Table 1: Description and Decision Authority for ACAT I – III Programs.
[53] WSARA, Section 203, January 6, 2009.
[54] DODI 5000.02, Paragraph 5.d(4)(b)2.

GENERAL COMPETITIVE METHODS & TECHNIQUES

PMs should use several "tried and true" methods to increase competition for any acquisition, regardless of which part of the system's life cycle is being executed. These general methods are addressed thoroughly in this section since the TMRR phase is where acquisition programs often begin. However, the methods presented here should be considered and applied to every phase of systems acquisition.

Thorough Market Research

Market research is a continuous process for gathering information about product characteristics, suppliers' capabilities, and customary business practices to support market analysis. Market analysis uses the information collected to support decision-making and develop acquisition strategies that leverage market capabilities and implement competition. Understanding what the market can offer should always be the first step in planning effective acquisition strategies. Beyond leveraging existing products, market research also helps to identify small businesses capable of meeting government requirements, which helps strengthen the industrial base and often saves money.

Market research is a valuable tool because it helps the PM identify sources that are capable of performing the efforts to be acquired. The results of market analysis can also be used to craft functional/product specifications and/or work statements in a manner that facilitates competition.

Another purpose of conducting market research is to determine the availability and suitability of commercial and non-developmental items (NDI) and whether these items can be used as-is, or modified, to fulfill government requirements.[55]

Leveraging commercial and NDI products offers the potential to save money by reducing the amount of government-funded development required and the risks associated with such development. In some cases, market research may identify existing items that are not suitable for competitive procurement because only one source manufactures the item. In most cases, however, market research is very effective for identifying competitive sources and alternative products that are potentially capable of satisfying the government's requirements.

Early and Frequent Communication with Potential Sources

The best way to ensure multiple sources can compete to fulfill program requirements is to open effective two-way communication channels with industry as early as possible and then keep those channels open as program planning matures. If industry is aware of potential future requirements aligned with their capabilities, they will prepare to respond when the solicitation is released. More importantly, potential sources can provide valuable input regarding possible alternative solutions, helping the

[55] "Market Research" Federal Acquisition Regulation, Part 10, February 2013.

government craft solicitation requirements which enable a breadth of competitive responses. In general, the best decision or solution is one selected from a broad range of alternatives.

Effective use of communication is key to ensuring contract awards yield best value solutions. Effective communication methods include published pre-solicitation notices, industry days, interactive webinars, small business conferences, pre-solicitation conferences, pre-proposal conferences, site visits, and one-on-one meetings. Despite the well-demonstrated benefits of open communication regarding government acquisitions, there is sometimes resistance (by both industry and government) to truly embrace early, frequent, and constructive engagements. This resistance is based on many common misperceptions and concerns regarding communications with industry. In recognition of this reality, the Office of Federal Procurement Policy (OFPP) Administrator issued a helpful memorandum in February 2011 titled, *Myth Busting: Addressing Misconceptions to Improve Communications with Industry during the Acquisition Process*.[56] The 2011 OFPP memo addressed ten specific misconceptions and was followed by a May 2012 OFPP memo[57] addressing nine additional misconceptions.

Performance-based Requirements

Describing contract outcomes in a performance-based manner, rather than detailing specific products, designs or how-to task requirements, is an effective strategy to encourage innovation and facilitate competition. Much of the existing policy and guidance related to performance-based requirements are focused on service contracts[58] and logistics support,[59] but the same concepts can be applied to product design and development efforts. This approach is particularly applicable to the TMRR phase when specific designs are not yet established and a variety of technical approaches may be used to achieve the desired technology maturation and/or risk reduction outcomes.

Performance-based requirements are written to describe measurable outcomes (what) rather than specific tasks to be performed (how). This gives offerors flexibility to propose cost effective and innovative ways to achieve the results. The approach is demonstrated to increase competition and reduce cost.

Performance-based requirements permit contractors to propose alternative solutions and/or approaches leveraging their existing products, technologies, and established best practices. This allows the government to select the best solution from a wide range of alternatives, each offering different cost/price and performance risk attributes, as opposed to all contractors proposing to perform the same government-prescribed

[56] “Myth Busting: Addressing Misconceptions to Improve Communications with Industry during the Acquisition Process,” Office of Federal Procurement Policy (OFPP), February 2, 2011.
[57] “Myth-Busting 2: Addressing Misconceptions and Further Improving Communication during the Acquisition Process,” OFPP, May 7, 2012.
[58] “Guidebook for Performance-Based Services Acquisition (PBSA) in the Department of Defense,” OUSD(AT&L), December 2000.
[59] “Performance Based Logistics Comprehensive Guidance,” ASD(LMR) Memorandum, November 22, 2013.

approach. A performance-based approach may also shift risk from the government to the contractor by making the contractor responsible for achieving the required outcomes (rather than simply performing government-defined tasks). Market research should be used to establish performance-based requirements and, where applicable, incentives that drive innovation, reduce cost, and facilitate increased competition.

Use of Open Systems Architecture

OSA strategies may be employed to overcome barriers to competition through the application of open standards and established business model principles. OSA is particularly valuable for development and sustainment of today's highly integrated, software-intensive systems. OSA combines technical practices designed to reduce cycle times needed to develop new systems and upgrade legacy systems, with business models that foster a more competitive marketplace and a more effective strategy for managing IP rights.

The essence of OSA is an organized decomposition of system functions, using carefully defined execution boundaries, layered onto a framework of software and hardware shared services resulting in a well-documented modular design.[60] OSA mandates that technical requirements must be based, to the maximum extent practicable, on established standards. Where there are no standards, the OSA methodology creates them. At a minimum, technical standards and related specifications, requirements, source code, metadata, interface control documents (ICDs), and any other implementation and design artifacts that are necessary for a qualified contractor to successfully perform development or maintenance work for the government are acquired and made available throughout the life cycle.

OSA enables competition when acquiring system upgrades and also makes it feasible to apply competition at the subsystem level during development and/or production. The OSA approach is especially well suited to programs using spiral development or modular acquisition approaches and may facilitate competition for future developmental increments. OSA also provides competitive options to manage technological obsolescence.

OSA cannot eliminate all risks of transitioning to a new competitive source at any point during the system's life cycle; but the approach helps to reduce risk and the cost of such transitions. Even when competition is not introduced, OSA creates a viable threat of competition because new sources can be brought into the program without the substantial cost and potential negative programmatic impacts that might otherwise be encountered. The threat of competition can be a powerful motivator for prime contractors to find innovations that improve system performance and reduce costs.

Additionally, to foster competition at the lower tiers, the PM should consider incentivizing prime contractors to use OSA in the design phase so that alternate sources

[60] "DOD Open Systems Architecture: Contract Guide for Program Managers;" Version 1.1; DOD Open Architecture Data Rights Team; June 2013.

can be tapped to develop "plug and play" capabilities with modular, standard interfaces.

Planning for and Managing Intellectual Property Rights

A program's IP strategy must be addressed in the acquisition strategy and Life Cycle Sustainment Plan (LCSP) to identify short and long-term needs required to achieve competition in design, manufacture, and sustainment. Data and license rights (agreements that provide the government certain rights to use technical data or computer software for certain purposes) are particularly critical to enable competition during the O&S phase given the often significant costs of supporting systems which may remain in operational use for decades. Even though technical data and software rights may not be required until much later in the system's life cycle, actions must be initiated during the TMRR and EMD phases to secure necessary data rights.

Data and usage rights are needed for both in-house maintenance (e.g., organic field and depot-level) and supplies and services to be competitively purchased from industry sources. The IP strategy must align with the overall program strategy, considering plans such as dual sourcing during production, organic maintenance requirements, and other product support strategies. At a minimum, technical data should be sufficient to permit recurring owner/operator maintenance and re-procurement of spare and repair parts from the actual manufacturer. The DOD is entitled to receive unlimited rights in technical data that is "necessary for installation, operation, maintenance, or training purposes"[61] (note this does not include detailed manufacturing or process data). If the prime contractor provided for competition at sub-tier levels, the government should obtain the data necessary to leverage or sustain this competition later during the system's life cycle.

Beginning with the very first contracts issued in support of a program, the PM should pay close attention to IP being used, created, and/or delivered during contract performance to ensure the government actually obtains the rights to which it is entitled.[62][63] While the government cannot require a contractor, as a condition of receiving a contract, to surrender rights to which the contractor is entitled, the availability of data and software rights can be a source selection evaluation consideration. When the government funds development activities, it is generally entitled to obtain technical data and software rights related to that development. However, the government must remain vigilant to ensure these rights are not lost. The PM should carefully monitor data deliverables to ensure markings are in accordance with data rights assertions and contract clauses. Non-conforming and unjustified technical data markings must be challenged and corrected.

[61] DOD FAR Supplement 227.7103-5 Government rights, paragraph (a)(5).
[62] "Patents, Data, and Copyrights," FAR Part 27, Subpart 27.102, "General Guidance," as of 1 Oct 2010.
[63] FAR Part 27, Subpart 27.402 (b), "Policy," as of 1 Oct 2010.

With prudent planning and management, the PM can obtain technical data and software, along with the necessary rights to provide for competition consistent with the program acquisition strategy, across the system's life cycle.

SPECIFIC COMPETITIVE METHODS & TECHNIQUES

As previously stated, competition is almost always used to solicit and award contracts ***for*** *the TMRR phase. It is unlikely that any of the circumstances permitting the use of "other than full and open competition," as described at FAR 6.302, will exist at this early point in an acquisition program's life cycle. The major question is whether competition will continue* ***during*** *the TMRR phase; that is, will multiple contractors be selected to perform the required TMRR activities?*

Introduction

Perhaps the most significant benefit of competition during TMRR is the reduction of technical risk. If two or more sources receive contracts for TMRR efforts, the probability of success is increased. Success, in this case, is not limited to simply meeting the phase's technical objectives; it includes the probability of obtaining the best possible final solution from a cost, schedule, and performance perspective. Different technical and programmatic approaches defined at this point have the potential to yield significantly different long-term outcomes. Simply put, the best solution is almost always one selected from a range of alternatives. At this early point in a program it is wise to remain open to alternative solutions, rather than focusing too early on a single approach.

If, on the other hand, the competition results in the award of a single contract for the required technical effort, the program's future is dependent on that single outcome. It may not be a good idea to "put all your eggs in one basket" by awarding TMRR efforts to a single source, especially if technical risks are high. If the single source fails, the PM will have no option but to start over or continue working with the original source as cost grows and schedules lengthen. Further, without multiple participants in the TMRR phase, it will be more difficult to sustain or reintroduce competition during follow-on phases. For this reason, the PM should consider approaches which engage two or more sources in performing required efforts. There are a few different approaches to engaging multiple sources, each of which offers different benefits and requires different levels of investment.

Although competition to receive a contract is the norm, there may be good reason to use full and open competition after exclusion of sources as envisioned by FAR 6.202, such as establishing alternative sources or set-asides to small business sources. The work to be accomplished may be very suitable for performance by small businesses and the program may also benefit from innovative approaches small businesses offer. While less common, the TMRR phase may also be an appropriate time to invoke the FAR 6.202 authority to exclude a specific source in order to develop an alternative source to increase or maintain competition—which is likely to result in reduced overall costs for the acquisition.

Separate Contract Awards for Severable Efforts

In some programs, it is possible to identify severable TMRR efforts, each of which is suitable to be competed and awarded to separate contractors. This situation is most likely to apply to subsystem technologies associated with the system to be developed and produced. For example, a missile program may require technology maturation efforts focused on the motor, fuse, and guidance system, or an aircraft program may require engine, sensors, and avionics technology maturation efforts. This approach can also be effectively used for high-cost items like ships and satellites requiring a wide range of technologies.

An advantage of this method, as compared to consolidating and soliciting the entire TMRR scope of effort, is that competitors will likely be subsystem providers rather than major system-level prime contractors. By separately competing severable tasks, subsystem developers compete against each other in their technical specialty areas. The subsystem providers then work directly with the program office and are not aligned to any particular prime contractor. These subsystem providers will, therefore, be free to offer their matured technologies to any prime contractor as the program enters the EMD phase and no prime contractor gains a competitive advantage for EMD during the TMRR phase. If investments are made in the most promising technologies at the second or third tiers, multiple prime contractors may be able to integrate these matured technologies into their developmental design and subsequent system-level competitions during EMD. The separate approach potentially reduces contract costs for TMRR efforts by eliminating prime contractor overhead costs and helps increase competition for the subsequent EMD effort.

USN Zumwalt-class Guided Missile Destroyer (DDG-1000)

The USN used EDMs to reduce technical risk.

Some weapon systems, most notably ships and complex satellites, are generally too costly to prototype at the system level. The USN's DD(X) program, now called the DDG-1000, successfully used a series of engineering development models (EDMs), essentially prototypes of critical subsystems, to reduce technical risk and refine subsystem designs. The program acquired 10 EDMs to demonstrate 11 critical technologies.[64] EDMs included the hull form, an advanced gun and its munitions, a composite deck house, a peripheral vertical launch missile system, dual-band radar systems, an integrated power system, an automatic fire suppression system, and an infrared mock-up.[65]

While there are added government costs of managing multiple TMRR contracts, the total added cost associated with this approach is generally not substantial since

[64] "From Marginal Adjustments to Meaningful Change: Rethinking Weapon System Acquisition," Birkler, John, et al, RAND National Defense Research Institute, 2010.

[65] "Defense Acquisitions: Progress and Challenges Facing the DD(X) Surface Combatant Program," GAO Testimony Before the Subcommittee on Projection Forces, Committee on Armed Services, House of Representatives; Statement of Paul L. Francis, Director Acquisition and Sourcing Management; GAO-05-924T, July 19, 2005.

typically only one source is tasked to accomplish each particular project. If alternative technologies are available for similar functions, however, the PM may choose to award multiple contracts focused on the same subsystem or component.

This approach should not be used when one of the major risk areas is subsystems integration. In such cases, the primary effort should be focused on maturing and integrating technologies to demonstrate or prototype critical systems capabilities.

Multiple Contract Awards for Similar Efforts

Another approach is to award the same or similar TMRR efforts to two or more contractors. This approach generally ensures that more than one source will be available to provide critical technologies for follow-on EMD efforts. This approach also mitigates the risk of failing to achieve the TMRR phase objectives; if one contractor is unsuccessful, another may succeed given the use of alternative technologies and approaches.

USN Air and Missile Defense Radar (AMDR)

The USN acquired similar AMDR technology development efforts from three contractors.

The Air and Missile Defense Radar (AMDR) suite fulfills Integrated Air and Missile Defense (IAMD) requirements for multiple ship classes, including the Arleigh Burke-class destroyer. This suite consists of S-Band radar, X-band radar, and a Radar Suite Controller. AMDR provides multi-mission capabilities, simultaneously supporting long-range, exo-atmospheric detection, tracking, and discrimination of ballistic missiles, as well as area and self-defense against air and surface threats.

In June 2009, after full and open competition, the USN awarded three AMDR concept study contracts to Lockheed Martin, Raytheon, and Northrop Grumman. Each of the contractors developed AMDR concepts showing the major subsystems and expected features of the AMDR suite. The concept studies phase concluded in December 2009. In September 2010, three TD phase contracts were awarded to refine each contractor's design concepts and mature critical technologies. The program completed TD contracts in September 2012 and released RFPs for the EMD phase in June 2012. Following MS B approval, a single EMD phase contract was awarded to Raytheon in October 2013.[66]

Recognize that the TMRR phase may include multiple contract actions, each addressing particular TMRR efforts, depending on the program's acquisition strategy. This method may include multiple technology demonstrations to permit the operational user and material developer to substantiate that a particular solution satisfies validated capability requirements; is feasible, affordable, and supportable; and has an acceptable level of technical risk. Each required contract action can be awarded to two or more sources.

[66] "Fact Sheet: Air and Missile Defense Radar (AMDR)," US Navy, November 15, 2013.

A drawback of this approach is it potentially doubles the cost of the TMRR effort and, therefore, requires an increased near-term program budget, which may (or may not) be offset by future competitive savings. The PM must complete a CBA to assess the costs of awarding multiple TMRR contracts against the benefits of such an approach.

Competitive Prototyping

Competitive prototyping is a specific method of awarding multiple contracts for the same or similar TMRR efforts. This method is discussed separately because the approach is specifically prescribed by law and regulation and involves two or more contractor teams building actual prototypes of key system elements. Pursuant to the 2009 WSARA and as implemented by DODI 5000.02, competitive prototyping is mandatory for MDAPs unless waived by the MDA. Waivers for MDAP competitive prototyping are authorized only if:[67] 1) the cost of producing the prototypes exceeds the expected life cycle benefits; or 2) the DOD will be unable to meet critical national security objectives without the waiver.[68] Competitive prototyping is encouraged for other non-MDAPs and should be considered when the potential benefits outweigh the increased costs.

Competitive prototyping is the ultimate "try before buy" (or in the case of aircraft: "fly before buy") approach, in that the required capability is produced and demonstrated before making the decision to contract for EMD. In recent years, the approach was used infrequently because it was believed to extend the program schedule and increase cost; but this belief was driven more by a desire to field systems quickly than by actual quantitative analysis. While it can take longer to produce prototypes in comparison with other risk reduction approaches, the increased time may be offset by shorter EMD phase performance periods.

Competitive prototyping can be costly because it involves two or more contractors producing actual working prototypes, but it is favored by policy because it evidences true risk reduction and produces both direct and indirect benefits.

In 2007, the DOD issued a policy memorandum encouraging increased use of competitive prototypes. The memo identified the following benefits:[69]

- Primary benefits:
  - Enhances true risk reduction
  - Helps enable innovative solutions
  - Validates design concepts

[67] WSARA, Section 203. Approved waivers are reviewed by the US Comptroller General (GAO) and their assessment is submitted to the Congressional defense committees. The PM must ensure a thorough discussion of supporting rationale for the waiver.
[68] Several waiver assessments concluded that DOD did not adequately support the basis for approved waivers. See: "Department of Defense's Waiver of Competitive Prototyping Requirement for Enhanced Polar System Program," GAO, August 23, 2012; and "DOD's Waiver of Competitive Prototyping Requirement for Combat Rescue Helicopter," GAO, March 7, 2013.
[69] "Prototyping and Competition," OUSD(AT&L) Memorandum, 19 Sep 2007.

  - Validates government cost estimates
  - Evaluates manufacturing processes
  - Helps refine requirements
- Secondary benefits:
  - Exercises both the contractor and government management teams
  - Develops and enhances systems engineering skills
  - Helps sustain government and industry critical core engineering skills
  - Attracts new scientists and engineers to support DOD requirements

Competitive prototypes can be produced at the system level or focused on specific critical subsystems or components. The rationale for the focus of prototype efforts must be linked to the areas of greatest risk associated with achieving the required system-level performance. Remember, the primary purpose of building and testing prototypes is to demonstrate a reduction in critical risks such that a decision may be made to enter EMD with confidence in successful program execution.

Finally, as a result of competitive prototyping, contractors usually won't end up having to solve a myriad of technical issues during EMD when they should be focused on producing the system's detailed engineering and manufacturing design. Ultimately, this approach is also expected to reduce the overall time required to field systems because it reduces the probability of encountering technology challenges during EMD.

To support the increased budget required for pursuing competitive prototyping, the PM must complete a CBA. Considerations and guidance for completing the CBA are addressed in Chapter 6, *Competition Decision Framework*.

Industry-funded Risk Reduction Efforts

Proposed acquisition programs with large production quantities and long-term sustainment opportunities may create incentives for firms to invest their own funding in TMRR activities. Companies will voluntarily invest in technology development efforts in order to become more competitive for pending TMMR phase solicitations. Alternatively, companies that do not win TMRR contracts may voluntarily invest in order to potentially compete for follow-on phases.

Independent investment is likely to happen only in markets where there are a limited number of sources possessing the capability to produce major systems, such as aircraft, armored vehicles, or ships. Such private investment has become more common over the last two decades given reductions and consolidation in the military industrial base.

The PM cannot require such investment or even place any reliance upon it actually occurring, but there are methods that help facilitate the activity. The primary means of facilitating private investment is to maintain a frequent and open dialog with all interested sources about agency requirements. If industry is kept fully apprised of the government's future program plans, including production quantities, performance specifications, and program schedules, they can conduct their own CBA to determine whether the potential sales revenue justifies the required investment costs.

USAF T-X Family of Systems

Open communication helped stimulate industry's investment in the USAF T-X program.

In 2010, the USAF announced its intent to acquire a T-38 trainer aircraft replacement, hoping to leverage off-the shelf designs with only a limited development effort. Existing non-developmental aircraft originally under consideration included the Lockheed Martin/Korean Aerospace Industries (KAI) T-50 "Golden Eagle," the Northrop Grumman/BAE "Hawk," and the Raytheon/Leonardo M-346, rebranded as the T-100. Boeing didn't want to be left out. In 2013, Boeing entered into a teaming arrangement with Saab and announced their plan to build a new, advanced, cost-efficient T-X Family of Systems training solution in anticipation of the upcoming competition. Boeing did not disclose how much money they planned to invest, but media reports indicated the company would design and build a completely new aircraft in time to participate in a potential competitive fly-off competition.[70]

Boeing made good on that pledge and began flight operations on their newly designed aircraft in just two years.[71] Just before the solicitation was issued in December 2016, SNC and Turkish Aerospace Industries (TAI) announced that they too had been working on adapting an existing aircraft design for the T-X program.[72]

Even when private investments are not targeted toward responding to a specific program requirement, the government can still enjoy risk reduction, cost savings, schedule reductions, and increased competition stemming from corporately funded independent R&D. These benefits may be obtained when potential requirements and capability gaps are communicated to suppliers.

After the US Army and US Marine Corps (USMC) contracted with five companies to quickly produce and field Mine Resistant Ambush Protected (MRAP) vehicles to help protect forces from roadside improvised explosive devices (IEDs) in Afghanistan, some of the companies recognized the importance of being more proactive—anticipating future military needs instead of waiting for a government request. For example, Navistar invested in its Saratoga system, a light tactical vehicle targeted to fill the gap between the projected, upgraded High Mobility Multi-purpose Wheeled Vehicle (HMMWV) Modernized Expanded Capacity Vehicle (MECV) and future Joint Light Tactical Vehicle (JLTV) programs.[73] The company recognized they had the potential to capture a greater share of future requirements if they were ready with the right technology when the military issued solicitations for those requirements.

70 "Boeing Teams with Saab to Develop a New Trainer for the USAF T-X Program," Eshel, Tamir, Defense Update.com, December 6, 2013.
71 "Boeing's in on T-X," Tirpak, John, Air Force Association Daily Report, March 30, 2017.
72 "Sierra Nevada Corp., and Turkish Aerospace Industries Develop New Trainer for USAF T-X and Others," Khan, Bilal, Quwa Defense News and Analysis Group, January 2, 2017.
73 "A survivor reaffirms the value of survivability;" OEM Off-Highway; Eauclaire-Kopier, Michelle, April 23, 2012.

FACILITATING FUTURE COMPETITION

Since the TMRR phase is where most major acquisition programs are 'born,' it is critical that plans and actions be developed and initiated to facilitate viable competition for follow-on phases. As already noted, one of the best ways to ensure there are two or more sources ready to compete for EMD contracts is to engage two or more contractors in TMRR efforts. Whether or not multiple contractors participate in TMRR efforts, there are several areas that should be addressed before and during the TMRR phase.

Competition Strategy

Before any TMRR phase contracts are awarded, the PM and acquisition team will develop a comprehensive program acquisition strategy. Part of this strategy must address how competition will be applied and sustained across the entire system's life cycle. The strategy should address the costs and benefits of introducing competition and relate the costs to the program cost baseline in order to assess the feasibility of maintaining multiple sources through EMD and production phases. With regard to the O&S phase, the system's initial LCSP must address operational support concepts and describe actions to be initiated to provide for competition during the O&S phase.

PMs must think broadly about what future work is reasonably viable to acquire competitively and then determine specific actions that must be taken today to enable such competition. There can be significant opportunities for competitive sustainment and systems or subsystems upgrades if specific opportunities are identified and targeted early. Ideally, the PM will act to preserve viable and affordable alternatives by identifying specific actions required to provide for competition. There is no simple one-size-fits-all solution. Competitive opportunities will vary from program to program depending on numerous variables including: the nature of the product, the market, technical considerations, operational and maintenance concepts, and program budgets.

Where direct competition is not feasible or affordable, the strategy should address the possibility of indirect competitive pressures through actions which provide for potential alternatives should the sole source provider experience serious performance shortfalls or simply become unaffordable. In his analysis of competitive market forces, Michael Porter described this indirect competitive pressure as the "threat of product substitution."[74] This sort of pressure may be difficult to leverage given the DOD's often substantial investment in development of specialized military capabilities that do not exist elsewhere, but there are almost always some options available. For example, total production quantities can be reduced and a new development effort can be initiated or options can be included in the development contract to purchase technical data sufficient to qualify a second source. Obviously the greater the cost and schedule

[74] "The Five Competitive Forces that Shape Strategy," Michael E. Porter, Harvard Business Review, January 2008.

impact of introducing competition later in the program's life cycle, the less effective this threat of substitution becomes.

Specific plans for competition across the system's life cycle will directly impact other actions initiated to enable competition, such as design concepts and the program's IP strategy.

Design Concepts

There are two primary design concepts that help enable future competition. The first is to incorporate NDI and/or commercial items for which the government has a previously established competitive support infrastructure. The second concept involves the use of open architectures and modular approaches that enable participation of competitive sources to support and/or upgrade various modules. Both concepts may potentially reduce the cost of switching to a new source and, therefore, also enhance the viability of the threat of substitution.

NDI and commercial items, including commercial derivatives, not only help reduce the cost and risk of development, they also offer pre-established support infrastructures. If these items are already in use within the government, there is normally an established support infrastructure relied upon by the government for spare parts, repairs, and other product support elements. Where the established support is not already competitive in nature, it will typically be based on established market prices which are normally fair and reasonable because most NDI and commercial items are more easily substituted than items developed for unique military applications. If a product is available "off the shelf," substitution costs may be low, even when limited development is necessary to meet DOD mission requirements. The sellers of these NDI and commercial items, therefore, must remain competitive to prevent substitution by other users—which keeps prices affordable for the DOD customer.

Similar benefits may also be available when items are previously developed under an earlier government contract. New systems which re-use previously developed hardware and software can benefit from existing support infrastructures which may be competitive. Even when the support infrastructure is not competitive, the DOD can still experience cost and affordability benefits through acquiring support for an increased quantity of items.

OSA and modular approaches are specifically designed to enable the introduction of new sources for sustainment and upgrades. By clearly defining and documenting the design interfaces between functional elements of a system, it is feasible to use competitive sources to maintain or upgrade these elements, as long as the interfaces remain consistent.

As stated earlier, OSA cannot eliminate all risk of transitioning to a new competitive source, but the approach reduces the risk and cost of such transitions and maintains a viable threat of substitution, creating indirect competitive pressures.

While these design concepts can be used to enable future program competition, their use also helps to control cost and maintain affordable programs. Ultimately, program affordability is a driving force behind the emphasis on using competition across the program's life cycle.

Intellectual Property Strategy to Enable Future Competition

The IP strategy must be addressed in the program's acquisition strategy. The necessary short and long-term needs for technical data, computer software, and the usage rights to both to introduce and/or sustain competition during development, production, and sustainment must be identified. While development and production costs can be substantial, the bulk of program costs are typically incurred during sustainment because of the extended time the DOD continues to operate, modify, and upgrade its major systems. For this reason, it is especially critical that programs address the strategy to acquire technical data necessary to repair and maintain systems, procure replacement components and spare parts, and modify or upgrade systems and subsystems, in the LCSP.

The DOD is generally entitled to unlimited rights in technologies and data developed at the government's expense.[75] However, most systems involve a mix of DOD-funded and privately funded (i.e., proprietary) technologies. For this reason, programs should seek to segregate DOD-funded development efforts from privately funded efforts since privately funded efforts normally result in the government having only limited/restricted rights to resulting technology and data.

To encourage contractors to offer or use commercial products to satisfy military requirements, statute and DOD regulations state that contractors shall not be required to: 1) furnish technical information related to commercial items or processes that are not customarily provided to the public; or 2) relinquish, or otherwise provide, the government rights to use, modify, reproduce, release, perform, display, or disclose technical data pertaining to commercial items or processes except for a transfer of rights mutually agreed upon.[76] Data rights for privately developed technologies are, therefore, subject to negotiation between the parties and contractors cannot be forced to relinquish legitimate proprietary rights as a condition of receiving a DOD contract.

The PM must also recognize that neither data nor data rights are "free," particularly when suppliers possess proprietary rights and/or patent protection. Even when the government funds the development of technologies, it must also fund the reasonable costs of preparing technical data in the desired format to be delivered. Including data deliverable requirements in developmental contracts, even if not separately priced, ensures the government receives the required data. Because data and rights have a cost,

[75] DFARS Part 227 incorporates applicable statutes and prescribes DOD policy and regulation related to patents and copyrights and the procurement of data and data rights.
[76] Title 10 USC Section 2320 and DFARS Subpart 227.7102-19(b), "Policy," revised December 6, 2013.

a CBA must be performed to assess the costs of purchasing the data and, when required, the necessary rights to use the data.

When uncertain whether the potential benefits outweigh the costs of purchasing data, consider establishing a priced contract option for technical data and/or computer software and required data rights not acquired on the basic contract. The contract option will provide flexibility to acquire data and associated rights in the future. Establishing an extended period of time during which the government may exercise this option is a way to preserve a threat of substitution.

Finally, the government will not necessarily require unlimited rights in technical data or computer software in order to use data to enable competition for supporting or maintaining systems. In many cases, program objectives can be satisfied by securing license rights which permit the government to use, modify, release, reproduce, perform, display, or disclose the data within the government without restriction, but only release or disclose the data outside of the government for government purposes.[77] Under such a government-purpose license rights agreement, the owner of the data gains some protection against other companies using their proprietary data for commercial competitive advantage. The government has an obligation to protect data under this form of license from public disclosure and must secure non-disclosure agreements (NDAs) before providing the data to any non-governmental entity.

[77] DFARS 227.7103-5, "Government Rights."

BEST PRACTICES

There are clear technical and programmatic benefits which can be obtained from engaging more than one contractor in performing TMRR efforts. The major benefits are increased technical risk reduction through alternative approaches to technology challenges and establishment of competitive sources for follow-on efforts. The following section reviews some best practices and lessons learned gleaned from program experiences.

Planning Competition for the Program's Life Cycle

Because the TMRR phase is where most acquisition programs are initiated, much of the work accomplished by the program office during this phase focuses on what will happen after TMRR. The PM must plan for how competition will apply to future phases and develop the IP strategy to ensure long-term affordability. A critical question is what can be done now to provide for appropriate competition during the O&S phase?

Planning for the future involves applying best judgment and then thoroughly documenting the applicable assumptions and rationales. The program team should identify multiple viable alternative competitive strategies and then assess the pros and cons of each in order to select the most beneficial plan. The initial plan will change as realities begin to displace assumptions, so expect to revisit the life cycle acquisition strategy as the program advances to later program phases.

Keep Industry Informed

It is almost always in the government's best interest to keep industry informed of plans for future system acquisitions. When industry is aware of the latest program requirements and schedule, they can respond more quickly to RFIs and RFPs. Firms can also make internal decisions regarding the commitment of human resources and privately funded development efforts.

Competition: More than Saving Money

The benefits of competition include much more than just driving a lower contract price or creating incentives to control contract cost growth. Reducing failure risk and driving innovation may be primary motivators for implementing competition during TMRR, even when competition is not planned during subsequent phases. The PM should consider all potential benefits of competition when developing the program acquisition strategy.

As stated earlier, the best solution is almost always one which is selected from a range of alternatives; at this early point in a program it is wise to remain open to alternative solutions, rather than focusing too early on a single approach. Engaging multiple contractors in TMRR efforts creates alternatives and options, permitting choices that might not otherwise be available.

Competition Doesn't Guarantee Success

The engagement of more than one contractor during the TMRR phase creates strong incentives for contractors to produce the desired results within cost and schedule thresholds; but it can't overcome all challenges that a program may encounter. If program requirements are too aggressive or demanding—pressing the state of the art beyond reasonable expectations—even competitors exerting their best efforts may fail. Establishing reasonable expectations, informed by meaningful market research and an effective dialog with potential sources, helps mitigate the risk of failure.

As demonstrated by several of the case studies and examples provided in the following pages, even if a program is making good progress, many are canceled in the early phases of systems acquisition due to changing mission needs or competing budget priorities. This is especially true in recent years as the DOD has struggled to meet its mission in a period of declining budgets.

CASE STUDY – F-35 JOINT STRIKE FIGHTER (JSF)

Introduction and Program Overview

The Joint Strike Fighter (JSF), or F-35 Lightning II, is one of the largest acquisition projects in history, with development and production costs of nearly $400B (in then-year dollars) and nearly $1T in anticipated total LCC (i.e., acquisition, operations, and support costs). It is expected to be the only new major fighter aircraft program for the next 30 years. Over the next several decades, three variants of the aircraft are slated to replace all F-16s, A-10s, AV-8Bs, and Harriers in the US inventory and augment the USN's F/A-18E/Fs. Eight countries are also participating in the developmental program and several other countries are planning to purchase production aircraft. Given current commitments and projections, the program expects to deliver over 3,200 production aircraft.[78]

The JSF is one of the most highly visible, greatly valued, and often controversial DOD acquisition programs. Despite increasing federal budgetary constraints and significant program LCC growth over the last several years,[79] the DOD remains strongly committed to the program because it represents the future of US attack and fighter aircraft capability. Lockheed Martin delivered the 200th aircraft to the DOD and partner nations in December 2016.[80] As of 2017, the company is in Lot 10 of low rate initial production (LRIP), which was awarded on a sole source basis.

Acquisition Strategy Implementation

The F-35 program traces its origins to several advanced tactical fighter development programs during the 1980s and 1990s including the Advanced Short Take-Off/Vertical Landing (ASTOVL) program (1983-1994), the Multi-Role Fighter (MRF) program (1990-1993), and the Advanced Tactical Aircraft (ATA) program (1983-1991), which resulted in the troubled development and eventual cancellation of the A-12 aircraft. After so many fighter aircraft acquisition programs had encountered difficulties, the DOD initiated the Joint Advanced Strike Technology (JAST) program in 1993. The goal of the JAST program was not to develop a new aircraft, but rather to focus on maturing technologies that a new series of tactical aircraft could use.

JAST was chartered to mature technologies, develop requirements, and demonstrate concepts for affordable, next-generation joint strike capabilities. As JAST plans took shape, it became apparent that JAST would be funding one or more concept demonstrator aircraft starting in 1996—about the same time the Defense Advanced Research Agency's (DARPA's) ASTOVL program planned to enter its Phase III (full-scale flight demonstrators). The management of both programs agreed that JAST would become the US Service "sponsor" for the flight demonstration phase of

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[78] "Selected Acquisition Report: F-35 Joint Strike Fighter Aircraft," DOD, as of December 31, 2012.
[79] "F-35 Joint Strike Fighter: Current Outlook Is Improved, but Long-Term Affordability Is a Major Concern," GAO Report Number GAO-13-309, March 2013.
[80] "F-35 Lightning II Program Status and Fast Facts," Lockheed Martin Corporation, March 21, 2017.

ASTOVL if Phase II was successful and if the concept appeared to satisfy the requirements of at least two of the three participating US Services. However, FY95 budget legislation passed in October 1994 by the US Congress directed that ASTOVL be merged into JAST immediately.[81]

In November 1996, concept development (CD) phase[82] contracts were competitively awarded to Boeing and Lockheed Martin, which required both companies to design, develop, and demonstrate prototype aircraft. At this point, the program name was changed to the JSF. Demonstrator aircraft began flying in 2000 and the program office conducted a comparative "fly-off" assessment, resulting in the award of a $19B system development and demonstration (SDD) contract to Lockheed Martin and a $4B engine development contract to Pratt & Whitney (P&W) in October 2001. Although Boeing's X-32 and Lockheed Martin's X-35 aircraft both met CD phase requirements, the program office concluded Lockheed Martin's "lift fan" design was superior to Boeing's "vectored thrust" approach for STOVL and the Lockheed Martin design offered greater growth potential and lower risk.[83]

Apparently, risk was not as low as the government hoped because just four years later the GAO reported the program was 70% over its initial cost estimates and years behind schedule.[84] In fact, the GAO was tasked by law to review the program annually given congressional concerns about the program's cost, schedule, and technical performance. Since the initial review, over thirty GAO reports have been issued addressing various cost, schedule and performance issues related to the program.

Before the 2001 SDD contract award, the DOD asked the RAND National Defense Research Institute (NDRI) to review potential opportunities and options to implement competitive strategies during production that might be used instead of the WTA approach planned for the SDD phase. RAND concluded:

> *The bottom line is that putting one company or consortium of companies in charge of the overall production of the JSF makes the most economic sense. If two or more competitors developed and built this next-generation aircraft, the Pentagon likely would not see lower overall program costs. That's because producing such a sophisticated weapons system involves high front-end-investments and non-recurring costs that probably would not be recovered through price reductions that might result from competitive forces.*[85]

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[81] Most of this discussion comes from a history of the F-35 Joint Strike Fighter Program Office website: http://www.jsf.mil/history/index.htm, accessed March 5, 2013.

[82] "Concept Development" and "Systems Development and Demonstration" phases were part of the prescribed Defense Acquisition Process during the late 1990s and early 2000s. While specific focuses vary slightly, these phases are analogous to the TMRR and EMD phases of today's acquisition process.

[83] "F-35 Joint Strike Fighter (JSF) Lightning II," Global Security; http://www.globalsecurity.org/military/systems/aircraft/f-35.htm, accessed March 6, 2014.

[84] "Opportunity to Reduce Risks in the Joint Strike Fighter Program with Different Acquisition Strategy," GAO Report Number GAO-05-271, March 2005.

[85] "Assessing Competitive Strategies for the Joint Strike Fighter: Opportunities and Options," Birkler, John, et al, RAND, MR-1362.0-OSD/JSF, March 2001.

The RAND report recommended, however, that the DOD consider making future investments in technology development relevant to the aircraft mission systems with the intent of developing a potential competitor for the development and production of inevitable future major mission system upgrades.

Another major focus area for developing competition on the JSF program relates to the on-again, off-again development of an alternate aircraft engine for the F-35. A General Electric (GE)/Rolls Royce (RR) team developed the F136 prototype engine, which was intended to be fully interchangeable with the P&W F135 engine used on the F-35. In 2005, the program office awarded a $2.4B SDD contract to develop and test the alternate engine. The plan was to introduce competition for the engines to be installed on production aircraft beginning in 2011 (LRIP Lot 6) and continuing for the life of the program.[86]

Although the DOD committed nearly $4B on development of the F136, it did so reluctantly. The President's budget requests from 2006 to 2010 did not include funding for the program, but Congress repeatedly added funding back in to the budget. The debate centered on whether it was cost effective to develop and produce the alternate engine. Secretary of Defense Robert Gates called the second engine an "unnecessary and extravagant expense." In the end, Congress gave in to the DOD position to end the program, driven largely by concerns regarding the growing federal deficit. In 2011, the alternate engine funding ended.[87] The GE/RR team self-funded the work for a while, but when it became apparent DOD funding would not be forthcoming in future budgets, the effort was terminated.

Conclusions

The F-35 program history provides an interesting perspective on several issues. Several questions which may be applicable to future programs warrant consideration. Were critical technologies sufficiently mature and was program risk adequately reduced during the CD phase? Did the program enter the SDD phase too early? If the DOD had foreseen the numerous challenges that Lockheed Martin would encounter in SDD, might decision makers have chosen to award two SDD contracts to maintain competitive pressures? Can it ever be cost effective to contract with two sources for development and production of complex high-cost systems? How can such a large, complex, and expensive program realistically take advantage of the potential benefits attributable to continuing competition?

[86] JSF Program website: http://www.jsf.mil/history/his_f35.htm, accessed March 6, 2014.
[87] "House Votes to End Alternate Jet Engine Program," Drew, Christopher, The New York Times, February 16, 2011.

CASE STUDY – JOINT & ALLIED THREAT AWARNESS SYSTEM (JATAS)

Program Overview

The USN-managed Joint and Allied Threat Awareness System (JATAS) is an Acquisition Category (ACAT) 1C program intended to equip the MV-22 Osprey and potentially other rotor aircraft (including the MH-60R, MH-60S, AH-1Z, UH-1Y and CH-53K platforms) with an advanced missile warning capability.

Acquisition Strategy Implementation

The program was preparing to enter the TD phase (pre-2013 equivalent of the TMRR phase) when the DOD issued new competitive prototyping guidance.[88] The JATAS program management team incorporated this approach into the JATAS technology development and acquisition strategy and, in January 2009, released a competitive solicitation calling for system-level competitive prototyping.

The program office competitively awarded cost-plus-incentive fee (CPIF) contracts to Alliant Techsystems (ATK) and Lockheed Martin providing for a 16-month competitive prototyping effort. Each contractor was required to complete a System Requirements Review (SRR), a System Functional Review (SFR), and a PDR that resulted in an approved design and an allocated baseline for its proposed JATAS. In addition, both contractors completed prototype ground and flight tests, and modeling and simulation were used to predict system performance.[89]

Impact of Competitive Prototyping

While the dual source effort clearly increased program costs and management effort, the continuing competitive environment incentivized both contractors to be extremely responsive to the government's requirements, while diligently striving to control contract cost, despite the use of a cost-type contract. The competition undoubtedly also played a role in achieving the aggressive 16-month schedule because the contractors knew that adherence to the technology development cost, schedule, and performance was to be an important discriminator in the follow-on EMD phase decision.

In the follow-on EMD competition, the program office obtained competitive, fixed prices for the EMD effort (fixed-price-incentive-firm (FPIF)), as well as options for LRIP and the first seven full rate production, firm-fixed-price (FFP) lots. The contract also included options to purchase hardware and software data rights to enable future competition. In July 2011, the USN awarded a $109M EMD contract to ATK.[90] Even

[88] "Prototyping and Competition," OUSD(AT&L) Memorandum, September 19, 2007.
[89] "Competitive Prototyping: A PMO Perspective," Overstreet, Capt. Paul, USN, et al, Defense AT&L, March-April 2013.
[90] "Incoming & Hostile: The USN's JATAS Aircraft Warning System," Staff writer, Defense Industry Daily, July 26, 2011.

though only a single EMD contract was awarded, the competitive prototyping effort enabled competitive pricing for much of the JATAS program.

Competitive prototyping not only reduced the overall technical risk by allowing each contractor to understand and mitigate the technical integration risks unique to their design, it also helped to reduce EMD program execution risks. The prototyping experience allowed the government to observe the effectiveness of the contractors' corporate management system, earned value performance, program management practices, and contract execution of the technology development effort and leverage that knowledge to assess EMD execution risk during the subsequent source selection. Additionally, personal relationships established between the contractor and government teams reduced the time required during EMD for the parties to form an effective working relationship. The government's technical team also gained valuable technical knowledge and experience from observing two different technical approaches, which strengthened the government's capabilities to manage the EMD effort.

One concern noted by the PM was that the competitive effort reduced the government's ability to influence the JATAS design. To avoid "technical leveling," the program office restricted itself to: 1) ensuring the contractors fully understood the government's requirements and intent, 2) ensuring the government fully understood each contractor's approach to meeting requirements, and 3) providing guidance about perceived risk if a particular approach might fall short of the government's requirements.[91] Generally, this was positive because it allowed each contractor to apply their own technical approach and innovations, but it inhibited a meaningful dialog about the pros or cons of a particular approach. Similarly, it limited the government's ability to capitalize on good ideas by adopting concepts into the JATAS specifications because that might afford one contractor a competitive advantage or inappropriately transfer technical approaches from one contractor to the other.

Another concern was related to the introduction of a gap in program performance after completing the prototype efforts and before awarding the EMD contract because the RFP could not be released until the PDR was complete and the Capabilities Development Document (CDD) was finalized. The program office used this time to have both teams conduct additional risk reduction efforts, which added cost and schedule to the program.

According to budget documents, the MDA decided to end the JATAS program in FY14,[92] just about the time the EMD program would have neared completion. Remaining funding was directed to the Common Infrared Countermeasures (CIRCM) program. The reasons for ending the program could not be determined from budget documents.

[91] "Competitive Prototyping: A PMO Perspective," Overstreet, Capt. Paul, USN, et al, Defense AT&L, March-April 2013.
[92] "Exhibit R-2, RDT&E Budget Item Justification: PB 2015 Navy, Program Element 0604272N/ Tactical Air Directed Infrared Countermeasures (TADIRCM)" U.S. Navy, March 2014.

CASE STUDY – US Army Ground Combat Vehicle (GCV)

Background

In April 2009, then Secretary of Defense Robert Gates announced his intent to significantly restructure the Army's Future Combat System (FCS) program. The FCS was a multi-year, multi-billion-dollar program begun in 2000 and it was at the heart of the Army's transformation efforts. In lieu of the canceled FCS Manned Ground Vehicle (MGV) program, the Army was directed to develop a Ground Combat Vehicle (GCV) that would be relevant across the entire spectrum of Army operations and incorporate combat lessons from Iraq and Afghanistan.[93]

The Army's 2009 modernization strategy focused on quickly developing a new GCV in a technologically versatile approach. This approach featured a modular design intended to accommodate vehicle growth in size, weight, power, and cooling requirements so that as technologies matured, they could be incorporated into new versions of the GCV with little or no modification to the basic vehicle.

The Army embraced a competitive TD phase and its February 2010 solicitation drew responses from three industry teams. The BAE-led team proposed an original design, claiming it would exceed the survivability of the MRAP vehicle and offer enhanced mobility capabilities to permit operation in both urban and cross-country environments. The General Dynamics team provided few details on its technical approach but stated its chosen design focused on soldier survivability and operational effectiveness and would incorporate mature technologies. The Science Applications International Corporation (SAIC)-led team stated its design would be based on the German-tracked Puma Infantry Fighting Vehicle (IFV) which was developed based on lessons learned from Iraq and Afghanistan. SAIC also emphasized all work, including production, would take place in the US.

The Army, in conjunction with the Pentagon's acquisition office, conducted a Red Team of the GCV program to "review GCV core elements, including acquisition strategy, vehicle capabilities, operational needs, program schedule, cost performance, and technological specifications." This review found the GCV had too many performance requirements and capabilities to make it affordable and relied on too many immature technologies.

In response, the Army pledged the new GCV RFP would "dial back the number of capabilities the new system must have—as well as significantly rework the acquisition strategy by focusing on early technology maturity and setting firm cost targets." In particular, the Army planned to set a vehicle unit cost limit in response to reports that initial estimates projected the GCV would cost more than $20M per vehicle.

[93] Nearly all information in this case study comes from: "The Army's Ground Combat Vehicle (GCV) Program: Background and Issues for Congress," Feickert, Andrew, Congressional Research Service, June 14, 2013.

Acquisition Strategy Implementation

On November 30, 2010, the Army issued the revised GCV RFP. The solicitation stated that proposed vehicles could be tracked or wheeled. The RFP also included affordability targets for the system (between $9M and $10.5M per vehicle) and an operational sustainment target cost of no more than $200 per operational mile. In addition, the Army required that the GCV fit on a C-17 transport but not on a C-130. The Army was expected to award up to three TD phase contracts by April 2011, and the TD phase was planned to last 24 months. An early prototype vehicle was to be delivered by mid-FY14 and the first full-up prototype was expected by the beginning of FY16. The Army initially planned for 1,874 GCVs, with the first production vehicle rolling off the assembly line in early April 2018 and the first unit equipped with GCVs in 2019.

The new solicitation envisioned a fixed-price incentive (FPI) contract versus the cost-plus-fixed-fee (CPFF) contract of the previous RFP. A ceiling of $450M per contractor for the TD phase was set. The incentive fee was to be split 80% to the government if the cost came in under the negotiated $450M ceiling price, with 20% going to the contractor. If the cost came in over the ceiling, the contractor would assume 100% of the above-ceiling cost.

On August 17, 2011, the GCV program was approved to enter the TD phase, and a day later, the Army awarded two TD contracts: $439.7M to the General Dynamics-led team and $449.9M to the BAE Systems-Northrop Grumman team. Although the losing SAIC-led team protested the awards to the GAO, the protest was subsequently denied.

Starting in May and running through June 2012, the Army also tested a number of foreign vehicle systems during a network integration exercise. The results of this comparative tests were used to complete the Army's AOA, which is a requirement normally completed before entry into the TD phase (now TMRR). The vehicles considered by the Army during the AOA were the Bradley M2A3; a turret-less Bradley; a Stryker Double V-Hull Infantry Carrier; the Swedish CV9035; the German-made Puma; and the Israeli Namer. Reports indicated the Army's GCV AOA did not identify an existing, less expensive combat vehicle that would meet the Army's requirement.

On January 16, 2013, then USD(AT&L), Frank Kendall, issued an Acquisition Decision Memorandum and accompanying information memorandum detailing major changes to the GCV program to "enable a more affordable and executable program." These changes included the following:

- The TD phase was extended for six months to enable contractors to modify their designs in support of the requirement modifications to the CDD.
- The EMD plan was changed from dual source awards to award of both EMD and production phase options to a single vendor. This one change saved nearly $2.5B in funding. MS B remained as a full and open competition for

the EMD phase and allowed other vendors (including non-US vendors) to propose modified NDI vehicles.

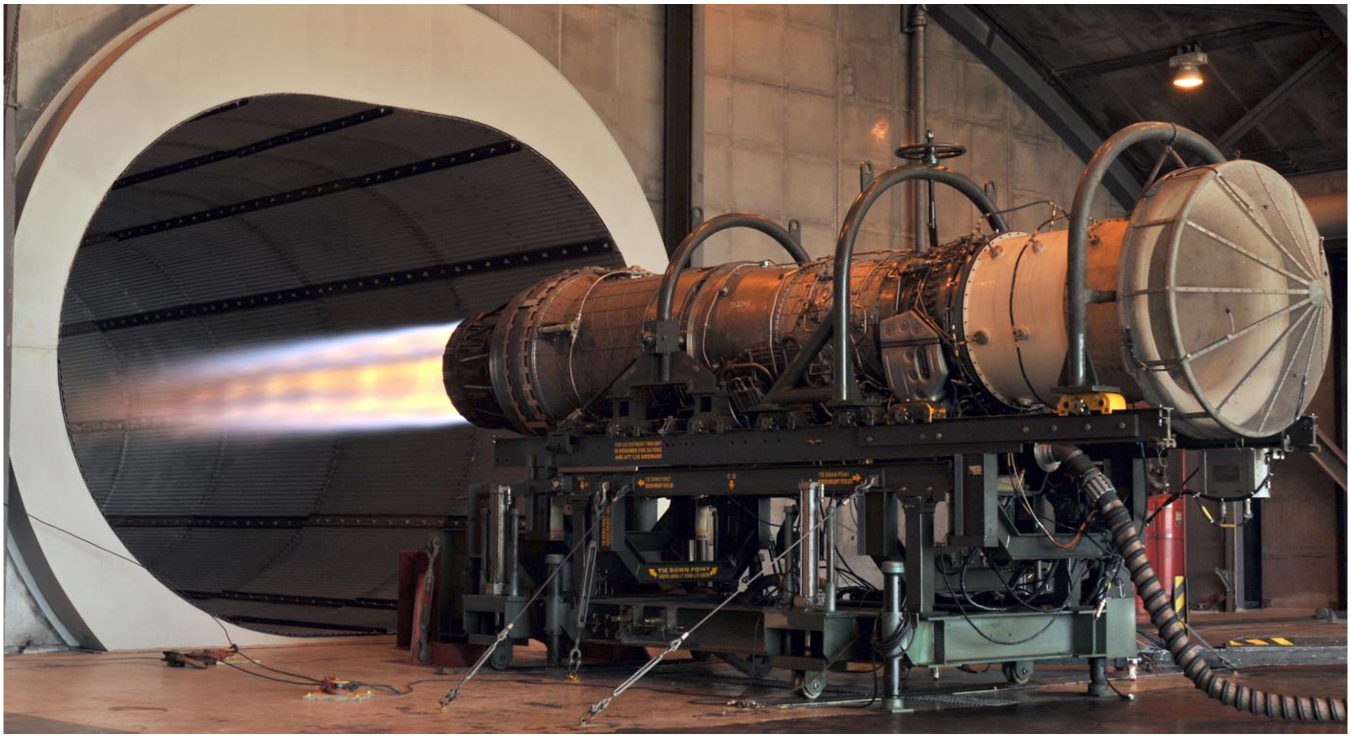
- In support of full and open competition resulting in a single award for EMD, the Army's previously planned procurement of long lead materials for test rigs and production prototypes was delayed until the EMD competition was complete and the winning vendor was determined.
- Lastly, in support of the schedule risk associated with integration during EMD and the six-month TD extension, MS C (production decision) was moved from FY18 to FY19 to make the program more affordable and executable.

On February 24, 2014, during a news conference outlining his recommendations to the President for DOD's FY15 budget, then Secretary of Defense Hagel stated that he had accepted the Army's recommendation to terminate the GCV program and re-direct the funds toward developing a next-generation platform. However, reports suggest that while the GCV program will not move forward if Congress approves the budget as proposed, some funding will be provided by the DOD to continue certain GCV-related engineering efforts. The Army also noted the GCV program's termination had nothing to do with performance but, instead, was based entirely on budgetary constraints.[94]

Conclusion

This case study offers an example of how many factors beyond contractor performance can impact program outcomes. The Red Team review highlighted the importance of getting requirements "right" and fully understanding the scope of technology maturity efforts to ensure achievable and affordable programs. Despite significantly scaling back on requirements and issuing competitive TD phase contracts, the program still required additional changes to be executable and affordable. The affordability concern likely drove the decision to change the strategy from a dual source to a single-award EMD phase. It is also interesting to note that a decision was made to keep the EMD contract award open to contractors who did not participate in the TD phase. The existence of several NDI vehicles (including non-US products) created potential market substitutes that could impact future contract award decisions. Unfortunately, given the recent budget decision, we may never know how competition would have impacted the final program outcome.

[94] "The Army's Ground Combat Vehicle (GCV) Program: Background and Issues for Congress;" Feickert, Andrew; Congressional Research Service; February 28, 2014.



3. Engineering & Manufacturing Development Phase

IMPLEMENTING COMPETITION

> *Competition for a "Weapon System Franchise," begins with development of the system, followed by serial production over a period that can continue for as long as 20 years. Typically, two (or very occasionally more) firms compete for an Engineering and Manufacturing Development (EMD) contract. The EMD process results in a detailed design of the system; design and production of the tooling and equipment, and sometimes facilities, needed to produce the system; and building of "production representative" units of the system for testing. Successive annual lots are then purchased using a series of separately negotiated contracts…. These contracts ordinarily are firm fixed price and are typically placed with the firm that won the EMD contract on a sole-source basis…. One variant on the standard "Weapon System Franchise" case is [called] dual sourcing.*[95]
>
> *Institute for Defense Analysis*

[95] "Mechanisms & Value of Competition for Major Weapon Systems, IDA, April 2011.

INTRODUCTION

The EMD phase begins following a decision to commit resources for development, manufacturing, and eventual fielding of a product after completion of required TMRR efforts. The DOD typically uses competition to select a contractor to perform EMD; continuing competition during this phase is less common due to the generally high cost of EMD efforts.

The DOD breaks the commitment of EMD resources into three separate, but related, decisions: 1) a requirements decision point, 2) a decision to release the development solicitation to industry, and 3) a decision to award the development contract(s), which is called the MS B decision. The MS B decision is the critical decision for an acquisition program because it definitively commits the DOD's resources to a specific product, budget profile, schedule, choice of suppliers, and other program details, leading to the eventual system production and fielding. Though as a practical matter, this decision is informally made when the solicitation is released to industry, because at that point the strategy must be thoroughly planned, risks are well-understood and under control, and decision makers have confidence that a program will be affordable and executable.[96]

Goal of the EMD Phase

The goal of the EMD phase is to develop, build, and test a product to verify that all operational and derived requirements are met. Following this verification process, a decision can be made to produce and field the system with confidence that the fielded system will satisfy operational needs. EMD includes finalizing the detailed hardware and software designs, building test prototypes or first articles to verify compliance with requirements, and preparing for production and deployment. Through a series of reviews, the initial product baseline is established for all configuration items.[97] Typically, one or more developmental systems are produced and undergo rigorous contractor and government testing and evaluation. During the EMD phase, the PM will also finalize planning for product support elements and integrate them into a comprehensive product support package—including necessary planning for competition during the O&S phase of the program. The EMD phase ends when:

- The design is stable.
- The system meets validated capability requirements.
- Manufacturing processes are demonstrated and under control.
- Industrial production capabilities are available.
- The system meets or exceeds EMD phase exit criteria and MS C entrance criteria.[98]

[96] DODI 5000.02, paragraph 5.c.(2)(b)3.
[97] DODI 5000.02, paragraph 5.d.(9)(b)1.
[98] DODI 5000.02, paragraph 5.d.(9)(d).

In general, there is usually some degree of concurrency between the completion of EMD and the commencement of initial production, including residual testing and additional design and development efforts, especially with regard to software fixes and additional coding efforts. The PM should recognize that the degree of concurrency between development and initial production efforts can complicate implementing and maintaining competitive sources during both EMD and production phases. Managing concurrency with only one participating contractor can be challenging enough; however, the challenges associated with multiple contractors introduces significant government monitoring and integration requirements.

In some cases, EMD phase products actually become fielded assets. In the case of high-cost end items, most notably large ships and space systems, the EMD end items are refurbished, as necessary, and fielded following developmental and operational testing. Many software intensive systems also don't have a production phase, but rather only a deployment phase, since it generally doesn't cost much or require extensive effort to produce additional copies of software or because only a single version of the software is required (e.g., centralized processing systems). In the case of incrementally fielded software intensive programs, EMD is replaced with an integrated development and deployment phase. In addition to the above-mentioned variations, DODI 5000.02 identifies several other potential variations on the traditional hardware-intensive four phase acquisition process, depending on the type of product or program being acquired.[99]

Impact of Earlier Life Cycle Management Phases

As discussed in the previous chapter, under the current DOD acquisition process, new systems originate based on conclusions reached during the MSA phase. When the resulting AOA concludes that existing products and technologies can be leveraged to produce the required capability, programs may be initiated in the EMD phase. When critical technologies are not mature and no existing products are reasonably capable of satisfying the need, a program will usually begin with the TMRR phase.

If a TMRR phase applies, TMRR results will impact the EMD contract(s)' acquisition strategy and competition. The impact's significance will depend on the specific work accomplished during TMRR. In many cases, the contractor or contractors that received TMRR phase contracts may gain a competitive advantage going into the EMD phase competition based on the knowledge and experience gained during the TMRR effort. However, it is possible for another contractor—that did not participate in TMRR—to compete for, and even win, an EMD contract. In other cases, the results of TMRR may be considered in the selection of a single EMD contractor, following a comparative evaluation of competitive prototypes and competitive proposals; such as the case with the F-35 JSF.

[99] See DODI 5000.02, paragraph 5.c.(3), "Defense Acquisition Program Models."

Unless waived by the MDA, a PDR will be accomplished during TMRR and prior to the start of EMD.[100] Thus, most EMD contracts will begin with preliminary design information as the design baseline to be further developed during EMD. If the PDR was waived prior to the start of EMD, the PM should plan to conduct the PDR as soon as possible following EMD contract award(s).

Competition Opportunities & Constraints

Competition for EMD

The majority of EMD contracts are competitively awarded; competition ***for*** EMD is the norm. It is difficult to justify a non-competitive EMD contract award since entry into the phase involves conducting design, development, and test efforts. Even if one contractor may require greater developmental effort than another, the relative differences in cost and performance must be fairly and objectively evaluated—conducting a formal competition is the most appropriate way to determine which alternative best meets government requirements.

Competition for development is also essential because of the unknowns that are generally present during this phase. Competition not only spurs innovation and drives potential LCC savings, but also enables the DOD to make a choice among alternative products—each of which offers different strengths and weaknesses. However, competition for development, as typically practiced, continues only through award of the development contract. After a developer is selected, the program then transitions to a sole source environment for both EMD contract changes and the follow-on production and deployment phase. Once the pressures of the competitive environment no longer exist, there remains little incentive for the winner to strive to improve performance, reduce cost, and maintain the program schedule. Consequently, experience suggests that firms tend to be overly optimistic in estimating the development effort. Many ultimately struggle during development, which often results in performance compromises, failure to meet schedules, and increasing cost. The government sometimes becomes an unwitting participant in cost growth through the implementation of contract changes intended to improve system capabilities or take advantage of emergent technologies.

Due to major industrial base consolidations over the last 25 years, competition for EMD may involve only two or three firms. This is especially true for major systems such as ships, aircraft, missiles, tracked vehicles, and space systems. A larger number of developers remain in the market for information technology (IT) systems, sensors, and small UAVs. Greater competition tends to be present for systems and subsystems where there are dual-use applications (i.e., similar products are purchased by both government and non-government customers). In many cases, there are also international firms which may compete head-to-head with US firms because of trade agreements which exempt certain countries from US domestic preference laws.

[100] DODI 5000.02, Paragraph 5.d.(7).

Competition during EMD

While competition for EMD contracts is very common, competition ***during*** EMD has been fairly rare over the last two decades. Given the substantial cost of most major EMD programs, planned production quantities are generally quite large in order to generate enough savings to offset the up-front investment necessary to maintain competition during both EMD and production.

In some cases, however, a program might use competition during EMD with the intent of down selecting to a single contractor to perform the production program. This strategy may be pursued as a means of reducing the technical, schedule, or cost risk during the EMD program. However, one study showed a significantly lower rate of cost growth on competitive development programs when compared to non-competitive programs, suggesting that competitive EMD programs are more likely to experience fewer design changes, unanticipated technical problems, and performance delays—thereby minimizing cost growth.[101] The real revenue-generating prize for a contractor is winning the production and deployment work and the contractor with the best performance during EMD has a decided advantage going into the production competition.

To enable competition for or during the production and deployment phase, there must be some form of competition, teaming, or co-development initiated during EMD. Competitive production strategies, such as leader-follower or licensing, must use the EMD phase to establish necessary relationships between the contractors that will work together during the production and deployment phase. If production dual sourcing is planned, then separate, parallel EMD efforts will be required.

The Importance of EMD in Enabling Future Competition

Even when planning only a single-source EMD effort followed by a non-competitive production program, the acquisition strategy and contract requirements implemented during the EMD program will have a significant impact on the government's ability to introduce future competition for system support and upgrades. Two major concerns for enabling such future competition are the program's IP strategy (i.e., technical data planning) and OSA implementation. To the extent practicable, the competitive pressures of competition for development should be leveraged to ensure enabling of future competitive opportunities. The proposed availability of technical data and its impact on LCC should be considered as part of the best value considerations during an EMD source selection.

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[101] Average cost growth for six dual source EMD programs (AIM-9M, AMRAAM, HARM, Hellfire, Peacekeeper, and Tomahawk) equaled 7.4%— approximately one fourth the average of 19 non-dual source programs (29.4%). From: "Competition in Defense Acquisitions;" Gansler, Jacques S., et al, University of Maryland Center for Public Policy and Private Enterprise, February 2009.

Applicable Laws and Regulations

There are no laws, regulations, or policies uniquely related to competition during the EMD phase beyond those already mentioned in Chapter 1. The EMD phase is when decisions are made to either use existing (previously developed) items/processes or develop new items/processes as part of the system development process. Because a system design baseline is initially established in the EMD phase, it is during this phase that technical data is often acquired and when rights in data are typically determined.

GENERAL COMPETITIVE METHODS & TECHNIQUES

There are several effective methods that should be used to increase competition for any acquisition, regardless of which part of the system's life cycle is being executed. Some of these concepts were discussed in greater detail in the previous chapter, so they are only mentioned briefly here. A more detailed discussion of concepts not previously introduced follows.

Effective Two-way Communication with Industry

The best way to ensure that planned EMD competitions are effective is to keep industry informed regarding the upcoming acquisition. Suppliers often invest a substantial amount of effort and internal funding to prepare for a major competitive acquisition. The more knowledge potential sources have regarding program content and schedule, and the greater their confidence in the accuracy of this information, the more they will be willing to invest in preparation.

DRFPs are an especially effective means of communicating with industry if the government is sincerely interested in receiving feedback and allows sufficient time for industry review/comment and for program office consideration of the input received. If the acquisition team has specific concerns or questions regarding the specifications, terms and conditions, proposal evaluation criteria, or other solicitation attributes, these should be highlighted in the DRFP to encourage specific feedback on those issues.

Other communication methods, including industry days, pre-solicitation notices, RFIs, pre-proposal conferences, site visits, and one-on-one meetings, can also help the government refine requirements, focus evaluation criteria, and ensure an efficient and effective competition.

Performance-based Requirements

Performance-based requirements facilitate increased competition by permitting contractors to propose alternative solutions and/or approaches which leverage their existing products, technologies and established best practices. For a developmental contract, the critical requirements document is the functional or performance specification that defines the required system performance attributes. Most contracts also include a SOW or SOO that describes activities the contractor must perform as the system proceeds through design, development, and test. Ideally, both the specification and SOW should describe desired outcomes in a performance-based manner, rather than detailing specific products, designs, or "how-to" task requirements. A performance-based approach can not only reduce cost, but also places cost, schedule, and performance responsibility on the contractor by making the contractor clearly and fully accountable to achieve the required results—rather than simply performing government-defined tasks.

Integration of Non-developmental and Commercial Items

There are some trade-offs associated with leveraging NDI and commercial items in the design and development of DOD systems. Use of existing components reduces the cost and risk of developing new items; but, to the extent that these items were developed at private expense, the DOD may be unable to obtain technical data and associated data rights required to facilitate competition during the O&S phase. Of course, if NDI is a common item already in use on other DOD systems, increased use of the item is likely to create supply chain efficiencies and the DOD may already possess sufficient technical data. In some cases, commercial items may also be interchangeable with other items because they are produced to market-based standards; this is particularly true for many IT products. For some commercial items, especially widely used items, an established competitive network of third-party support providers exists. The fact that an item is commercial or NDI does not necessarily mean that re-procurement or support can only be accomplished on a sole source basis.

In general, DOD policy encourages the acquisition and integration of commercial items and NDI[102] because the perceived benefits outweigh any potential disadvantages. Incorporating NDI into the development of a new system can, however, have implications for long-term sustainability due to the long operational life cycles of many DOD systems. The PM should consider potential application of these types of items during the development of the program acquisition strategy, including IP and product support considerations. If appropriate, the EMD source selection evaluation criteria can include an assessment of benefits and risks associated with various contractor approaches.

Modular Development of Information Technology

Federal agencies have traditionally taken a multi-year "grand design" approach for developing and modernizing IT systems. This approach is grounded in the notion that responsible development necessitates a full detailing of requirements before work can start. Although providing a thoroughly detailed requirements description seems to be a good idea, practical evidence and private sector experience has shown that large and complex IT implementations often encounter significant cost and schedule overruns for a variety of reasons.[103]

To help resolve these issues, modular approaches are recommended for IT system development. The modular approach focuses on implementing capabilities that can be defined, developed, and deployed within months instead of several years. Modular approaches involve dividing investments into smaller parts in order to reduce

[102] FAR Part 10, "Market Research," and FAR Part 12, "Acquisition of Commercial Items," require agencies to evaluate if commercial or NDI can be used to satisfy requirements, including incorporation at the component level. The regulations also state agencies shall require prime contractors to incorporate commercial or NDI in items provided to the government, to the maximum extent practicable.
[103] "25 Point Implementation Plan to Reform Federal Information Technology Management," Kundra, Vivek, U. S. Chief Information Officer, The White House, December 9, 2010.

investment risk, deliver capabilities more rapidly, and permit easier adoption of newer and emerging technologies. Section 5202 of the Clinger-Cohen Act of 1996 and FAR 39.103 highlight potential benefits of modular contracting and state that agencies should, to the maximum extent practicable, use modular contracting for acquisition of major IT systems. By applying a modular approach, agencies can obtain the following benefits:[104]

- Delivery of usable capabilities that provide value to customers more rapidly as agency missions and priorities mature and evolve.
- Increased flexibility to adopt emerging technologies incrementally, reducing the risk of technological obsolescence.
- Decreased overall investment risk as agencies plan and execute smaller projects and increments versus "grand design" solutions.
- Creation of opportunities for competition and small businesses participation.
- The ability to terminate a failing program with fewer sunk costs, capping the risk exposure to the agency.

Recognizing the value of modular development for certain kinds of software-intensive systems, the most recent issuance of DODI 5000.02 incorporated a tailored defense acquisition process model which provides for incrementally developing and fielding fully mature and tested sub-elements of the required overall capability.[105]

Use of Open Systems Architectures

The EMD phase is the most appropriate time to encourage, incentivize, or even mandate, implementation of an OSA approach. OSA is valuable because it enables the opportunity for competition when acquiring system upgrades and also makes it feasible to apply competition at the subsystem level during development and/or production. The OSA approach is especially well suited to programs using spiral development or modular acquisition approaches and may facilitate competition for future developmental increments.[106] OSA also provides competitive options to manage technological obsolescence. OSA is composed of five fundamental principles:

- Modular designs based on standards, with loose coupling and high cohesion, that allow for independent acquisition of system components.
- Enterprise investment strategies, based on collaboration and trust, that maximize reuse of proven hardware system designs which reduce cost while ensuring quality.

[104] "Contracting Guidance to Support Modular Development," Office of Federal Procurement Policy, U. S. Office of Management and Budget, June 14, 2012.
[105] DODI 5000.02, Paragraph 5.c.(3)(d), "Incrementally Deployed Software Intensive Program."
[106] "DOD Open Systems Architecture: Contract Guide for Program Managers," Version 1.1, DOD Open Architecture Data Rights Team, June 2013.

- Transformation of the life cycle sustainment strategies for software intensive systems through proven technology insertion and software product upgrade techniques.
- Dramatic lowering of development risk through system design transparency; continuous design disclosure; and government, academia, and industry peer reviews.
- Strategic use of data rights to ensure a level competitive playing field and access to alternative solutions and sources, across the life cycle.

The DOD's implementation of OSA is focused on requiring each contractor competing for award of a developmental contract to fully describe their plan for meeting OSA requirements in their technical proposal. During the source selection process, the government is then able to evaluate contractor plans and the extent to which the contractor's proposed design satisfies the OSA goals. A recently issued DOD guide[107] provides detailed guidance to support greater use of OSA, including suggested RFP language.

[107] Ibid.

SPECIFIC COMPETITIVE METHODS & TECHNIQUES

*As previously stated, competition is almost always used to solicit and award contracts **for** the EMD phase simply because it is unlikely that any of the circumstances permitting the use of other than full and open competition, as described in FAR 6.302, will be present at this point in an acquisition program's life cycle. The major question is whether competition will continue **during** the EMD phase and/or whether EMD includes actions which facilitate future program competition. Several specific approaches to maintaining competition during EMD and facilitating competition for or during the production and deployment phase are discussed below.*

Award Two or More Contracts

The first method is to select two[108] contractors to receive contracts for EMD based on each firm's unique design. Each contractor is tasked to produce one or more production representative system(s) which undergo contractor and government testing. In this case, the end items are developed to meet (or exceed) identical performance specifications, but the competing designs may be quite different. Depending on the magnitude and complexity of the system, this can be a very expensive approach, not only because the development and test costs are effectively doubled, but also because the approach can lead to fielding, and eventually supporting, two different product configurations which perform the same mission. Ideally, the products will be fully interchangeable at the system or subsystem level to minimize any operational limitations, even though each may require its own unique product support network.

This method can be used to posture a program for dual sourcing[109] in the production and deployment phase. In a dual sourced production program, the government selects two firms to produce the same (or a functionally equivalent) systems. There are many rationales for implementing dual sourcing during EMD and production. One common reason is to protect an industrial base capability; that is to ensure continued existence of at least two sources capable of producing both the current and future versions of a particular weapon system. Another major reason is to preserve competitive pressures to minimize system cost growth. Lastly, dual sourcing may also contribute to technological competitions in which firms are incentivized to introduce innovative advancements to win future contracts.[110] If production quantities are substantial, it may be economically feasible to use dual sourcing to develop two functionally equivalent designs. Dual sourcing decisions should also consider any supportability impacts associated with operating and maintaining different product configurations. Dual

[108] Generally, competition during EMD is limited to only two sources due to the significant cost of awarding more than two EMD contracts.
[109] Dual source development and production programs may involve competition between firms producing alternative items which perform the same function or two firms capable of producing identical items.
[110] "The Mechanisms and Value of Competition for Major Weapon Systems," Dominy, James R., et al, Institute for Defense Analysis, April 2011.

sourcing strategies have been successfully used on several missile and bomb programs, perhaps because of the relatively low O&S costs for these systems.

There may be cases when this strategy is used despite the significant up-front and increased sustainment costs. The most notable situation is when there is an urgent need to develop and field a large number of systems and no single source can provide the required production capacity. Later in this chapter, a case study of the MRAP vehicle program is presented. The MRAP program office engaged multiple sources in the development and production of systems to enable rapid fielding. A dual sourcing strategy can also be used when there are two or more products that appear capable of meeting the requirements and, rather than relying on prototypes or comparative analysis of projected capabilities, it is desirable to build and test the actual systems before down selecting to a single system to be acquired during production. In the latter case, acquiring representative competitive prototypes during TMRR would be a preferable approach and a less costly alternative means of evaluating the different systems; but if the program is initiated at EMD, competitive prototypes may not be possible.

Investing in the development of competing systems or subsystems can produce significant cost savings, as well as create incentives for increased performance or reliability, as demonstrated by the so-called, "Great Aircraft Engine War" in the 1980s.

USAF Fighter Aircraft "Great Aircraft Engine War"

Developing inter-changeable fighter aircraft engines drove major reliability improvements and saved billions of dollars.

In 1970, the USAF selected P&W's F100 engine to power the F-15 aircraft. Several years later, the same engine was also selected for the F-16. After losing the F-16 opportunity, GE risked being eliminated from the military fighter aircraft engine market, so they continued to privately fund development work in hopes of a future opportunity to regain market share. While P&W's engine delivered exceptional performance, reliability, and availability became major concerns. So, in 1979, the USAF awarded development contracts to GE to develop and demonstrate its alternative F110 engine and to P&W to improve F100 reliability. The result was two engine designs which were fully interchangeable and could be used on multiple fighter aircraft. In the 1980s, these two engines made possible one of the largest and most effective dual source production programs in DOD history, generating more than a four-fold increase in reliability, improved product warranties, and saving billions of dollars on the cost of new engines.[111]

Another advantage of developing competitive EMD systems—even if only one system will actually be produced—is that competitive pressures remain in place during development which incentivize innovation, responsiveness, cost control, and timely performance. In addition, competitive production pricing can be obtained before entering into production contracts, and, because the design is fully developed, comparative differences in product supportability—including reliability,

[111] The Air Force and the Great Engine War, Drewes, Robert W., National Defense University Press, 1987. (A detailed case study regarding this competition is in Chapter IV, Production and Deployment).

maintainability, and the extent of competitive product support—can also factor into the down-select decision.

Contractor Teaming or Co-Development

Contractor teaming or co-development is another approach to enable dual sourcing. The approach involves selecting a team comprised of two major contractors, both of which have the capability to design, develop, and test a system through EMD. In one method, the development effort is essentially divided between the team members, with each member designing and developing different subsystems and components. The contractors then exchange design and manufacturing data, so that both contractors are capable of producing the entire system. In a second method, the contractors work jointly to develop the design and both assemble production representative systems for testing. Under this method, the sharing of data is intended to be continuous and both contractors actually produce entire identical developmental systems.

The contractor team can be established in one of two manners. A prime contract can be awarded to one of the contractors, specifying that contractor to award a subcontract to the other team member. This has the disadvantage of establishing one of the team members as the prime contractor, who is clearly accountable for program success. Another method is to allow the contractors to form a separate entity or joint venture, which offers the potential advantage of maintaining both contractors in equally responsible roles. Once EMD testing and validation is complete, the team is split to enable a competitive production program.[112] Production quantities are then allocated annually to the contractors based on a chosen method to maintain competition throughout the production phase.

Co-development programs can be a form of international collaboration which results in multiple firms with the capability to produce the system, subsystems, or components. In this case, firms from multiple nations participate in the development program because each country plans to purchase quantities of the production system. These programs are usually led by a single US prime contractor who brings non-US firms into the program as subcontractors. The subcontractors either develop certain components that are used on all production systems, or, through sharing of technical data, multiple firms are set up to produce various components which may be used on production systems sold to their country (as part of an offset agreement) or sold to the prime contractor on a competitive basis. One benefit of international co-development is the potential for competition in the purchase of spare parts. Major programs involving international co-development include Joint F-35 aircraft, the USAF's F-16 aircraft, and the US Army's Multiple Launch Rocket System (MLRS).

While teaming may be an effective means of enabling a dual source production program involving a single configuration of the system, it can be challenging for contractors to transition from historical competitors to teammates, and then back to

[112] "Establishing Competitive Production Sources: A Handbook for Program Managers," Kratz, L. A. et al, Prepared for Defense Systems Management College, August 1984.

competitors. Companies may be less than fully cooperative in sharing technical information during the development process, especially if they consider information regarding processes and technology to be part of their established competitive advantage. The approach can result in less innovation than traditional head-to-head competitions as contractors try to protect their knowledge and expertise. One program which used a co-equal teaming arrangement reported difficulty working issues because the team did not respond as a single prime contractor.[113] Another challenge involves the management of engineering changes once the production program begins—since the team no longer exists, which contractor leads the design and development of changes? Either the government must select a lead contractor or become fully responsible for configuration management.

While teaming strategies were attempted with limited success on several development and production programs in the 1980s and 1990s, there are no apparent, recent programs that used this strategy. Likely, the consolidation of the defense industrial base in the last 20 years has so reduced the number of suppliers for major aircraft, ships, missiles, and other systems that it is very difficult to obtain adequate competition if each team requires two firms fully capable of producing the end item.

Technical Data Package Acquisition

Another EMD strategy that can facilitate a future dual source production program is to acquire a complete TDP during EMD. Of course, the technical data must be accompanied by the data rights necessary for a second source to use the data to produce the item. If unlimited rights cannot be obtained, the strategy may provide for the development contractor to license the use of their data to another company.

This strategy may be effective in two situations. First, when the government funds the development of a significant portion of the items that make up the end item, the government will obtain a greater amount of data with unlimited rights. The second situation involves less complex items with fewer components and, therefore, requires a smaller amount of technical data to enable dual source production. Acquiring a TDP may not be effective for major systems involving highly complex subsystems and components because licensing costs are likely to be so high that the second source will be unable to effectively compete against the developer. A potential tailored approach for large complex systems is to acquire the technical data sufficient to enable competitive assembly, integration, and test of the system and incentivize or require lower-tier competition. Then two firms can independently produce the system—providing competitive pressure at the prime contractor level—and both primes can take advantage of lower level competition for some subsystems and major components.

When acquiring a TDP during EMD, the government is responsible for validating the accuracy and completeness of the TDP, which is accomplished through the developmental design review process and final configuration audits. A significant

[113] "A Case Study of the Teaming Concept in the Procurement of the V-22 Aircraft," Colvard, Richard D., Naval Post Graduate School, December 1994.

disadvantage of this approach is the government assumes some liability if the TDP turns out to be inadequate and the second source cannot produce a compliant system.

At one time, there were nine major US shipyards independently competing to build USN ships, but today there are only two (three, if you count the 1999 establishment of a US shipyard by an Australian shipbuilder). The USN tends to avoid all-or-nothing competitions in order to preserve this limited competitive field, and often actively manages the workload to keep the two major firms sufficiently active to remain in operation.[114] In some cases, the USN conducts a competition for the design of a lead ship and then the shipyards compete for production based on the lead ship design. The strategy is generally more effective when the proposed ship will not require significant technological innovation or go beyond the existing shipbuilding state of the art.

USN Arleigh Burke-Class Guided Missile Destroyer (DDG-51)

Following a lead ship design effort, the USN competed production between two shipyards.

In 1985, Bath Iron Works (BIW), now part of General Dynamics, won the lead ship design for the first Arleigh Burke-Class Destroyer (named the USS Arleigh Burke, DDG-51). Subsequently, BIW and Ingalls Shipyard competed for annual production contracts based on competitive cost proposals. Ingalls won the contract to produce the second ship (USS Barry, DDG-52) which was commissioned in 1992. In 1994, the USN began allocating ships to each yard in order to balance the work. Some competitive forces were kept alive through the use of the Profit Related to Offerors (PRO) pricing system which rewarded the lower cost proposal with a higher profit. As of 2012, there were 62 active ships in this class—34 were produced by BIW and 28 by Ingalls. The DDG 51 destroyer class is one of the longest acquisition programs of its kind in USN history. The ship is still in production and both shipyards are still participating in the program.[115]

Initiating a Leader-Follower Construct

The leader-follower approach is similar to the EMD TDP approach discussed previously, except the developer (leader) is required under the terms of its development contract to support a second source (follower) in getting up to speed on producing the end item. The leader must share not only system technical data, but also the knowledge and expertise necessary for the follower to successfully produce the end item. Where legitimate limitations in data rights exist, the leader can charge the follower for the license rights necessary to use the data. License costs are allowable contract costs which impact the follower's contract price. The major advantage of this strategy is that the government is not liable for the adequacy of the technical data required to produce the end item.

The leader-follower relationship is typically established during the EMD phase and continues through the first several production lots until the follower demonstrates sufficient expertise to independently produce the system. As a practical matter, some

[114] "Mechanisms & Value of Competition for Major Weapon Systems, IDA, April 2011.
[115] "Acquisition and Competition Strategy Options for the DD(X)," Schank, John F. et al, RAND National Defense Research Institute, 2006.

form of a business relationship will be required throughout the production program because few system designs remain stable during the entire production and deployment phase. Engineering design changes are commonly required to: correct problems with the design that become known during operational use, resolve obsolescence issues, integrate more advanced technologies, and/or upgrade performance to respond to new threats or mission requirements.

An alternative strategy which can reduce follower dependency on the leader is to allow the follower to produce a similar product, rather than building the identical product. This approach allows the follower to replace portions of the leader's design with items or components that are unique to the follower's design. Under this approach, the follower is permitted to independently pursue design changes, with government approval, that improve affordability. A drawback of this approach is the government will end up managing multiple configurations of the system, which can drive increased product support costs.

Competition Among Near Substitutes

A "near substitute" is a product that has overlapping capabilities with another item, but is substantially different in some respects. A near substitute is generally the same commodity class (e.g., aircraft, missile, ship, ground vehicle, etc.), as opposed to an entirely different concept or approach to achieve a similar result. While it may be possible to achieve specific military objectives using systems that have no meaningful overlapping capabilities—for example, using tactical jamming devices to penetrate enemy airspace instead of designing stealth features into an aircraft platform—this mode of competition falls outside of the near substitute definition.[116]

Near substitutes generally imply the existence of a previously developed product which can be offered under a competitive acquisition or proposed for further development or modification in response to such an acquisition. The strategy is mentioned here because when near substitutes exist, the government may be able to conduct a competition involving only a limited EMD program. If the magnitude of the EMD effort is substantially reduced, carrying more than one contractor through EMD may be more affordable. More importantly, if the EMD competition results in the award of a single contract, the existence of the product that was not selected for EMD may create a credible threat of substitution at a future point in a program's life cycle if cost or performance problems occur. The USAF's recent KC-X program leveraged the existence of near-substitutable systems and commercial items to enable a competitive, limited EMD strategy.[117] The Army used a similar strategy to acquire a modified commercial excavator for use in combat environments.

[116] "Competition among Near-Substitutable Systems," Harmon, Bruce R., DAU Research Symposium, September 2012.
[117] KC-46 TANKER AIRCRAFT: Acquisition Plans Have Good Features but Contain Schedule Risk," US General Accountability Office, GAO-12-366, March 2012.

US Army High-Mobility Engineer Excavator – Type I (HMEE-I)

TACOM leveraged near-substitutable, commercially-available excavators to meet a combat need.

The High-Mobility Engineer Excavator – Type I (HMEE-I) is a high-speed (up to 60 mph) blast and ballistic-protected excavator used to clear roads, lay power lines, and create obstacles to hinder enemy forces. The Army's Tank-Automotive and Armament Command (TACOM) realized that commercially available heavy-duty backhoe/loaders could, with some modification, meet the military's need. In 2003, the Army conducted a competitive evaluation of three existing commercial products, including one international vendor. Two suppliers received contracts to develop a militarized version of their equipment, while taking maximum advantage of existing commercial technologies. In 2008, TACOM awarded a production contract to JCB North America to produce and deliver 800 HMEE-I vehicles. These systems were well-suited for excavating, earth-moving, and loading work during combat operations in Iraq and Afghanistan. JCB has since sold and continues to offer versions of this specialized excavator to foreign militaries through both direct purchase and foreign military sales (FMS) programs.[118]

Competitive Multi-sourcing with Distributed Awards

This method involves keeping two or more sources engaged in the EMD phase, but at different levels of involvement. There are several possible variations on this method; some of which are discussed herein; others are left to the creative imagination of the government program team. One approach is for the government to competitively award a full EMD prime contract to the contractor offering the best solution for the government's requirements. At the same time, the government awards a limited development contract that provides a small amount of funding to a second source (most likely the second best offer received in response to the EMD solicitation).

Keeping a second source under contract, at even a low level (e.g., 5–10% of prime contract costs), can maintain significant competitive pressure on the EMD prime contractor by greatly reducing the program's barriers of entry (i.e., it lowers the costs of switching if the prime does not perform satisfactorily). It also allows the second source to refine and mature its technical approach and gain familiarity with the program's operations. The cost of implementing this competitive multi-sourcing approach can be relatively small compared to the benefits of competition provided.[119]

Under this variation, the second source may elect to co-develop the system, adding its own funding to that provided by the government, in the hopes of participating in the future production program. If the government commits to awarding production contracts using full and open competition, the second source may be encouraged to make such privately funded investments in product development.

The EMD solicitation can also be structured to provide for cost sharing by the two selected offerors. For example, the best offer receives only 90% of the price proposed

[118] "JCB High-Mobility Engineer Excavator Type I, United States of America," Army-Technology.com, Projects, http://www.army-technology.com/projects/jcbhighmobilityengin/, undated.
[119] "Continuous Competition as an Approach to Maximize Performance," Wydler, Ginny et al, The MITRE Corporation, September 2012.

and is then obligated to invest its own funding to complete the effort. The second source receives only 10% of their proposed price, but is only obligated to match the government's 10% investment and perform a limited effort, not resulting in development of the full system.

Another variation of this method is to fund multiple contractors part way through EMD (e.g., until completion of the critical design review (CDR)) and then conduct a competitive down select to a single contractor to complete the EMD program and proceed to production. This strategy reduces the cost of carrying two contractors all the way through EMD, but ensures competitive pressure remains in effect through the early part of EMD. Competitive pressures can drive positive cost control, timeliness, and system performance outcomes.

The multi-sourcing model can also extend into production with the winner's contract price being fully funded, while the second source continues their remaining development effort based on some amount of government provided funding. Another variation includes funding a second contractor during production to build a prototype for the next program increment. In addition to getting a head start on the next spiral of development, this approach allows the DOD to potentially introduce a second capable source and position the source to compete with the prime for the next program increment.

This unique competitive multi-sourcing concept was originally presented[120] at a Defense Acquisition Research Symposium in September 2012 which focused on "The Limits of Competition in Defense Acquisition." This concept has not yet been applied to an established acquisition program, but the approach makes sense in these days of declining numbers of acquisition programs and a shrinking pool of suppliers. Like all strategies envisioning dual sourcing during EMD or production, however, the effectiveness of this approach depends on the following conditions:

- Large production quantities with economic production rates.
- Credible competition – the second source must represent effective leverage (e.g., a peer competitor) and realistic alternatives to the single-source environment.
- An effective CBA – while only requiring a 5-10% investment in the near term, continuing to use this strategy over multiple phases can be costly. There must be quantifiable benefits in terms of reduced production cost, improved responsiveness, reduced barriers to program entry, etc., to justify the necessary investment.

[120] Ibid.

US Army Joint Tactical Radio System (JTRS)

JTRS and Falcon III: a case where the loser won and the winner lost!

In 2005, two teams competed for the Army's Airborne, Maritime/Fixed Station variant of the Joint Tactical Radio System (JTRS). The Lockheed Martin team won the competition; however, Harris Corporation, a member of the losing team, used its own capital to continue to develop its radio based on the JTRS software communications architecture. The result was the Falcon III radio, which the Army and USMC purchased in large numbers. The Falcon III did not have all of the functionality of the planned JTRS, but it had enough capability for some applications and was available immediately, while the JTRS program remained in development until its cancellation in 2011.[121] This example illustrates two points: (1) the value of winning a production program can compel a firm to invest its own resources towards that end; and (2) the program won at the EMD down select is still contestable by a highly motivated competitor.[122]

Leveraging Privately-funded Development

Competition among near substitutes and competitive multi-sourcing both seek to take advantage of privately funded development efforts. There are other ways to stimulate and leverage privately funded development through maintaining open communications with industry and continuously surveying the market to identify NDI and commercial products which may meet the DOD's requirements. To take advantage of this potential, the DOD must be willing to reopen competition to permit the entry of alternative products during later phases of a program.

As mentioned in the prior chapter, the PM cannot require or even rely on privately funded development; but it is critically important to maintain open communication with industry and remain aware of developments within the applicable marketplace. Two short case studies provide examples of how this kind of competition has occurred.

[121] "Pentagon Shutters Joint Tactical Radio System Program Office," Brown, Bob; NextGov, August 1, 2012.
[122] "Mechanisms & Value of Competition for Major Weapon Systems, Dominy, James R., et al, IDA, April 2011.

Iridium Communications Network

The DOD saved money by leveraging a commercial system—even though it had failed commercially.

Iridium was a commercial effort initiated by Motorola in 1990 to provide global mobile telephone service using a constellation of satellites in low-Earth orbit. The system was originally designed for a total of 77 satellites and service began in 1998 with 72 satellites in orbit. Lockheed Martin, the satellite contractor, achieved unprecedented efficiencies by adopting an assembly line approach that produced a complete satellite in just 28 days.

Despite these impressive technical achievements, Iridium was initially a commercial failure. Far fewer users subscribed than expected and those who did subscribe complained of poor service quality. Iridium LLC, the corporation established to build and manage the constellation, quickly entered bankruptcy protection. While Iridium was a commercial failure, it survived as a niche DOD service provider in the government market under a new owner.[123] While private development did not enable competition in this case, it permitted the DOD to bypass a costly acquisition program and simply purchase services to fulfill government needs.

Competition for a Single Development-Build Program

Some systems are so expensive and produced in such small quantities that it simply doesn't make economic sense to produce EMD systems solely to validate and test the developmental design. The single development-build program integrates the competition for development and production into a single competition. This approach is widely used in the acquisition of specialized space satellites and can be employed for any high cost, low quantity system. The competitive benefits only impact the initial development-build contract award. The cost of these systems is so high that dual sourcing strategies or other approaches to maintain competition during development and production are never used. Because of the technical complexity and uncertainty, these contracts are normally awarded on cost-reimbursable contracts, so the effect of competition on the final price is limited at best.

Another drawback of this approach is that production commitments for a small number of systems are made before the technology development has even begun. Programs using this strategy tend to encounter the same cost and schedule growth that plagues many large development programs awarded competitively, but without continuing competitive pressure. In the single development-build case, contractors are not competing for a series of production lots that will follow a prototype, but for construction of a single unit or relatively few units that are both the first units produced *and* final products. The incentive is not to innovate successfully during the production of a system, but rather to innovate at the proposal stage in order to win the design and build contract. Once the contract is won, incentives to "get it right" are diminished and insufficient resources may be devoted to solving technical challenges associated with producing the promised product.[124]

[123] Ibid.
[124] Ibid.

Lower-tier Competition

When competition during EMD is not affordable or not likely to be effective, the government may obtain some of the benefits of competition through incentivizing or requiring lower-tier competition. Recognize, however, that prime contractors must rely on hundreds of team members, subcontractors, and vendors to design and build a modern military system. Management of these sub-prime tiers represents a significant and time-consuming management challenge as the prime contractor is ultimately accountable to the government if the performance of any of its subcontractors and suppliers impacts their government contract. For this reason, prime contractors will often establish long-term relationships with firms they trust who have a proven track record of successful performance. Normally, recurring competition at the sub-prime tiers should only be expected for commodity or commercial-type items, where suitable goods are available, often off-the-shelf, from many qualified vendors.

The government may choose, however, to focus on specific, major subcontracted components during the EMD phase where a lower-tier competition has substantial potential to generate cost, schedule, or performance benefits. Requiring the prime to use competition in the selection of sources (competition ***for*** development) for a limited number of major development efforts will generally not have a significant impact on the prime contract price. However, continuing such lower-tier competition during EMD such that two (or more) qualified lower-tier suppliers will be available for subsequent phases of the program, adds potentially substantial non-recurring costs to the contract price and the overall program cost. When considering a strategy to continue lower-tier competition during EMD and/or production, a CBA should be conducted in the same manner as before adopting a dual sourcing strategy at the prime contractor level.

FACILITATING FUTURE COMPETITION

EMD results will have a significant impact on the potential for introducing or sustaining competition during the production and O&S phases of a program. When competition during EMD is implemented, the program will be postured for much greater competition in the subsequent phases. If only one EMD contract is awarded, the PM should consider concepts that may facilitate future competition, such as those described below.

Intellectual Property Strategy

This issue has been discussed in great detail in this and preceding chapters. Technical data, along with the necessary data rights, is a great enabler for future competition; however, the program strategy must be realistic and consistent with the current laws and regulations. There is no sense buying truckloads of proprietary data that will sit on a shelf and never be used. The program's IP strategy should be appropriately tailored to focus on how technical data can be used to benefit the program, considering areas where the government fully funded development and other areas anticipated to be major production and support cost drivers.

Identify Component Breakout Opportunities

EMD is the time to begin thinking about when and how component breakout can be used to enable competition or reduce cost through purchases from the actual manufacturer. There are risks associated with breaking out items when the design is continuing to evolve due to residual developmental fixes or required technology refresh activities. Like the issue of technical data, breakout strategies must carefully consider affordability implications and programmatic impacts at the specific subsystem or component level—not simply apply the same strategy across the entire system.

Anticipated Design Changes

Very few product configurations remain unchanged during a multi-year production schedule. If the system contains IT, data storage, and data processing capabilities, for example, the PM can expect technology updates will be required for later production systems, along with retrofit of fielded systems. Program plans should identify areas of potential design change and consider the feasibility of using competition to execute such upgrades. Planning well in advance of a specific need may provide opportunities to apply innovative cost saving strategies. Use of modular design concepts and OSA may enable the use of competition in such cases. Of course, risks associated with integrating a competitive upgrade with on-going, prime contractor system production must be carefully examined.

BEST PRACTICES

*Competition **during** EMD can be expensive, but it can also produce significant cost savings, drive increased innovation, reduce cost and schedule growth risks, and strengthen the industrial base. Over the years, many studies have evaluated the long-term savings achieved through continuing competition; but it can be hard to separate other programmatic impacts from competition's influences. There is no single savings factor that can be claimed; every program will have a different outcome driven by a variety of factors and each projection must stand on its own merits. Best practices from prior programs and research follow.*

Competition Must be Credible to be Effective

If dual sourcing is planned, it is essential to set requirements that are within the technical grasp of more than one company. Ideally, competition during EMD will involve peer or near-peer competitors who regularly compete against each other in the products or technologies relevant to the proposed acquisition. If one firm has a significant competitive advantage over the other(s), the government must be prepared to support additional investments in development or it may be impossible for the second firm to effectively compete against the stronger company. If dual sourcing is not possible, the government may consider awarding small design efforts to losing competitors to keep their design capability fresh and maintain the threat of competition. Engineering design teams are assets that need an experience base to maintain and grow their skills.

Understanding the Market is Critical

Effective market research is a prerequisite to designing the acquisition strategy. The PM must understand the capabilities of the most likely competitors to craft a strategy that effectively removes impediments to competition. Does the market offer technology alternatives or market substitutes that may enable real alternative solutions or will two sources performing independently essentially take the same approach? If the answer is the latter, perhaps a teaming/co-development or leader-follower strategy may be more effective. Do enough competitors have access to the necessary facilities, equipment, and other resources required to perform the effort? How might the existing market be impacted if only one EMD contract is awarded? Are there industrial base viability issues? Openly discussing proposed strategies with potential offerors will help the program office design a strategy which yields the desired outcomes.

Maintain a Life Cycle Perspective

The strategy for any phase must consider how that strategy will impact future phases—especially because decisions made early in a program's life can have substantial impact on strategies and concepts applicable to future phases. The EMD strategy must also align with the anticipated production strategy—there is little value in carrying two sources through EMD if it does not enable competition for or during the production phase. When assessing EMD competition strategies, the PM must consider how final product designs will impact O&S. EMD can result in two different configurations which perform the same function or two sources, each capable of producing identical items. In most cases, fielding different product configurations will increase the cost of O&S.

Use Source Selection Evaluation Criteria to Incentivize

This chapter discussed the importance of EMD outcomes in enabling future competition and cited deliverables and methods, including technical data, OSA, modular development, co-development, teaming, lower-tier competition, and other concepts which require commitment on the part of the EMD contractor(s) to yield the desired outcome. In some cases, it is not practical to establish definitive contract requirements to enforce these outcomes (for example, a contractor cannot be required to surrender legitimate proprietary rights in technical data to be considered responsive to a solicitation).[125] When definitive requirements cannot be contractually mandated, the PM should consider the use of source selection evaluation criteria to distinguish between offeror proposals, placing greater value on specific deliverables and/or plans that best align with the government's desired outcomes.

Of course, if too many elements are established as important evaluation criteria, the emphasis placed on any single element will be diluted. The source selection evaluation approach should: 1) avoid "boiler-plate" criteria that establish too many priorities, and 2) carefully consider what the program's critical issues are, taking into account the system's mission, technologies, major cost-drivers, and supplier markets.

[125] DFARS 227.7103-1(c)

CASE STUDY – USAF AIM-120 ADVANCED MEDIUM-RANGE AIR-TO-AIR MISSILE (AMRAAM) PROGRAM

Introduction and Program Overview

The Air Intercept Missile (AIM)-120 Advanced Medium-Range Air-to-Air Missile (AMRAAM) program was initiated in the late 1970s as a Joint USAF/USN program to develop and produce a more effective air-to-air missile to replace the AIM-7 Sparrow. The Sparrow had only a semi-active guidance system with only a receiver to hone in on radar reflections from the target transmitted by the launching aircraft. Because of this limitation, pilots could only engage one target at a time, making them vulnerable to attack by other enemy aircraft. AMRAAM required a fully active guidance system (transmit and receive capability) providing a true "fire and forget" capability. The new missile would be able to find and track targets on its own, after launch, without assistance from the launch aircraft.

AMRAAM performance requirements included high-speed propulsion, high maneuverability, and all-weather beyond-visual-range capability in a package that was highly reliable and considerably smaller and lighter than the AIM-7—making it suitable for use on the new, smaller F-16 aircraft. In addition, the new missile was to be compatible with the F-14, F-15, F/A-18, British Tornado, Sea Harrier, and German F-4G. The intent was to achieve these significant improvements while keeping unit costs well below the Sparrow's unit costs. In fact, the joint program office forecasted that AMRAAM would achieve twice the combat capability as the AIM-7 at one-half of the cost.[126]

Acquisition Strategy Implementation

The AMRAAM acquisition strategy embraced competition from the beginning. In 1976, five contractors were selected to perform feasibility and design studies: Hughes, Ford Aerospace, General Dynamics, Northrop, and Raytheon. Following concept definition, two contractors, Hughes and Raytheon, were competitively selected to develop prototypes for the demonstration and validation (Dem-Val) phase in 1978. The full scale development (FSD) phase (equivalent to EMD) resulted in an initial $386M FPI contract award to Hughes in December 1981 (ceiling price of $526M).[127] The FSD contract included two fixed-priced options for delivery of production missiles. The option approach allowed the program office to obtain competitive pricing, but Hughes insisted that the option be based on a specific date rather than linked to FSD contract outcomes. In July 1982, Raytheon won the competition to become a second source in a leader-follower arrangement to begin by the fourth production lot. Hughes was, in effect, tasked to teach Raytheon how to make the missile.

[126] "The Development of the AMRAAM: A Case Study of Risk and Reward in Weapon System Acquisition," Mayer, Kenneth R., RAND, N3620-AF, 1993.
[127] "AMRAAM Cost Growth and Schedule Delays," GAO, NSIAD-87-78, March 1987.

Shortly after FSD contract award, Hughes began to fall behind schedule. This was not a surprise to most people close to the program, given the technical problems both contractors had encountered in the Dem-Val phase, external pressures to shorten the FSD schedule, and the high degree of development and testing concurrency in the program. Eventually, the program grew from 48 to 79 months. The FPI contract was not renegotiated based on the increased effort and Hughes was forced to cover the cost of overruns (it is estimated that Hughes invested $255M in AMRAAM development). The Lots 1 and 2 production options were extended and the quantities changed, causing the fixed prices on the options to be renegotiated.[128]

In hindsight, the second source was brought into the FSD program too early because, due to trouble encountered by Hughes, the design was far from stable in 1982. This forced the program office to deal with two contractors amidst problems in missile design, testing, and production processes. Moreover, the competition would be unable to save as much money as originally envisioned because the stand-up of a second source was then delayed several years until the design stabilized. There were also major challenges in making the leader-follower strategy work. Basically, Hughes engineers were very reluctant to share design information with Raytheon, their major competitor. One program office official said, "We got wonderful proposals about what [the contractors] would do, but they tried to get out of it as soon as the contract was awarded. [Hughes] spent as much time fighting transferring stuff as [it has] actually transferring data."[129]

Conclusions

Today Raytheon is the sole producer of the AMRAAM missile—the AIM-120D is the latest configuration. The program has grown substantially beyond the originally planned customers and quantities and Raytheon has produced tens of thousands of missiles over the last 20 years for 36 countries. This is not because the leader-follower acquisition strategy was so successful, but rather due to the downsizing of the defense industrial base in the 1990s. In 1997, the Aerospace and Defense operations of Hughes Aircraft merged with Raytheon after being acquired by General Motors (GM) in 1985. Within the missile sector today, just two prime contractors account for approximately 85% of the DOD's munitions and missile procurement funding. Competition at the sub-tier level exists in some instances, depending on the specific missile system in development.[130]

[128] "The Development of the AMRAAM: A Case Study of Risk and Reward in Weapon System Acquisition," Mayer, Kenneth R., RAND, N3620-AF, 1993.
[129] Ibid.
[130] "Annual Industrial Report to Congress;" OUSD(AT&L), Office of the Deputy Assistant Secretary of Defense for Manufacturing and Industrial Base Policy, October 2012.

CASE STUDY – USN MULTI-FUNCTIONAL INFORMATION DISTRIBUTION SYSTEM-LOW VOLUME TERMINAL (MIDS-LVT)

Introduction and Program Overview

The Multi-Functional Information Distribution System-Low Volume Terminal (MIDS-LVT) is a multi-national, multi-service cooperative program sponsored by five North Atlantic Treaty Organization (NATO) countries (US, France, Italy, Germany, and Spain) with the USN as lead service for US applications and overall program management. The program is managed by the USN's MIDS international program office (IPO), which operates under an international agreement among the five participating nations. MIDS is being developed by an international consortium (MIDSCO) with representation from US and NATO defense and aerospace companies. [131]

MIDS-LVT is an advanced Link-16 command, control, communications, and intelligence (C3I) system incorporating high-capacity, jam-resistant, digital communication links for exchange of near real-time tactical information, including both data and voice, among air, ground, and sea elements. MIDS-LVT is intended to support key theater functions such as surveillance, identification, air control, weapons engagement coordination, and direction for all the Services and Allied forces. The system provides jamming-resistant, wide-area communications on a Link-16 network among MIDS and Joint Tactical Information Distribution System (JTIDS) equipped platforms.

MIDS is designed to be fully interoperable with JTIDS, an earlier Link-16 system. As a pre-planned product improvement of the JTIDS Class 2 Terminal, the MIDS-LVT will employ the Link-16 (TADIL-J) message standard of USN/NATO publications. Although the MIDS-LVT terminal will have the same performance capabilities as the Class 2 JTIDS Terminal, its size and weight will be significantly reduced.

The MIDS IPO is procuring three variants of the MIDS terminal:

- MIDS-LVT (1) is used by USN ships and USN, USMC, and USAF aircraft, as well as those of European nations. US LVT (1) platforms include aircraft carriers, cruisers, F/A-18, F-16, EA-6B, and Airborne Laser. European platforms include Eurofighter-2000 and Rafale Allied platforms.
- MIDS-LVT (2) is used by Army (US and France) air-defense platforms (e.g., Patriot Missile) for engagement operations, command and control, surveillance, intelligence, weapon status and coordination, and battlefield situational awareness (air and ground). It's a smaller, lighter replacement for the Army's Class 2M terminal. Derived from LVT (1), it has 85% parts

[131] This case study has been extracted directly, with limited editing, from: "Competition in DOD Systems Acquisition: Past Lessons and Future Considerations," Beltramo, Michael N. et al, Technomics Inc., December 2009.

commonality with LVT (1), with main differences in cooling, power supply, host interface, and air-platform features.

- MIDS-LVT (3), also known as the Fighter Data Link (FDL), is used by the USAF's F-15 fighter and strike aircraft.

Acquisition Strategy Implementation

After a MS II[132] decision in late 1993 and in accordance with an international agreement, a sole source EMD contract was awarded to MIDSCO in March 1994. This international consortium, headquartered in the US, was composed of five major subcontractors—one from each of the five participating nations, including: BAE Systems (formerly GEC-Marconi) of the US; MID SpA (formerly Italtel) of Italy; Thomson-CSF of France; Daimler Benz Chrysler Aerospace (DASA) (formerly Siemens AG) of Germany; and Indra (formerly ENOSA) of Spain. The MIDS-LVT strategy called for the purchase of a TDP during EMD to enable competitive production for the system.

The EMD program experienced significant cost and schedule growth. Beginning in 1999, the MIDS IPO announced delays in the EMD phase. One of the two principal reasons cited was the lack of a sufficient number of terminals for terminal platform integration activities. The other principal reason cited was the slow pace and incremental delivery of the TDP, which was an EMD deliverable and a key to ensuring competition and contractor readiness in the production phase. The TDP is owned by the MIDS member nations and not by MIDSCO, so the entire TDP (or portions of it) can be provided to other US contractors that are not members of MIDSCO. As a result of the EMD phase delay, LRIP was delayed one year and full rate production was delayed two years.

In late FY97 and early FY98, the US Government entered into production readiness agreements with the following contractors: Data Link Solutions (DLS, a limited liability company comprised of BAE Systems-CNI Division and Rockwell Collins); ViaSat, a small business with partners Harris and Xetron (a subsidiary of Northrop Grumman); Allied Signal (division acquired by Raytheon); and Thomson-CSF, with subcontracts to Indra, MID SpA, and DASA (all of which were EMD participants). Two of the agreement contractors, DLS and Thomson-CSF, were associated with all five of the EMD major subcontractors. The remaining two agreement contractors, ViaSat and Allied Signal, represented new industry participation in the MIDS-LVT program. Production readiness efforts were successfully completed by three of the four production readiness contractors, resulting in each being placed on the Certified MIDS Manufacturer's Register (CMMR). Allied Signal did not receive CMMR status.

The acquisition strategy included having two US vendors and one European vendor. The US vendors are DLS and ViaSat. The European vendor is EuroMIDS, a consortium comprised of four companies—one from each of the European MIDS

[132] The Milestone II decision is equivalent to the current Milestone B decision to enter the EMD phase.

participating nations—Thales (France), Marconi Mobile (Italy), Indra (Spain), and EADS (Germany).

Beginning in 2000 with Lot 1 (the first of several LRIP lots) and continuing in July 2009 with Lot 10 (a full rate production lot), MIDS-LVT (1) US production terminals have been competitively procured using FFP IDIQ contract vehicles with DLS and ViaSat. Production delivery orders are competed annually through a request for improvements (each contractor proposes reduced pricing based on projected learning improvement gains), and awards are split between the two IDIQ contractors based on a best value determination.

It is important to note that the DLS quantities shown in Table 3 do not include LVT (3) or USAF FDL units, and the ViaSat quantities do not include LVT (2) or Army variant units. In both cases, these quantities are directed buys rather than competitive procurements. However, since there is a significant level of commonality between LVT (3) and LVT (1) and likewise LVT (2) and LVT (1), it is reasonable to conclude that DLS and ViaSat bids for the LVT (1) lots shown in Table 3 consider the learning and rate effects of these other variants, both of which should have served to lower proposed prices.

Table 3 MIDS-LVT US Annual Procurement Quantities FY00 – FY09

FISCAL YEAR	LOT NUMBER	DLS QUANTITY	ViaSat QUANTITY	TOTAL QUANTITY
00	1	27	27	54
01	2	81	49	130
02	3	132	100	232
03	4	117	144	261
04	5	177	137	314
05	6	104	222	326
06	7	170	142	312
07	8	139	188	327
08	9	155	140	295
09	10	93	93	186
TOTAL		1195	1242	2437
% OF TOTAL		49%	51%	

The MIDS program office, which is part of the Naval Space and Warfare Command (SPAWAR), states in program office literature that the annual split buy strategy reduced average unit cost by approximately 58% between FY00 (Lot 1) and FY07 (Lot 8) and that both US contractors are delivering terminals in advance of contract schedule.

Conclusions

This program is one of very few acquisitions to have successfully used an EMD-developed TDP to support competitive procurement of production units. Certainly, the international collaboration underlying this program provided a unique forum for sharing of technical data among a diverse group of participating companies, and the large quantities involved in the program served as an incentive to participate. Nothing in the literature suggests that licensing agreements applied in this case, but it is possible that some components were proprietary to one of the participants or a subcontractor. If MIDS-LVT uses any commercial components, the TDP may specify that those parts are to be purchased only from identified, qualified sources.

None of the MIDS-related documents collected by Technomics provided data to confirm or refute the program office's claim that the first eight lots of competitive LVT (1) procurement indicate a reduction in average unit cost of more than 50%. Because there is no cost reporting required on the competition firms' FFP contracts, this computation is likely based on FFP contract prices, which may or may not be the eventual final price to the government. Additionally, the documents do not include any findings or information that address whether competition has resulted in savings or added costs at the program level. That is, an average unit cost reduction of the magnitude noted by the program office does not translate into program savings unless the sum of the unit cost savings for all units offsets the non-recurring cost associated with establishing competition.

CASE STUDY – USN/USAF JOINT AIR-TO-SURFACE STANDOFF MISSILE (JASSM) VERSUS USN STANDOFF LAND ATTACK MISSILE-EXPANDED RESPONSE (SLAM-ER)

Introduction and Program Overview

The Joint Air-to-Surface Standoff Missile (JASSM) program was initiated in September 1995 as a joint USN/USAF program. The JASSM is a low observable standoff cruise missile designed to be launched from a number of tactical fighter and strategic bomber aircraft. The USN's Standoff Land Attack Missile-Expanded Response (SLAM-ER) program was a major modification of the SLAM (which in turn was an adaptation of the Harpoon anti-ship missile) intended to give the USN a standoff capability against land, as well as ship targets. As an upgrade to a small number of existing missiles, the SLAM-ER was not subject to the DODI 5000.02 acquisition milestone review process. The SLAM-ER had an approximately two-year head start on JASSM, with an EMD contract awarded to McDonnell Douglas (later merged with Boeing) in March of 1995.[133]

The JASSM and SLAM-ER share many capabilities, but with some important differences. The JASSM is heavier, has longer range, and carries a larger penetrating warhead. Guidance systems are similar, with global positioning system (GPS) bringing the missiles close to their targets while imaging infrared sensors are used in the terminal phase. Both missiles use the same Williams turbojet engine. A distinguishing attribute of the SLAM-ER is its two-way data link with man-in-the-loop functionality. This gives the SLAM-ER the capability to attack moving targets such as ships, as well as providing additional tactical flexibility. The JASSM's "fire and forget" capability is meant only for use against stationary targets; a similar capability was incorporated in the SLAM-ER as a retrofit in the FY99 production lot. The JASSM is also distinguished by its stealth capabilities.

Acquisition Strategy Implementation

As a new-start major program, JASSM was required to complete an AOA-like activity (then called a Cost and Operational Effectiveness Analysis or COEA) prior to MS I (roughly equivalent to today's MS A) and the start of the program definition and risk reduction (PDRR) phase (now known as the TMRR phase). COEA I compared potential JASSM capabilities and associated technologies to those achievable through existing systems modifications. COEA I determined JASSM was the preferred alternative. MS I occurred in June 1996 and Lockheed Martin and McDonnell Douglas were each chosen to design and build prototype missiles. Prior to MS II (equivalent to the current MS B) and the beginning of EMD, an updated COEA (COEA II) was conducted, where the two candidate systems from the PDRR phase were compared directly to the SLAM-ER. COEA II also found the JASSM to be the preferred system.

[133] This case study has been extracted directly, with limited editing, from: "Mechanisms & Value of Competition for Major Weapon Systems, IDA, April 2011.

MS II occurred in November 1998 and Lockheed Martin was chosen as the EMD prime contractor.

The JASSM program embraced several acquisition reform initiatives, including adoption of commercial practices, minimization of military specifications and data reporting, and cost as an independent variable (CAIV). The general approach gave the contractors maximum flexibility in making trade-offs within the constraints of high-level key performance parameters (KPPs) and a unit cost goal of $400-$700K in FY95 dollars. Another aspect of the acquisition strategy was the use of price-based acquisition (PBA). This approach resulted in the inclusion of fixed-price options for the first five production lots (accounting for 1,146 of the 2,400 initial production quantities) as part of the EMD contract, as well as the elimination of cost reporting for those lots. The approach yielded Lockheed Martin concessionary pricing for those lots, but created a high risk that subsequent lots would increase in price and the government would have only limited historical cost information for use in contract negotiation and program planning. That transition point opened another opportunity for contrasting JASSM against SLAM-ER.

Because of the PBA strategy, the Institute for Defense Analysis (IDA) was tasked to perform an independent market survey analysis in support of the JASSM 2004 MS III (now MS C) full rate production decision. A unique aspect of this analysis was the use of effectiveness measures to help determine fair prices for JASSM in relation to the prices and capabilities of other standoff missiles, including the SLAM-ER. The model did not force a one-for-one substitution of the competitive missiles for JASSMs; instead, platform/weapon/target assignments were determined by an optimization model where blue (friendly) losses were minimized. From this, a utility measure was calculated which provided a basis for comparing these near-substitutable systems. Essentially, the comparative model determined a price/effectiveness ratio. In practice, price/effectiveness scores varied over a range, depending on effectiveness modeling assumptions and pricing ground rules for the competitive missiles. In general, however, the analyses showed that the SLAM-ER and the Storm Shadow, a France/UK joint venture, produced greater effectiveness per dollar than the JASSM. This information may have provided some negotiation leverage for the program office in pricing the production contract.

It was never likely that the USAF would buy the SLAM-ER in place of JASSM. However, there was a possibility that the USN would procure fewer SLAM-ERs in favor of JASSM. It should be noted that although the USN was a participant in the JASSM program, its contributions to research, development, test, and evaluation (RDT&E) were minimal and no procurement buy was ever funded (although quantities up to around 700 were considered). In the end, the USN did not significantly change their SLAM-ER inventory goal (which varied between 400 and 600), although they did buy out their requirement substantially faster than originally planned. The USN formally pulled out of the JASSM program in February 2005; they were satisfied with the SLAM-ER for their standoff missile requirements.

Conclusions

It is clear that SLAM-ER and JASSM exerted some competitive pressure on one another throughout their acquisition cycles. What is less clear is whether program outcomes were materially impacted. The JASSM program's ambitious unit price goals may have been prompted by competitive pressure from the SLAM-ER and the lower JASSM price estimates were an important advantage in the MS II AOA. However, in the course of program execution, JASSM average procurement unit prices almost doubled ($720K versus $400K FY95 dollars) while SLAM-ER prices changed little.

In terms of missile capabilities, the upgrade paths of the missiles showed convergence in some objective capabilities. Already mentioned is the upgrade of SLAM-ER with automatic target recognition and there are plans for JASSM to add a two-way data link and maritime attack capabilities. JASSM and SLAM-ER compete with one another for foreign sales, although JASSM's additional capabilities mean that it is available to fewer nations due to export control restrictions. A notable direct competition was to equip Australia's F/A-18s, where the JASSM was chosen over the SLAM-ER.

This case provides an example of how near-substitutable systems can provide competitive pressure even when there is no actual head-to-head competition. The IDA comparative model also illustrates the type of analysis that may be required to compare product prices when each product offers differing capability, similar to the way the USAF used an Integrated Fleet Aerial Refueling Assessment (IFARA) model to evaluate the pros and cons of alternative aircraft refueling capacity and fuel burn rates in the KC-X (KC-46) tanker source selection.[134]

[134] KC-46 TANKER AIRCRAFT: Acquisition Plans Have Good Features but Contain Schedule Risk," US General Accountability Office, GAO-12-366, March 2012.

CASE STUDY – JOINT PRIMARY AIRCREW TRAINING SYSTEM (JPATS)

Introduction and Program Overview

In the late 1980s, both the USN and the USAF were using dated aircraft for training undergraduate pilots and navigators in the fundamentals of aircraft handling, as well as formation, instrument, and night flying. The USAF flew the Cessna T-37 Tweet, a twin-engine jet. The USN employed the Beech T-34C Turbo Mentor with a single turboprop engine. The T-37 and the T-34C became operational in 1959 and 1974, respectively.[135]

In 1977, the USAF began to consider a replacement for the T-37B. In early 1981, an RFP was issued to Cessna, Fairchild Republic, General Dynamics, Rockwell International and Vought (teamed with Messerschmitt Bolkow Blohm in Germany) for a New Generation Trainer (NGT). The RFP called for an aircraft with two turbofan engines, a pressurized cockpit, and a gross weight slightly less than the T-37B. In 1982, Fairchild Republic was named the winner of the NGT program and began development of the T-46 Thunder Piglet. Initially, the USAF planned to purchase 650 of the trainers through 1993 to serve well into the 21st century. Fairchild-Republic also hoped to sell an attack version of the aircraft overseas.

The Fairchild Republic T-46 prototype was first flight tested at Edwards Air Force Base (AFB) on October 15, 1985. Although it performed well in tests, by mid-1986, it was one year behind schedule and experiencing severe cost overruns. The USAF recommended program cancellation which subsequently occurred in 1987 after only three aircraft were completed. The T-46 program was Fairchild's only remaining aircraft contract. After the USAF discontinued the program, Fairchild Republic in Farmingdale, NY closed in 1987.

Acquisition Strategy Implementation

In 1988, the USAF began a life extension program for the 644 remaining in-service T-37Bs to increase the fatigue life until a replacement was identified. In 1989, the DOD "officially" recognized the need to replace those aircraft in the Trainer Aircraft Master Plan (TAMP), developed in response to congressional direction. The TAMP defined the basic requirements for the Joint Primary Aircraft Training System (JPATS). Perhaps as a result of the T-46 debacle, the TAMP dictated that the new aircraft must be NDI—there would be no from-the-ground-up design and development effort considered. From the outset, this seemed to limit the field to foreign contenders, since presumably no US aircraft manufacturer had a suitable aircraft that would readily meet JPATS requirements.

As a result of the NDI edict, US aircraft manufacturers scrambled to team with foreign companies who had a trainer in production that might meet the anticipated

[135] "Competition in DoD Systems Acquisition: Past Lessons and Future Considerations," Beltramo, Michael N. et al, Technomics Inc., December 2009.

requirements. Complicating the challenge was the fact that the joint program office failed to constrain the competitors with respect to weight, power, range, speed, or other factors which drive aircraft LCC. Additionally, the program office established aircraft specifications that no available NDI aircraft could readily meet. Thus, all existing aircraft that may compete for the program required significant redesign. The JPATS specification called for:

- Greater power than the existing turboprop engines provided
- Improved avionics suite
- Stronger canopy to meet bird strike requirements
- Modern escape and oxygen systems
- Elevated rear seat for better instructor visibility
- Sturdier landing gear
- Service life of 18,720 flying hours

Would-be US co-producers identified six foreign aircraft as JPATS candidates. The aircraft ranged from light, single engine propeller-driven aircraft to twin engine jets. Cost and performance capabilities differed substantially commensurate with physical and technical differences. The competitors' estimated unit production costs varied from about $2M to $4M.

The six foreign companies and their US partners set out to modify their basic aircraft to meet the rigorous JPATS requirements. Design and development of these "updated" aircraft was neither a simple nor inexpensive task. It involved the production of new prototype aircraft and their recertification. To put this into perspective, knowledgeable sources estimated that each competitor invested up to $100M to remain in the competition. If this estimate is valid, together the firms spent enough money to purchase about one third of the 712 aircraft needed by the services before a contract was even awarded![136]

In June 1995, a contract was awarded to Raytheon Beech Aircraft, which proposed to modify the Pilatus PC-9. The aircraft would complete final development and manufacture in Wichita, KS. Three of the other competitors filed protests (Cessna, Rockwell Collins, and Lockheed Martin) which delayed the actual program start until February 1996. Prior to the receipt of proposals, the government's total program estimate was roughly $7B, but through various acquisition reform initiatives and the commercial derivative strategy, the awarded program for development, production, training, and support of 700 aircraft was closer to $4B.[137]

To meet requirements, Raytheon modified a version of their existing, widely used turboprop trainer. The JPATS contract required the aircraft to be certified as airworthy at the time of delivery. This meant the aircraft must have an aerobatic civil certificate

[136] Ibid.
[137] Successful Integration of Commercial Systems: A Study of Commercial-Derivative Systems, Stockman, William et al, Dayton Aerospace, Inc., June 2011.

from the Federal Aviation Administration (FAA) or an equivalent military certification. As part of the contract, the civilian aircraft had to be missionized with military equipment not normally found on most civilian aerobatic aircraft. The final changes to the base aircraft included:

- Pressurization
- New engine (from 950 shaft horse power (SHP) to 1,100 SHP)
- New four-bladed propeller
- Increased weight (25-30%)
- New ejection seats
- Redesigned, stronger canopy
- Multiple, ergonomic cockpit modifications
- Change to wing incidence angle and enhanced leading edge
- New tail
- Stronger landing gear
- New on-board oxygen generating system
- Liquid crystal cockpit displays
- New fuel system and fuel tank arrangement

When development was complete, there were very few parts left in common with the original aircraft. This missionization effort essentially turned the planned non-developmental, commercial derivative program into a major development program. While this normally spells disaster for a commercial derivative program, Raytheon relied on its experience in aircraft of this size and made the changes with only a one year slip in the schedule. The original initial operating capability (IOC) date was May 1999; the first squadron actually achieved IOC in May 2000.

Conclusions

According to the 2013 JPATS Selected Acquisition Report (SAR), the program performed well against all cost, schedule, and performance parameters after being re-baselined, primarily due to government requirements changes in 2007.[138] In January 2012, Lot 18 was awarded for 36 aircraft, bringing the total number of fielded and ordered aircraft to 685, with only two production lots remaining—for a total of 751 aircraft. Raytheon sold the Hawker-Beech Aircraft business in 2006 to a private equity investment firm, leaving the company with a heavy debt burden which, after the 2008 economic crash and ensuing slowdown, eventually forced the company into Chapter 11 Bankruptcy in May 2012. After further reorganization, the company was eventually purchased in 2014 by Textron Aviation, which continues to produce variants of the T-

[138] "Selected Acquisition Report: Joint Primary Aircraft Training System as of Dec. 31, 2012," RCS: DD-A&T (Q&A) 823-560, May 21, 2013.

6 aircraft for several international customers, with over 850 systems produced as of 2017.[139]

This case study highlights the challenges of attempting to use a commercial item to satisfy a unique military requirement. Even though all competitors were basing their offers on an existing (non-US) military training system, no system was capable of meeting the specific acquisition requirements without a significant development effort. The USAF obviously wanted to open the opportunity to the broadest possible competition, but it may have achieved the same outcome—at less cost—with a narrower playing field.

Some critiques of the program claim the USAF, by failing to define basic parameters, kept too many firms in the competition at great expense to both the USAF and all the firms that made private investments to adapt their aircraft to meet specific JPATS requirements. Had the USAF bounded important aircraft parameters, the source selection would have been easier and quicker, protests may have been avoided, and less financial burden would have fallen on the competitors. This case certainly demonstrates, however, that industry will make substantial private investments if the program promises a large enough production quantity. However, government interests may not be served if, in the long run, acquisition programs transfer too much financial burden on the commercial and defense industrial base.

[139] https://en.wikipedia.org/wiki/Beechcraft_T-6_Texan_II, accessed May 11, 2017.

CASE STUDY – MCSC MINE-RESISTANT AMBUSH-PROTECTED (MRAP) VEHICLES

Introduction

The Mine-Resistant Ambush-Protected (MRAP) program is unique; it benefited from many regulatory waivers and the highest level of leadership support within the DOD due to an urgency to field these systems to save soldier and Marine lives in an on-going combat operation. Then Secretary of Defense Robert Gates called MRAP DOD's number one priority and, in June 2007, assigned a relatively rare "DX" rating under the Defense Priorities and Allocations System (DPAS), giving the program the highest priority for supplier parts and materiel in the government and private sector.[140] In addition, the MRAP program began as an ACAT III program; but, due to rapidly growing demands for more vehicles, grew into an ACAT ID program. While this program may not be a model for other programs to follow, it does provide useful insights regarding the effective use of competition.

In late 2006, the DOD launched the acquisition program to rapidly procure thousands of MRAP vehicles for use in Iraq and Afghanistan. With a raised, V-shaped, armored hull, MRAPs provide improved protection against IEDs—the insurgent weapon of choice and a significant source of casualties in these combat environments. The DOD originally intended to procure three categories of MRAP vehicles. These included:

- Category I, capable of carrying up to seven personnel and intended for urban operations
- Category II, capable of carrying up to 11 personnel and intended for a variety of missions such as supporting security, convoy escort, troop or cargo transport, medical, explosive ordnance disposal, or combat engineer operations
- Category III, intended to be used primarily to clear mines and IEDs, capable of carrying up to 13 personnel[141]

MRAP technology is not new. It was developed in South Africa in the early 1960s to mid-1970s for the armed forces of various South African nations to combat the same type of IED threat US Forces faced in the Middle East. Engineers of that era concluded that mine blasts could be directed out and away from a vehicle by elevating the chassis and creating a V-shaped hull along its base. Variants based on this original MRAP technology have been in production outside the US since that time by subsidiaries of General Dynamics Land Systems (GDLS) and BAE Systems. The Army and USMC first employed MRAPs in limited numbers in Iraq and Afghanistan in 2003, primarily for route clearance and explosive ordnance disposal (EOD) operations. Route

[140] Most of the information in this case study comes from: "Study of the Mine Resistant Ambush Protected (MRAP) Vehicle Program as a Model for Rapid Defense Acquisitions," Blakeman, Seth T. et al, Naval Postgraduate School, December 2008.
[141] "Mine-Resistant, Ambush-Protected (MRAP) Vehicles: Background and Issues for Congress," Feickert, Andrew, Congressional Research Service, January 18, 2011.

clearance MRAPs quickly gained a reputation for providing superior protection for their crews, and some suggested that MRAPs may be a better alternative for transporting troops in combat than up-armored, high mobility, multi-wheeled vehicles (HMMWVs).

Warfighters initially requested fielding of more MRAPs as early as 2003. However, due to time constraints, budgetary considerations, and the general optimism and belief in a short conflict in Iraq, senior defense officials focused on up-armored HMMWVs and other anti-IED efforts, such as bolt-on armor kits. As the conflict progressed and the enemy shifted tactics from roadside bombs to buried, under-body attacks, it became apparent that up-armored HMMWVs did not provide the necessary level of protection. MRAP requests increased and in October 2006, US Central Command (CENTCOM) issued a Joint Urgent Operational Needs Statement (JUONS) for 1,185 MRAPs. The Joint Requirements Oversight Council (JROC) rapidly validated the requirement for 1,185 vehicles.

Acquisition Strategy Implementation

The acquisition strategy was formed in support of three primary program objectives: (1) field survivable, mission capable vehicles; (2) field the vehicles as rapidly as possible; and (3) grow the industrial base capabilities while simultaneously managing all aspects of the acquisition process. In early November 2006, the Marine Corps Systems Command (MCSC) released the first RFP and in December 2006 ten manufacturers responded. Phase 1 of the source selection resulted in the selection of nine manufacturers to receive IDIQ contracts in January 2007 with immediate orders for fabrication of a limited number of prototype vehicles for testing. Two of the nine contractors failed to meet contract requirements and were eliminated from the program prior to initiating testing on their prototypes.

The initial testing phase started in February 2007 and continued through April of that year. The testing focused predominantly on threshold survivability requirements and eliminated two more manufacturers for failure to meet minimum survivability or usability requirements. Due to the urgent need to field the MRAP capability, in February 2007, the program office issued LRIP orders to five manufacturers whose vehicle designs were considered low risk. These orders, placed prior to testing, represented deliberate risk acceptance by the PM in an effort to begin production on vehicles considered likely to meet minimum requirements. The manufacturers whose designs were judged to be a higher risk would not receive LRIP contracts until they successfully passed the initial test phase threshold requirements. Two of the MRAP designs originally assessed as low risk were later excluded from the production program, while one of the designs assessed as higher risk was awarded follow-on production orders.

The next phase of the source selection process resulted in the procurement of MRAP vehicles from five manufacturers: (1) BAE Systems, (2) Armor Holdings (now owned by BAE Systems), (3) GDLS, (4) Force Protection Industries, Inc., and (5) Navistar's International Military and Government, LLC subsidiary (now called Navistar

Defense). Although limited commonality existed in engines, transmissions, tires, and axles, that was not a major concern in the source selection decision, demonstrating the program emphasis on procuring vehicles quickly from multiple manufacturers at the expense of long-term sustainability and life cycle costs.

The early decision to include multiple manufacturers proved to be wise because increasing requirements quickly outpaced the industrial capacity of any one manufacturer to produce the required number of vehicles. By May 2007, the requirement had grown to 7,774 vehicles and by September 2007, the requirement had increased again to 15,374 vehicles.

The defense acquisition framework, from MSA through O&S, is designed to be executed in serial fashion, relying on a milestone review and decision process. The program's objective to field significant numbers of MRAP vehicles by the end of 2007 forced the program to plan for and manage all aspects of the process simultaneously, rather than sequentially. Executing activities in parallel produced faster results, but made the program very challenging to manage. For example, the MRAP program simultaneously conducted developmental testing, operational testing, production, integration, fielding, support, and even disposal. Despite the program's initial high visibility and interest, the program began as an ACAT III program with component-level decision-making. It grew to an ACAT I program as the warfighter continued to request additional quantities. As a result, the program's acquisition program baseline was not approved by the DOD until June 2008—but by that time more than 9,000 vehicles had already been produced, with approximately 5,000 more under contract. At that point, requirements for only 1,595 of the total planned purchase quantity of 15,374 remained unfilled.

Contractually, MRAP vehicles were treated as commercial items and therefore were procured under fixed-price contracts from the start. Given the commercial item designation and the relatively small 1,185 vehicle production quantity at the program's start, the program office did not initially purchase technical data from any of the vehicle manufacturers. Sustainment for the MRAP program was originally contracted from each manufacturer through a contractor logistics support (CLS) agreement, to include spare parts and field service representatives (FSRs). However, as the required number of MRAP vehicles increased, the program office changed the sustainment plan to enable transition from CLS to a hybrid of contractor and organic maintenance. In addition to the growing fleet, the program office recognized by early summer of 2007 that a pure CLS approach would not be feasible given the widely-decentralized operations in Iraq. This necessitated contract renegotiations for factors such as engineering data for parts provisioning and cross-training of FSRs to support sustainment of all vehicle variants.

Conclusions

The MRAP acquisition approach demonstrates several important benefits of competition. First, the acquisition clearly demonstrated that an urgent requirement need not be an impediment to embracing competition. Second, engaging multiple contractors spurred both a rapid response and design innovation on the part of all competitors. While numerous contract awards were issued to acquire assets for testing, the program office never guaranteed that all manufacturers who successfully completed testing would receive a production contract. The MRAP contracts also incentivized delivery speed by establishing the order of testing based on the order of vehicle delivery. Each contractor, therefore, had to make their own design tradeoff decisions between system performance and schedule, given the demanding schedule and WTA possibility. In addition to the competitive pressures, each contract also included a $100,000 incentive per vehicle for early test vehicle delivery , thereby motivating the manufacturers to deliver test vehicles even earlier than their proposed schedules.

The MRAP acquisition also demonstrates that developing and maintaining competition requires an upfront investment of both time and money. While the program was far from typical, it is clear that awarding nine separate contracts, testing seven different contractor vehicles, and managing production programs awarded to five different contractors (all within less than two years) was a monumental effort! The program spent hundreds of millions of dollars to acquire and test multiple different configurations of vehicles, as opposed to selecting a single competing design based solely on evaluations of paper proposals. The program office also grew rapidly as acquisition professionals were reassigned from other programs or temporarily detailed to support the huge workload of this fast-moving program.

Finally, although only briefly mentioned in the preceding summary, choosing to field multiple, unique system configurations to perform the same function/mission has significant potential impact on product support. On the other hand, the program office was able to implement some corrective actions to improve supportability even after fielding most of the systems. No doubt the continued existence of competition provided some influence to control the added costs associated with negotiating the required contract changes.

CASE STUDY – JOINT LIGHT TACTICAL VEHICLE (JLTV)

Introduction

The JLTV is an ACAT 1D developmental program intended to augment the HMMWV fleet currently in use by the Army and USMC. It is designed for the USMC to replace HMMWVs only for the most demanding mission profiles, and for the Army to replace approximately 1/3 of the light wheeled vehicle fleet by 2040.[142]

HMMWVs, which first entered service in 1985, were developed during the Cold War when IEDs and other anti-vehicle explosive devices were not a major factor in military planning. The HMMWV's demonstrated vulnerability to IEDs and the difficulties and costs experienced in "up-armoring" HMMWVs already in the inventory have led to renewed emphasis on vehicle survivability. The JLTV family of vehicles provide additional survivability, a greater payload, and responsive, well-integrated command and control.

Acquisition Strategy Implementation

The JROC approved the JLTV program requirements in November 2006 and the Army is the lead Service for acquisition. JLTV procurement plans include 49,909 vehicles from FY15 to FY40 for the Army and 5,500 vehicles from FY15 to FY21 for the USMC.

On October 28, 2008, awards were made for the JLTV TD phase to three industry teams: (1) BAE Systems, (2) the team of Lockheed Martin and General Tactical Vehicle, and (3) AM General and GDLS. The TD phase contracts required each of the teams to build and demonstrate a JLTV system prototype. On November 7 and November 12, 2008, protests were filed with the GAO against the TD contract awards by the Northrop Grumman-Oshkosh and the Textron-Boeing-SAIC teams alleging there were "unintended discrepancies" in how the government rated bids in terms of the systems maturity, logistics, and costs criteria. After a three-month stop work, the GAO denied both protests and the three contractor teams resumed TD efforts.

On January 26, 2012, the Army issued the JLTV EMD phase RFP.[143] It stipulated that up to three EMD contracts could be awarded. The JLTV acquisition strategy and source selection plan served as a framework for industry to conduct effective strategic planning and enabled firms to compete for both TD and EMD contracts. The JLTV joint program office used RFIs, industry days, and DRFPs to effectively communicate program requirements and demonstrate the government's commitment to the JLTV program. The EMD RFP provided for full and open competition and contained language that specifically allowed offerors that were excluded from the TD phase to

[142] Most of the information in this case study comes from: "Joint Light Tactical Vehicle (JLTV): Background and Issues for Congress," Feickert, Andrew, Congressional Research Service, March 11, 2014.
[143] "Promoting Effective Competition in the Joint Light Tactical Vehicle Program," Mills, Stephen J., Defense AT&L Journal, January – February 2014.

compete for EMD contracts. Based on this approach and various changes to the JLTV program schedule, requirements, and cost, additional teams submitted proposals in response the EMD RFP. The six teams that submitted offers were:

- AM General
- Lockheed Martin-led team including BAE Systems
- Oshkosh
- Navistar
- General Tactical Vehicles (a joint venture between AM General and GDLS)
- BAE Systems-led team including Northrop Grumman

On August 22, 2012, the Army announced the award of three FFP JLTV EMD contracts totaling approximately $185M to AM General (South Bend, IN), Lockheed Martin (Grand Prairie, TX), and Oshkosh (Oshkosh, WI). Two of the three selected contractors were not winners of the previous TD phase contracts![144]

The EMD period of performance was 27 months. Each contractor received initial funding between $28M to $36M, with the balance of funding up to the full contract amount provided in FY13 and FY14. Within 12 months of contract award, each team was required to deliver 22 full-up prototypes and provide support for a 14-month comprehensive government testing program which included blast, automotive, and user evaluation testing. The overall EMD phase was scheduled for 33 months. According to the Army, the EMD phase was designed to develop the next-generation vehicles for a limited user test, prepare the capabilities production document, and lead to a MS C procurement decision in FY15.

In the end, a key motivator to both Oshkosh and AM General to compete for the EMD phase was a major change in user requirements driven by a September 2011 Senate Appropriations Defense subcommittee's threat of program cancelation. The new user requirements changed the overall technical focus of the program from an expensive, high-risk approach, to an approach with less technical risk and a significantly lower production cost. This change reduced the relevance of the competitive prototyping strategy employed in the TD phase, which was based on much different JLTV user requirements.

Unsuccessful EMD bidders, Navistar Defense, BAE Systems, and General Tactical Vehicles, were permitted to continue developing JLTV candidate vehicles at their own risk and expense. Reports suggest some bidders considered continuing JLTV candidate development for submission in the production source selection.[145] However, in 2015, Oshkosh won a $6.7B Army contract to begin initial production of about 17,000 light-duty JLTVs for the Army and USMC. The first JLTV delivery order was announced on March 23, 2016, with the Army ordering 657 units, along with kits and support.

[144] Ibid.
[145] "Three JLTV Winners Announced; Losing Companies Still May Have a Shot," Bertuca, Tony, Inside Defense.com, August 23, 2012.

Conclusions

This case provides a great example of the effective use of competition in both the TD and EMD phases. The value of a continuing open dialog with industry is also evident given the unusual re-entry of two contractors who did not receive TD phase contracts. The strong competitive interest in this program is also reflective of the numerous firms participating in this market segment, the large quantity of planned production systems, and perhaps declining defense budgets. These firms were undoubtedly concerned that there would be few, if any, other opportunities of this magnitude to design and build Army ground vehicles in the coming years.

The JLTV program's acquisition strategy includes a competitive focus well into the production and deployment phase through the optional purchase of the JLTV TDP, which provides an opportunity to compete follow-on production efforts with other firms. This competitive component of the JLTV program was briefly mentioned in the JLTV SAR Executive Summary dated December 31, 2012.[146]

The JLTV program has leveraged significant competition to date and clearly evidences support for the concept of maintaining a competitive environment throughout the program's life cycle. The decision to continue competition into the EMD phase with three teams was costly, but it clearly enabled the continuation of competition for, and possibly during, the production and deployment phase.

[146] "Selected Acquisition Report: Joint Light Tactical Vehicle," RCS: DD-A&T(Q&A)823-279, as of December 31, 2013, May 21, 2013.

4. Production & Deployment Phase

IMPLEMENTING COMPETITION

"Powerful enemies must be out-fought and out-produced," President Franklin Roosevelt told Congress and his countrymen less than a month after Pearl Harbor. "It is not enough to turn out just a few more planes, a few more tanks, a few more guns, a few more ships than can be turned out by our enemies," he said. "We must out-produce them overwhelmingly, so that there can be no question of our ability to provide a crushing superiority of equipment in any theatre of the world war."

President Franklin D. Roosevelt

INTRODUCTION

PMs are encouraged to support competition during production phases (either at the prime or subcontractor levels) to reduce the government's costs of purchasing goods and services. There is a belief that competition pressure always drives down system or subsystem unit costs and reduces total system cost. Competition should only be pursued, however, if a CBA indicates that the program's total LCC is likely to be less than staying with a single producer. Production competition works best when the system design is fully developed and stable, competition begins early in the production phase, and a large quantity of items is required.

Impact of Earlier Life Cycle Management Phases

Design competition, which occurs during a program's TMRR or EMD phases, involves development of competing solutions to satisfy a mission need. The purpose of the competition in those phases is to select the best technical approach within affordable costs. Theoretically, if a down select is made upon entering production (i.e., award to a single contractor), the winning design is determined to be the best solution in consideration of total cost and system performance. In effect, the benefits of design competition are "carried over" into the production contract. Design competition, according to this carry-over theory, should result in a lower total program cost. Proponents of the carry-over theory adopt acquisition strategies that feature several competing design firms, ultimately leading to a single production contractor.

Program management decisions made during the EMD phase critically impact the feasibility of competition in the production phase. If the EMD phase only supported a single contractor, competition for major programs during production is normally ruled out. Competition during the production phase will also be limited if the EMD contract did not acquire sufficient data rights or if the product design is highly complex.

Competition in the Production Phase

PMs must first evaluate their program using a decision framework to determine if the benefits outweigh the costs (see Chapter 6 for one such framework). The PM must complete a detailed analysis that considers all cost and benefits related to competition throughout the program's life cycle. This can be a very data-intensive analysis and requires a skilled team of production engineers, cost estimators, contracting officers, and technical data experts.

Costs of Production Competition

In a perfect theoretical market, there are no additional costs of competition—buyers simply go to the auction and pay the prevailing market-clearing price. Within the DOD, the reality is the PM incurs several additional costs if a competition is planned during the production phase, especially when dual sourcing applies. Additional costs include:

- EMD investment to develop and qualify a second source.
- Increased funding in the short term to initiate production with two firms prior to any demonstrable savings being realized.
- Costs associated with increased schedule to allow the second source sufficient time to qualify for production—this is exasperated if the second source is dependent on a TDP from the winning design.
- Increased program management effort since the government is basically managing two programs.
- Additional tasks of integrating the efforts of the two producers to meet overall program needs.

Benefits of Production Competition

There are basic benefits of competition during production that occur even if the PM eventually down selects to a single provider or maintains a second producer throughout the production program. Firms that must compete for a program often:

- Assign their best professionals to win and maintain the workload.
- Allocate a larger share of internal capital for infrastructure and tooling improvements.
- Move production to lower cost facilities or regions of the country.
- Focus on innovative ways to re-engineer their production processes to reduce costs and improve schedule, including such techniques as lean manufacturing.
- Take steps required to improve their production quality and enhance their competitive position.

Impact on Operations and Support

Program management decisions in production can have major impacts on long-term support costs and operational capability. All MS C decisions must consider the impact to LCC, to include long-term O&S. This assessment begins with a detailed analysis of each competing design's LCC and operational effectiveness. The PM must not let short-term budget issues drive the program to inefficient decisions that will cost significantly more in the long run or impact warfighter capabilities. Therefore, when considering or conducting competition during the production phase, the program team must ensure that:

- Each competitor provides a detailed LCC estimate based on a reasonable sustainment plan. This must be a major factor in the source selection criteria. The analysis must include an evaluation of budget requirements.
- The source selection criteria must evaluate the O&S costs and operational capabilities. The government must consider both organic, commercial, and a combination of these sources for sustainment.

- The program has acquired sufficient technical data to allow for the execution of the potential sustainment options.
- The program will obtain sufficient budget to fund the capital requirements of the selected system during the production and O&S phases.
- Where two sources are providing different products to meet the same mission need, the program must consider the additional costs of two different designs, operational profiles, and maintenance requirements.
- Where two sources are providing the same product (e.g., leader-follower) the program must consider the government's cost of managing two suppliers.

Competition Opportunities & Constraints

Competition at Lower Levels

Prime contractors should seriously evaluate and implement competition for all materials and services that they do not build or accomplish in-house. Expect primes to compete all subcontractor requirements to gain the best prices, consistent with required schedule or quality requirements. Prime contractors, however, face the same challenges with regard to continuing competition into production. When an item is developed specifically for the system, it may not be cost effective to maintain more than one source of supply for it.

Data

Technical data rights are a major decision for the government and must be acquired prior to the production phase if successful dual sourcing options are to remain feasible. The program office must also do a thorough analysis of data requirements for sustainment and operations.

Industrial Issues

Competitors emerging from the EMD phase should have sufficient manufacturing capacity and labor force capabilities to successfully enter and compete in production. Outside firms desiring to enter the competition may require significant investment in specialized tooling, production equipment, and labor force training. While the PM may not have strategic industrial base responsibility, the service-level acquisition authorities must consider the impact of down selecting to a single provider if it results in diminished industrial base capabilities.

Program Size and Scope

Large programs with significant quantities produced over an extended period are highly desirable for competitors and enable significant unit costs savings due to learning curve gains. Long production programs also permit amortization of fixed investments over significant production quantities, thus allowing contractors to realize a better ROI.

Low Rate Initial Production versus Full Rate Production Implications

In programs where competition is continued into production maintaining each contractors' design, it is best to let both contractors produce LRIP systems. This allows for an initial quality, schedule, cost, and performance evaluation over a limited number of units. This also enables the producers to make changes and more effectively estimate their actual proposed costs for full rate production. The government also has an opportunity to perform additional tests on these LRIP units in realistic operational environments to determine which design best meets requirements.

If both designs are satisfactory, full rate production provides opportunities for both producers to compete and offer their best pricing over a much larger quantity and longer time period. Depending on the system uniqueness, this may also allow the government to open the competition to outside firms that produce similar systems—that were not funded in the EMD or LRIP phase.

US Army Rifleman Radio Program

The Army reintroduced open competition for full rate production of the Rifleman Radio.

One example of allowing outside firms to produce similar systems was the Army Rifleman Radio Program. The Army initiated a program to provide new digital handheld and backpack radios to all the Services (Joint Tactical Radio System). After many setbacks, the program produced handheld and backpack radios provided by two different producers. LRIP contracts were awarded to Thales and General Dynamics. After test and evaluation, the Army planned to re-introduce competition and open full rate production to other firms in the military digital radio industry. Four firms that did not receive LRIP contracts were potential competitors for the full rate production program—planned as a lifetime buy worth several billion dollars.[147] The Army purchased about 21,000 radios under the LRIP program and will continue to field these radios into 2019; but, as is often the case with technology-related capabilities, the Army's requirements have changed. The Army is now pursuing a new two-channel radio and the previously planned big production buy will not take place.[148]

Multi-year Awards in Competition

Multi-year contracting is a special authority for acquiring more than one year's requirements—including weapon systems—under a single contract award, without having to exercise an option for each additional program year.[149]

[147] "Billions at Stake as Army Opens Competition for Rifleman Radio," Freedberg, Sydney J., Breaking Defense.com, October 22, 2012.
[148] "Army to Launch Another Competition for New Soldier Radio," Cox, Mathew, Military.com, September 21, 2016.
[149] Reference: DFARS 217.1, "Multi-year Contracting."

Multi-year awards enable the contractor to leverage larger combined production quantities across the number of years included in the contract in order to make economic order quantity (EOQ) supply chain buying decisions and efficient factory loading decisions to achieve savings. Under a multi-year procurement, the DOD can contract for up to five years of quantities, although funding is still appropriated on an annual basis.[150] The major benefit is program cost savings that arise from a stable budget and schedule environment. This approach can also incentivize both dual source contractors to invest in their production programs and realize a reasonable return on that investment.

Potential Savings

Multi-year procurement can potentially save money and improve the defense industrial base by permitting more efficient use of a contractor's resources. Multi-year contracts are expected to achieve lower unit costs compared to annual contracts through one or more of the following sources:

- Purchase of parts and materials in EOQs
- Improved production processes and efficiencies
- Better utilized industrial facilities
- Limited engineering changes due to design stability during the multi-year period
- Cost avoidance by reducing the burden of placing and administering annual contracts

Multi-year procurement also offers opportunities to enhance the industrial base by providing defense contractors a longer and more stable time horizon for planning and investing in production and by attracting subcontractors, vendors, and suppliers. However, multi-year procurement also entails certain risks that must be balanced against potential benefits, such as the increased costs to the government should the multi-year contract be changed or canceled and decreased annual budget flexibility for the program and across the DOD's weapon systems portfolio. Additionally, multi-year contracts often require greater budgetary authority in the earlier years to cover the government's cancellation liability in the event the multi-year contract is stopped at the end of any program year or terminated for the government's convenience at any time.

Industry often uses long-term, multi-year contracts to establish long-term relationships with its suppliers. This allows the suppliers to invest capital in tooling, facilities, and personnel and have time to earn a sufficient ROI. This may also strengthen communication and cooperation, resulting in superior services and products. The

[150] "DOD's Defense Acquisition Practices and Processes for Multi-year Procurement Should Be Improved," GAO, GAO-08-298, February 2008.

downside for these awards is that competition is less frequent, which may reduce opportunities for competitive savings or possible insertion of new, improved products.

The PM's challenge is to balance the long-term benefits of multi-year buys with the potential savings from more frequent competition. If the contract period is too short, producers will not invest in production technologies and facilities that will lower costs since there are fewer opportunities to gain a return. Recent GAO studies[151] have shown multi-year procurement tends to reduce program cost by about 7%.

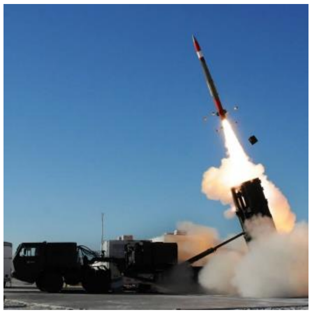
The government can obtain the benefits of multi-year awards and production competition if sufficient attention is given to the duration of the multi-year award. Extended awards may facilitate contractor planning and supplier purchases, thus leading to reduced costs. However, extended awards also tie the second producer to the smaller production quantity—for a longer period, adversely impacting the firm's ability to price competitively for future awards. Thus, the PM must weigh the frequency of competition against extended multi-year awards. Potential product innovation and design growth incentives should also be considered when determining the length of multi-year awards.

Applicable Laws and Regulations

There are no laws, regulations, or policies uniquely related to competition during the production phase beyond those already mentioned in Chapter 1 of this guide.

[151] "DOD's Defense Acquisition Practices and Processes for Multi-year Procurement Should Be Improved," GAO, GAO-08-298, February 2008.

GENERAL COMPETITIVE METHODS & TECHNIQUES



Direct Competition with Winner-Take-All

WTA competitions are the most common and are generally the easiest acquisition approaches for the production phase. The WTA strategy is the normal case after carrying two or more competitors through EMD or if sufficient competition exists within the applicable industrial base—without government funded EMD. The PM must ensure potential bidders are informed of the key aspects of the program and have adequate time to prepare competitive and compliant proposals. WTA competition works best when:

- Development activity is truly finished and the final production version is as close to "off the shelf" as possible. PMs who allow some additional development work to fine tune the design (especially when buying commercial derivatives) will often see the program deteriorate into EMD-related tasks with cost and schedule slips.
- Competition occurs as early as possible in the production program.
- There is sufficient production quantity to attract interest.
- Program requirements are open enough to allow for multiple, viable offerors.
- Program funding and schedule are stable in the long term.

Many studies of sole source versus dual source programs observe that unit costs drop significantly with the WTA approach. However, in order to represent the best approach for the government, the total savings must exceed the up-front, non-recurring investments required to establish the second source in EMD and any savings that may have resulted from a second source participating in the production program.

Depending on the DOD market at the time, competitors often view WTAs as "must-win" situations resulting in corporate pressure to win at all cost. This is especially true if the competitor senses this is the last major program for many years and that the losers will be forced to leave the industry. WTA strategies may encourage:

- Low, unrealistic bids to "buy-in" with the hope of making up losses on additional orders, change orders, or long-term sustainment opportunities. If competitors have other major defense programs, this can also impact performance on those contracts.
- Proposals that assume major systems demonstrated during EMD are actually ready for production—even if they are not. This, in turn, may result in major redesign and post-production modifications/rework and often under-performance in the field.
- Optimistic proposals with unrealistic cost, schedule, and technical assumptions. This often causes significant cost, schedule, and technical problems resulting in multi-million dollar program overruns.

- Competitors to be unwilling to sell full TDPs to prevent future re-competition or dual sourcing. This serves to protect their competitive advantage for sustainment opportunities and future modifications.
- Competitors to consider teaming to eliminate the competition and force the government into a sole source award (to the team).

WTA competitions with short contracts—meaning multiple, future re-competes—are generally most effective. Situations with multiple suppliers and known cost structures tend to closely resemble perfect competitive markets, so savings are expected and can often reach up to 40% compared to sole source prices. Research has found that challengers to the original winner often do quite well and overcome any learning curve disadvantages if entry costs are relatively low.[152] The opportunity to win the full production buy provides great incentive for an outsider to lower costs and improve efficiency. As long as this approach can retain effective outside competition, then it is usually superior to dual sourcing outcomes which provide lower yearly quantities and opportunities for gaming. One big assumption is that the loser will still be around to bid on the next lot buy. This may be a faulty assumption and leave the PM with a sole source provider.

USN Littoral Combat Ship (LCS)

The USN successfully applied a dual source versus a WTA production strategy.

The Littoral Combat Ship (LCS) is a relatively inexpensive USN surface combatant equipped with modular "plug and fight" mission packages for countering mines, small boats, and diesel-electric submarines, particularly in littoral (i.e., near-shore) waters. Rather than being a multi-mission ship like the USN's larger surface combatants, the LCS is a focused-mission ship, meaning a ship equipped to perform one primary mission at any given time. The USN initially intended to conduct a WTA competition between two variant designs and require the winner to provide sufficient data so the USN could competitively contract with other shipbuilders using the same ship design in the future. The result of the competition was such that both variants became so affordable, the USN was able to acquire ten of each variant. The LCS competition strategy is expected to save the USN over $1B over the Future Years Defense Program (FYDP), with additional savings expected over the life of the program. In addition, the two different designs will incentivize each supplier to continue to improve its performance to get a larger share of the best value award.[153]

Commercial/Military Derivatives

Commercial derivative acquisition is a type of competition that has been around for centuries and involves adapting commercial products to meet military needs or adapting existing military designs. Under this approach, the government buys a system

[152] "A Review of the Literature: Competition versus Sole-Source Procurements," Washington, William N., Acquisition Review Quarterly, Spring 1997.
[153] "Navy Littoral Combat Ship (LCS) Program: Background and Issues for Congress," O'Rourke, Ronald, Congressional Research Service, March 2011.

that is already developed and in production, either as a commercial or military product. The idea is simple—instead of developing a stand-alone military system, buy a system already being produced with proven performance and significantly lower costs.[154] Commercial derivatives offer major life cycle savings as long as DOD system requirements are adjusted to match the commercial system versus altering the commercial system to match DOD requirements.

This is a good acquisition strategy if the following apply:

- The mission requirements are fully understood before starting the acquisition; the military operational requirements may be different from commercial uses.
- The "green" existing commercial system closely matches the required military requirements—if not, adjust DOD requirements, where possible.
- The existing system is developed, produced, and competed in a truly competitive market, meaning a lot of other customers paid, or are paying for, the non-recurring costs and production units are far down the learning curve.
- The commercial system is still in production and in use by non-DOD customers such that the commercial market continues to discipline the manufacturer.
- The commercial market is expected to remain viable throughout the operational life cycle of the military system.

Commercial derivative systems apply to the production environment because, by definition, they are already in production and, if appropriate, already meet DOD requirements without significant investment. With limited market research, the PM can set up a competition to leverage new sources of supply that can quickly enter the DOD market. This approach can also create a threat of substitution, but is only valid if the requirements support the competition and the non-recurring costs are minimal.

Commercial derivative systems can work quite well if the acquisition strategy adheres to the assumptions stated above. The basic approach is to:

- Determine the system requirements to include KPPs, schedule, and cost—but allow necessary flexibility to permit consideration of commercial systems.
- Conduct thorough market, engineering, and performance research of candidate commercial systems as compared to the alternative of developing a new design.
- To the degree possible, relax DOD requirements and then evaluate all remaining candidates, choosing the best fit based on a rigorous risk assessment.
- Make the contract and program as commercially competitive as possible.

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[154] Successful Integration of Commercial Systems, Stockman, W., Ross, M., Bongiovi, R., and Sparks, G., PE Systems and Dayton Aerospace Inc., 2011.

- Structure the solicitation so the best candidate system offers maximum performance with minimum modification.
- Consider and use product support that best emulates what is available in the commercial market.

There are several other challenges to DOD PMs attempting to encourage production competition through commercial solutions. The commercial environment is quite different from the DOD acquisition environment and this frequently deters new commercial entrants.

Commercial vendors are sometimes puzzled at the lengths the DOD goes to ensure "fairness" and to implement socio-economic programs. The acquisition process controls often encourage competitor protests that slow down the contracting process and add to vendors' costs of competing. While most firms do engage in some sort of socio-economic support, it doesn't approach the scale of DOD programs.

Also, the DOD acquisition rules and regulations are quite different from customary commercial practices, although this impediment is somewhat mitigated by FAR Part 12 commercial procurement policies. There is an increased cost of managing a DOD program that new entrants often fail to appreciate and price in their proposals—often 10% or more.[155] This is due to various reporting, oversight, training, and additional program management costs.

While the commercial market understands profit (and competition's effect on it), DOD regulations and negotiators sometimes seek to regulate profit artificially. DFARS rules for determining profit on DOD contracts, based on a government assessment of what is fair and reasonable, have no commercial equivalent. Industrial groups claim these rules fail to adequately consider the market environment and company investments. In the end, these policies may drive firms away from the DOD market. In most cases, however, there is a simple solution to any excess profit fears—meaningful competition coupled with the use of fixed-priced contracts.

Closely tied to the profit issue, contracts awarded on a competitive basis typically do not require detailed cost and pricing data, but significant post-award modifications may be subject to the Truth in Negotiations Act (TINA) and Cost Accounting Standards (CAS). In the commercial market, vendors customarily consider their cost and pricing data to be proprietary and are reluctant to release it to anyone—including the DOD. In addition, it can be very expensive to provide the data and necessary supporting information in a manner that the government can understand and analyze. Some commercial sources would rather pass on the sales opportunity, rather than end up in cost-based negotiations with the government.

Data rights may also become a significant issue if the DOD seeks to obtain greater data rights than normally provided to other commercial buyers. Commercial derivative

[155] "Efforts to Reduce the Cost to Manage and Oversee DOD Contracts," GAO, NSIAD 96-106, April 1996.

programs begin with existing systems that already have well established data rights policies with their commercial customers.[156] Most commercial customers require few upgrades or unique modifications to the existing commercial product. Commercial manufacturers are also continually providing upgrades or variants to attract buyers to an existing product line. Commercial customers rarely obtain data rights associated with their specific modifications to an existing design, preferring instead to rely on the provider to maintain design and configuration information.

In addition to the issues stated above, the DOD may also want detailed design and test data to support DOD-directed modifications. Most commercial derivative acquisition strategies require offerors to work out arrangements with subcontractors for modification work if the OEM is not performing the modifications in-house. In the commercial world, purchased systems include the operations and maintenance (O&M) manuals as customarily offered by the seller—and little else. The DOD may want much more information, in part to retain the option of competing future system modifications and spare parts buys.

USAF Academy Powered Flight Program (PFP)

A successful commercial derivative program avoids DOD unique modifications.

An excellent example of a new commercial firm entering the DOD competitive market is Cirrus' capture of the Powered Flight Program (PFP) at the US Air Force Academy (USAFA) in 2008.[1] The USAF decided to re-introduce the program and wanted a quick, low cost solution via a commercial competition of existing aircraft. After market research, the USAF held a traditional source selection (lowest price, technically acceptable) with strict adherence to a "no modifications" requirement. The winning aircraft was a Cirrus SR-20. Cirrus was the top selling general aviation aircraft in the world at the time and the only difference between the military and commercial versions was the paint scheme. The USAF chose the low-cost bidder who met all the requirements. The USAF also chose to use CLS which was significantly cheaper than standing up USAF capability.

[156] "Adopting Commercial Practices in the Department of Defense: Barriers and Benefits," Lean Aircraft Initiative Policy Group, 16 Sept 1996.

SPECIFIC COMPETITIVE METHODS & TECHNIQUES

Dual Sourcing

The theory of dual sourcing is simple—insert competition for the production of a common design and hope the recurring cost savings exceed the non-recurring costs of bringing on and sustaining the second source. Non-recurring costs include additional facilities, tooling, hiring and training personnel, TDPs, production validation, quality systems, and government program oversight, associated with the second source. This non-recurring investment must be offset by the total expected drop in recurring production costs (e.g., learning or improvement curve gains) that the competition may incentivize.

Teaming

There are two versions of teaming in acquisition literature. The first entails the teaming of two major contractors to design and test a system through EMD. Each team member designs and fabricates subsystems and components of the system. The contractors then exchange design and manufacturing data so that both contractors are capable of producing the entire system. Following qualification, the team is split for competitive production.

In this arrangement, the contractor team can be established in one of two manners. In the first, a prime contract is awarded to one of the contractor teammates, specifying that a subcontract must be awarded to the other teammate. A disadvantage is this establishes one of the team members as the prime contractor during the early portion of the program. A variation on this method is to allow the contractors to form a separate legal entity or joint venture, which has the advantage of maintaining both contractors in equally responsible roles. Regardless of how the teams are structured, the understanding in this type of dual sourcing is that at some point the teams will split and compete against each other in production, with both receiving productions shares.

The second method encourages contractors to form teams in order to assemble the needed capital, infrastructure, workforces, and expertise to tackle a major DOD weapon system program. This new team will then compete against other primes or contractor teams to satisfy the government's requirements.

Most PMs view teaming as a good thing because it provides:

- A better base of resources to develop, produce, and support a weapon system.
- A larger technical and research base to support a new design and production.
- Deeper corporate pockets to support the program.
- A larger, more diverse experience base.
- Depending on the market, a spreading of the defense budget across a larger percentage of the industrial base.

There are some downsides to producers that team on major weapon systems, including:

- Teams will not share crucial technical data with partners if that data will be needed in a future competition against that partner.
- Teams need a clear chain of command and teams with equal partners will often have difficulty making key, painful production decisions. The PM must clearly understand who is actually in charge.
- Partnerships often have issues determining responsibility for capital investments and the distribution of workload (despite allocation of PWS elements, etc.).
- There may be anti-trust considerations.

Managed Competition with Dedicated Sources

As the industrial base shrinks for specific systems, the PM may find themselves needing to maintain at least two sources for industrial base and national security reasons. In this case, production of new systems is allocated by the government to keep both facilities in business. This approach is commonly used with major ships and space systems. For a variety of reasons, this normally results in one provider having a more efficient—and thus lower cost—to produce systems.

One of the key techniques used to execute this strategy is the PRO concept. PRO is a competitive allocation procurement strategy tailored to a dual source production program. The concept is to defeat offeror pricing strategies that do not provide overall best value to the government. Under PRO, contractors compete for a target profit (FPI-type contract) based on their offer. The lowest cost bidder is awarded a contract at its proposed target cost and receives a higher target profit percentage. The "losing" bidder is awarded a contract at its proposed target cost, but the loser's target profit is set to a lower percentage than the winner's. The losing profit percentage is a function of the difference between the losing bid and the winning bid; the bigger the difference between the bids, the lower the loser's target profit. The formula for deriving the loser's target profit is specified in the RFP.

Commercial Competitive Development Model

While rare, this open-market strategy encourages all contractors to develop products at their own cost. The government has the option to buy these products at a per-unit cost once the items are fully developed and ready for production. Firms are willing to fund the development if they believe the government will choose to buy their products at a price and quantity that enables them to recoup costs and earn a reasonable profit in the production phase. This approach is best suited to IT systems that allow contractors to develop applications that will run on an existing infrastructure. However, it can also be used to develop components on top of open hardware platforms. For instance, airframes, ships, and vehicle classes present a standard platform, but competition could occur for the various subsystems (e.g., avionics, navigation, and fire control). This approach was heavily used during WWII for a wide variety of systems and equipment.

Form, Fit, and Function

The Form, Fit, and Function (F3) technique involves the solicitation of alternative suppliers based upon performance and external interface specifications, allowing design and manufacturing flexibility. The government provides potential second sources with functional specifications regarding overall performance, size, weight, external configuration, interface requirements, and mounting provisions. Once selected, the second supplier is given total design freedom concerning the internal configuration of the equipment.

The primary advantage of the F3 technique is that it does not require a detailed data package. Thus, the government need not validate and maintain a design package. Furthermore, the government does not assume responsibility or liability for technology transfer. The second source contractor is responsible for the item design. If the end item does not meet specifications, the contractor must alter the design. This method also maximizes the potential production unit cost reduction due to competition, because each firm can design the system based on its manufacturing process. The second source is not constrained to manufacture to the developer's internal design.

The F3 technique also presents several disadvantages. The second source must undertake a system development program. For more complex items, this may require considerable time, effort, and money, thus delaying the initiation of competitive awards. In addition, since the design of the second source's item is different from that of the original producer, the second source's end items must be qualified on unique test equipment. Furthermore, special tooling may be required for manufacture. Thus, the F3 technique may involve two different sets of tooling and test equipment.

The F3 technique also leads to multiple configurations of the end items in the DOD inventory. This may increase logistics costs by requiring two sets of test equipment and different spare parts. In addition, the end item manufacturers may be able to exercise monopoly pricing on spare parts, since they each provide unique configurations.

The F3 technique also presents the risk that in a competitive environment the contractor with the least appreciation for the complexity of the system may be the low bidder. Once awarded production quantities, this contractor may encounter significant problems. The PM can avoid this problem by carefully constructing the source selection criteria to highlight contractors' awareness of critical elements and incorporating product demonstrations into the source selection criteria.

Technical Data Package

The TDP technique of establishing a second production source involves the solicitation and selection of a second source based on a stand-alone TDP. The government procures the TDP from the original developer by exercising a rights-to-data clause in the developer's contract or through a separate procurement. The government must acquire unlimited data rights to openly compete a dual sourcing strategy. Anything less than unlimited data rights may seriously increase the cost, schedule, and technical risk of a second source being unable to produce the winning producer's design.

Four steps are associated with the TDP technique:

1) System developer prepares the TDP.
2) Program office validates the TDP.
3) The second source accepts and translates the TDP.
4) Second source qualifies and fabricates based on the TDP.

The key to successful technology transfer is an adequate TDP which defines the following technical aspects of the end item:

- Specific requirements of the product in terms of detailed physical and performance characteristics within the operational environment for which the product is intended.
- Quality assurance provisions, including sampling plans and acceptance criteria, acceptance inspection equipment, examinations, and tests to be conducted.
- Preservation, packaging, and packing to ensure adequate and economical preparation for delivery and protection of the product from the time of production to time of deployment.
- Manufacturing instructions or descriptions to ensure that contractors in the general field of capability can expeditiously initiate production of the item covered by the TDP.

The TDP technique of establishing competitive production sources presents several advantages. The PM can use a valid TDP repeatedly to maintain competition throughout a production program. In addition, by procuring a TDP, the PM maintains the potential for future competition while committing only a small initial investment. This is particularly attractive because the original producer may offer lower prices as a step towards avoiding competition. Thus, the PM may realize the benefits of competition without incurring the additional tooling and qualification costs associated with competitive production. For this approach to be effective, the first producer must believe that the TDP is adequate and that potential competitors exist.

The TDP technique also presents several disadvantages. In order to validate the TDP, the PM must have access to a qualified engineering team. This team may be required to function through initial production to ensure resolution of any TDP problems.

By validating and releasing the TDP, the government assumes responsibility for its adequacy. Thus, if the TDP is insufficient to enable the second source to produce, possibly because of inadequate drawings or differences in production processes, the government may be liable. Contractual documents must be carefully crafted to ensure the two contractors' responsibilities are clear and protect the government from being held liable to accomplish tasks beyond its capability or control.

Given weapon system complexity, it may be difficult to document weapon system technology strictly through drawings. Even when drawings are complete and accurate, technological differences between the two companies' manufacturing methods may preclude the second source from manufacturing strictly from the TDP. The second source may be required to undertake reverse engineering to translate the system design. Alternatively, the government may have to pay the originator of the TDP to "stand up" the second source's production line. However, once the second source is established, the TDP approach may result in logistics complications later if the two designs are significantly different.

Licensing

The licensing technique of establishing competitive production sources normally involves inclusion of a clause in the developer's contract enabling the government to conduct competition for production quantities, select a winner, and appoint it as a licensee. The developer or licensor is directed by the government to provide technical assistance and manufacturing data to the licensee in exchange for royalties or fees.

The PM must recognize that if a licensing technique is employed, the system developer retains rights to proprietary data and maintains system responsibility. The developer grants permission to manufacture the system to the licensee through a license agreement. The agreement normally restricts the use of the technology to the specific program.

The licensing technique provides several advantages to the PM, including:

- It enables the PM to maintain the potential for competition throughout the production phase where that plan was made clear in the licensee's contract.
- The potential for competition may serve as sufficient motivation to the system developer to control costs, quality, and schedule—without actually transferring technology.
- It enables technology transfer to be achieved with little program office involvement. Thus, the administrative burden on the program office is less than the burden associated with other techniques.
- Inclusion of the license clause in the development contract establishes the potential for production competition early in the program.
- Detailed decisions on subcontractors and production splits can be determined as the program evolves.
- It does not require a great deal of non-recurring cost assuming the industrial base has a qualified producer to do the work.

The primary disadvantage of the licensing technique is that the system developer retains proprietary control over the design and TDP. This may complicate selection of the licensee, since the full TDP cannot be released. Potential complications are:

- The restrictions placed on the technology may inhibit application of the technology to other projects. Thus, under a licensing technique, technical transfusion is slower than under other techniques where the government procures unlimited data rights.
- The use of royalty fees increases the cost of the second source's end items and may preclude the second source from offering competitive prices.
- The second source may be faced with an uncooperative licensor. Under a license approach, motivating the developer to assist the licensee may be difficult.
- Design accountability can become a complex problem. The PM may be faced with a situation in which the licensee wins the entire production award but the system developer retains configuration responsibility. In such a circumstance, design accountability can be complex since the developer is no longer under contract.

Reverse Engineering

Reverse engineering is the process of functionally and dimensionally duplicating an item by physically examining and measuring existing parts to develop the technical data (physical and material characteristics) required for competitive procurement. The reverse engineering process may be performed on specific items which are currently purchased sole source. This may be necessary due to limited data rights, an inadequate TDP, diminished or non-existent source of supply, or as part of a product improvement program. Such items may be reverse engineered if an economical savings over their acquisition life cycle is demonstrated and if other methods of acquiring the necessary technical data for competitive re-procurement are either more costly or not available. In the case of diminished or non-existent manufacturing sources, reverse engineering is often an appropriate strategy even when LCC savings cannot be demonstrated—simply to ensure a continued source of supply.

Component Breakout

DOD policy is to break out weapon systems components or other major end items under certain circumstances prescribed by the DFARS. Rather than have the prime contractor procure all components and/or subsystems from its subcontractors, the DOD may consider competitively acquiring the components or subsystems directly from a vendor source. The DOD then provides the components to the prime contractor as government furnished equipment (GFE). Under this approach, the DOD avoids pass-through costs associated with the prime contractor's overhead and profit.

In most cases, the DOD will find it is worth the cost/price premium to have the prime contractor retain accountability for integration. However, to assess whether it would be a smart decision to employ component breakout, conduct a CBA that considers the following:

- Extent to which the DOD can fairly allocate schedule and other risk to preclude the prime contractor from using the GFE conveyance as an inappropriate excuse to secure an equitable adjustment (should the prime contractor encounter other, unrelated problems).
- Component breakout is normally not justified for a component that is not expected to exceed $1M for the current year's requirement.
- Whether quantities are sufficient to create cost efficiencies.
- Timing within the acquisition life cycle—if still in early production lots, the opportunity may be riper for component breakout than it would be in the last planned production lots.
- Contractor's make or buy plan and the DOD's opportunities to influence those decisions to promote competition at the sub-prime level.
- Qualification of alternative sources (schedule and any technical risk to qualify new sources).
- Availability of mechanical drawings and other technical data.
- Budget implications—unfortunately the DOD often misses opportunities to employ component breakout when the budget assumes the prime contractor will bear component costs and the DOD is leery of introducing schedule risk by involving another party.
- Complexity of the system and whether the DOD has the organic skill set to perform integration.

If the government previously obtained a sufficient TDP, they can compete a key component(s) that suddenly becomes unavailable or unaffordable. This is only possible if sufficient data rights to directly buy the part(s) have been acquired. Otherwise, the contractor or program office will have to re-compete the part and likely a new design and the weapon system deliveries may be adversely impacted.

USN DDG-51 Destroyer

Break out of MRGs from the DDG-51 program saved the USN a lot of money.

The value of considering a breakout option is illustrated by a review of the DDG-51 Destroyer costs. During the review, the government noted that the new cost for the Restart Main Reduction Gear (MRG), previously contracted by two construction shipyards as Class Standard Equipment, was now more than three times the previous cost. The incumbent manufacturer had exited the MRG market and had sold its IP to another firm. The prime passed on this subcontractor's new bill to the government without aggressive cost management. The program executive officer (PEO) broke out the MRG from the prime contract and conducted a full and open competition, resulting in government savings of over $400M for a lot buy of nine ships.[157]

Leader-Follower

The leader-follower technique may be used when there is a product or system developer or sole producer that can be designated as a leader company. The leader provides assistance and know-how to one or more follower companies so the followers can become a source of supply. The objectives of this technique are to:

- Reduce delivery time
- Achieve geographic dispersion of suppliers
- Maximize scarce tooling or special equipment use
- Achieve competition savings during production
- Achieve uniformity and reliability in equipment, compatibility, or standardization of components and interchangeability of parts
- Eliminate proprietary data use problems that cannot be solved by more satisfactory solutions
- Facilitate the transition from development to production and to subsequent competitive acquisition of end items or major components
- Maintain and even expand the industrial base

For this technique to be effective, there must be an incentive that motivates the leader to participate in this capacity.

[157] "Guidelines for Creating and Maintaining a Competitive Environment for Supplies and Services in the Department of Defense," OUSD(AT&L), August 2014.

The key advantage of the leader-follower technique[158] is the limited government liability associated with technology transfer. Unlike the TDP technique, under this technique the program office is not required to validate a TDP. Thus, the government need not assume responsibility for the adequacy of the data. In some cases, a complete TDP is not required. The program office must monitor technology transfer; however, the direct contractor-to-contractor transfer facilitates the development of the second source, while minimizing the government's involvement in validating technical data. Problems encountered in translating technical data can be solved through direct engineering exchange between the two contractors. In some cases, the leader can qualify the follower for production.

The downside of leader-follower, as with many forms of dual sourcing, is that there are two producers, each producing smaller quantities than a sole source produces, which can raise the cost of the systems.

There can also be major performance risks since a follower must obtain a fully complete and accurate TDP from either the winner or the government. The risk is significantly reduced if this strategy begins during EMD.

Determining Production Quantity Allocations for Dual Sourcing

To attempt a dual sourcing strategy, the PM must develop a fair and legal method of splitting the production between competing producers. Most producers will eventually figure out how to "game" the allocation to maximize their profits and benefits. The PM's objective is to purchase the systems at the lowest possible cost while meeting quality and performance standards.

Splitting the production buy ensures the viability of future competition. The split award also involves an apparent short-term loss in efficiency in that award of the entire year's production buy to the low bid contractor (WTA) may yield a lower procurement cost for the given year, compared to a split buy. On the other hand, the loss of a year's production experience will reduce the higher priced contractor's capability to compete for future awards. This may result in establishing the winner of the initial competition as a sole source supplier, potentially subjecting the government to monopoly pricing.

Program Manager Allocation

Under this approach, the program strategy defines—prior to the bids—that the split will be 60/40 or 55/45 in favor of the lowest priced or best value proposal. Obviously, this is a simple approach and allows offerors to determine the costs (and profits) for winning and losing scenarios. The concern is that it allows the offerors to "game" the bid and potentially increase prices if losing results in more revenue (profit) than winning. The offerors will only provide a single proposal, but will not know in advance

[158] FAR (17.401 through 17.403) provides specific detail on the Leader Follower approach and requirements.

which part of the split they may win. This approach is only reasonable if the split amounts are similar in magnitude. Some gaming may be deterred by awarding the full buy to the winner if the follower profit or cost is deemed unreasonable.

A subset of the PM allocation approach is the minimum sustaining rate approach. The use of a minimum sustaining rate involves the guarantee of a fixed portion of the annual production buy to the higher bidding contractor. This rate is normally the lowest production rate required to maintain contractor production. Such a minimum may be as low as 10% of the buy.

Minimum Total Cost Rule

The minimum total cost rule involves solicitation of contractor prices for various portions of the total quantity buy. For example, lot prices for 40%, 45%, 50%, 55% and 60% of the buy may be requested. The contractors' corresponding competing bids are summed for a total lot cost and the least cost combination determines the award percentages. This approach minimizes the effects of gaming if one or both offerors try to lose intentionally based on a single allocation point.

In the following example, the producers were asked to bid on different numbers of systems ranging from 40% to 60%. The PM then determined the total buy for the team. In this case, the lowest total buy price ($123.6M) corresponded with Contractor A producing 40% and Contractor B producing 60%.

Table 4 Minimum Total Cost Rule – Original

CONTRACTOR A		CONTRACTOR B		TOTAL
% of BUY	**BID COST $M**	**% of BUY**	**BID COST $M**	**BUY**
40	$52.50	60	$76.80	$129.00
45	$58.50	55	$70.80	$129.30
50	$63.90	50	$64.50	$128.40
55	$69.30	45	$58.20	$127.50
60	**$72.00**	**40**	**$51.60**	***$123.60***

Similar to other dual sourcing allocations methods, this approach is also subject to producers gaming. They can change bid higher unit costs on the smaller quantities in an attempt to win the major share at a higher price (and thus raise the government costs). Using the same example, now Contractor B has slightly raised prices for the 50%, 45% and 40% cases—changing the total cost and winning a higher percentage of the program.

Table 5 Minimum Total Cost Rule – Modified

CONTRACTOR A		CONTRACTOR B		TOTAL
% of BUY	BID COST $M	% of BUY	BID COST $M	BUY
40	**$52.50**	**60**	**$76.80**	***$129.00***
45	$58.50	55	$70.80	$129.30
50	$63.90	50	$67.70	$131.60
55	$69.30	45	$64.00	$133.90
60	$72.00	40	$61.90	$133.90

Solinsky Rule

Another quantity allocation technique involves solicitation of contractor bids for various quantities and the calculation of mid-point bid prices. These prices are used as inputs to an arc-tangent formulation that determines the production split. This method is referred to as the Solinsky rule.

The Solinsky Rule[159] was developed by the Army to enhance aggressive bidding by awarding percentage production shares based on the difference in bid prices for a mid-range quantity. If the differential between the contractors' bids is large, the percentage share differential is large. Similarly, if the bid difference is small, the percentage share differential is small. The bid differential is calculated with the following equation:

$$\frac{Company\ B\ price - Company\ A\ price}{Company\ B\ price + Company\ A\ price}$$

When the Company B price is higher than the Company A price, the bid differential is calculated for the mid-range quantity only. As an example, if the total buy equals 10,000 units and bids were solicited for ranges of 2,000-4,000, 4,000-6,000, and 6,000-8,000 units, the bid differential will be calculated for the 4,000-6,000 range only. This normally results in a value between 0 and 0.3. The percentage split is calculated using this bid differential and a program office determined arc-tangent function.

As shown in Figure 3, the Solinsky Rule can be portrayed as a four-quadrant diagram. The ratio of Company B's bid to Company A's bid is presented along the X-axis. The percent of the production buy awarded to Company A is shown along the Y-axis. A family of arc-tangent curves, similar to Curve 1 and Curve 2 in the figure, can be generated by the program office by varying the constants associated with the arc-

[159] "A Procurement Strategy for Achieving Effective Competition While Preserving an Industrial Mobilization Base," Kenneth S. Solinsky, U.S. Army Electronics R&D Command, Night Vision and Electro-Optics Laboratory (undated).

tangent function. As shown, the possible award outcome can vary significantly depending on the particular arc-tangent function that is chosen. A particular function is selected by the program office prior to releasing the RFP.

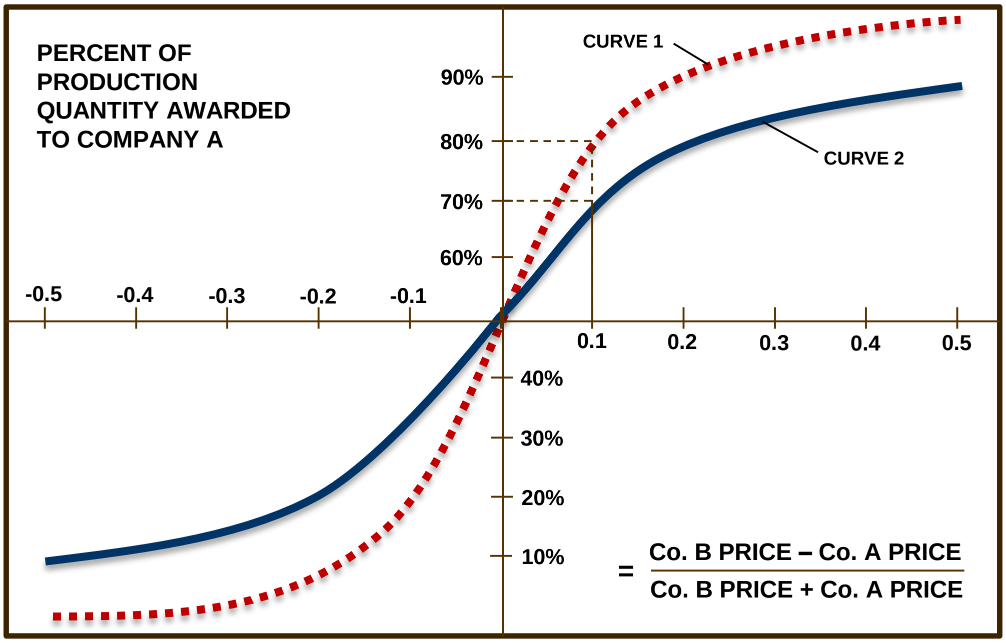

Figure 3 Solinsky Rule

The Solinsky Rule limits potential problems associated with the minimum cost rule; however, it is also susceptible to contractor gaming because of its reliance on a single mid-range price. The method presents an incentive to contractors to minimize the mid-range price and inflate prices outside of the mid-range. This is particularly attractive to contractors because the actual award will probably be outside of the mid-range. A profit-maximizing firm may increase the price of outer range quantities to the point where marginal profits gained from the higher price are equal to the marginal profits lost from a lower award quantity.

Pelzer Rule

The effect of price competition on product quality is an area of great concern. Many argue that price competition forces contractors to trade off cost and quality, often leading to reduced system performance. Pelzer[160] developed an allocation technique that reduces this risk by incorporating quality and other relevant factors into the award formulation.

The Pelzer Rule assumes that the system developer will enjoy considerable production experience relative to the second producer. Thus, the second producer cannot be price

[160], "Proposed Allocation Technique for a Two-Contractor Procurement." Jay L. Pelzer, AFIT Thesis, Air Force Institute of Technology, May 1979.

competitive. To adjust for this, Pelzer develops an index weighting system which reflects relative price decreases over a three-year period.

The technique involves requesting bids from both contractors for various production quantities. The bid prices are then fit to a quadratic equation to reflect the effect of production rate variations on unit costs. Average unit costs are calculated for both contractors and then input into the selection formula.

The selection formula includes other factors, such as equipment performance and timeliness of delivery, measured as achieved versus desired performance. The factors are weighted according to their relative importance. A series of mathematical derivations produces a competitive index that determines the production quantity split. The Pelzer Rule approach presents several advantages over prior allocation techniques. Contractor gaming is limited by the use of a three-year, moving-average index. In addition, the inclusion of factors other than price reduces the risk of late deliveries or poor performance.

The Profit Related to Offerors Concept

The PRO Concept was developed by the USN Strategic Systems Project Office (SSPO) for use during competitive production of the Trident MK-5 Inertial Measurement Unit (IMU) and Electronics Assembly. It was later used on the DDG-51 competition. This approach differs from other allocation techniques in that both competing contractors may receive 50% of a low quantity production award. Profit margin is adjusted based on the contractors' bids while producers are encouraged to realistically bid production costs. The program office sets the profit for the winning proposal (lowest cost/price) at a higher level (rate and dollars) than that for the losing proposal. Both contracts normally have a share line (profit or fee) if actual costs exceed the proposed costs. If the competition is successful, both cost proposals will be close which results in both producers receiving similar profit margins. If the loser's unit price is significantly higher, they are given a reduced, negotiated profit using weighted guidelines.

This method avoids the potentially low quantity bidding games associated with allocation techniques. It also rewards product quality and performance, not mere low bid price. Finally, due to equal quantity awards, the technique ensures that both producers are qualified and ready to re-compete.

USN DDG-51 Profit Related to Offerors (PROs)

The PRO method is estimated to have saved $300M on a three-ship DDG 51 buy in 2012.

The USN typically buys two DDG-51destroyers annually—one for each of the two remaining shipyards. Each yard submits their estimated cost to build a single destroyer. The yard offering the lower cost is awarded a contract with a higher profit margin. The yard offering the highest cost still receives a contract to build a ship, but with a lower profit margin. In 2012, the low bidder's target profit was 14% and was determined using the following formula:

$$High\ bid\ target\ profit\ \$ =$$
$$low\ bid\ profit\ \$ - 65\%\ (high\ cost\ offer\ \$ -\ low\ cost\ offer\ \$)$$

The contracts also use a fixed-price incentive arrangement, providing for a 50/50 share ratio both above and below the target cost. The share ratio creates a strong incentive against submitting unrealistically low bids.[161]

Buyouts

A program buyout typically occurs after a series of annual competitions and involves the award of all remaining production to the winner of a final competition—even if the remaining items are to be produced over several years.

If the buyout is well planned, it enables the PM to obtain the benefits of competition, as well as the efficiencies of a large production run. For example, the PM should be sure the program is at the end of its production. If production is extended beyond the buyout, the losing contractor will not be involved in the program and the PM will be in a sole source situation. Also, a buyout program can backfire if the system design is not firm. Future system changes via engineering change proposals (ECPs) can provide the winning producer with opportunities to gain excess profits.

Configuration control responsibilities following the buyout should also be considered. If the system developer loses the buyout, the second source may assume design responsibilities or the system developer may retain configuration responsibilities. The latter alternative presents the awkward situation in which a contractor who is not producing an item maintains configuration control.

[161] "Can Navy Afford Next-Gen DDG-51 Destroyer, Packard Award or Not?" Freedberg, Sydney, Breaking Defense.com, December 12, 2012.

BEST PRACTICES

Competition cost savings are normally realized during the production and deployment phase. The following best practices will help ensure dual sourced production programs are effective.

Importance of LRIP in Production Competition

In programs where competition is continued into production maintaining each contractors' design, it is best to let both produce LRIP systems. This allows for an initial quality, schedule, cost, and performance evaluation over a limited number of units. This also allows producers to make changes and determine their actual proposed costs for full rate production. While a primary benefit of competition is reducing recurring production cost, competition often encourages improvements in system performance, quality, and schedule.

Technical Data Transfer to Competitors

The key to successful technology transfer is an adequate TDP which defines the following technical aspects of the end item:

- Specific requirements of the product in terms of detailed physical and performance characteristics within the operational environment for which the product is intended.
- Quality assurance provisions, including sampling plans and acceptance criteria, acceptance inspection equipment, examinations, and tests to be conducted.
- Preservation, packaging, and packing to ensure adequate and economical preparation for delivery and protection of the product from the time of production to time of deployment.
- Manufacturing instructions or descriptions to ensure that contractors in the general field of capability can expeditiously initiate production of the item covered by the TDP.

Winner-Take-All Competition

WTA competition for production works best when:

- Development activity is truly finished and the final production version is as close to "off-the-shelf" as possible. PMs who allow some additional development work to fine tune the design (especially when buying commercial derivatives) will often see the program deteriorate into EMD-related tasks with cost and schedule slips.
- Competition occurs as early as possible in the production program.
- There is sufficient production quantity to attract interest.

- Program requirements are open enough to allow for multiple viable offerors.
- Program funding and schedule are stable in the long term.

CASE STUDY – USAF GREAT FIGHTER AIRCRAFT ENGINE WAR OF 1984

The 1980's "war" as described by Major General Robert Drewes in his book *The Air Force and the Great Engine War*[162] actually began in the late 1960s, long before the "dueling" engines were developed or produced. The USAF came out of the Vietnam War with a relatively poor win ratio against Soviet and Chinese fighters compared to Korea and WWII opponents. At the same time, the Soviets were unveiling a new generation of fighters that potentially surpassed anything in the existing or projected USAF inventory. This created intense pressure to accelerate the development of the USAF F-16 and F-15 programs and the USN F-14 and F-18 programs. The USAF funded a small technology development program for three potential engine designs from P&W, GE and the Allison Division of GM. Each was sent an RFP for the initial engine development program and P&W and GE were selected in August 1968. In February 1970, P&W was selected as the production winner to supply engines to the F-15 (F100) and to begin development work of a variant for the F-14 (F401). Eventually, P&W won the contract for the major F-16 engine buy. While the new engine provided amazing capabilities over legacy engines, it suffered from frequent failures, high maintenance costs, and increased unit costs.

As P&W enjoyed its monopoly hold on the jet fighter engine market, GE sales dropped significantly and GM's Alison Division eventually exited the market. This left P&W as the major fighter jet engine supplier. GE had some bomber engine work, such as the B1A bomber engine (a program that was cancelled), but still continued an aggressive jet engine R&D program. In particular, they developed a building block approach that allowed them to quickly size engine cores to meet different aircraft requirements. This allowed GE to use their own funds to start development in 1975 on a new engine for the F-14—*and* F-16s and F-15s. The government encouraged GE to invest due to several congressional attempts to fund a new engine development program, as well as increasing F100 operational and technical issues. GE also had a reputation with the Services of providing superior customer service, warranties, and hands-on support.

Meanwhile, things kept getting worse at P&W. The major engine issues created a backlog of repairs and fixes which, when coupled with large labor strikes, caused the USAF to run out of engines. At one point the USAF was so desperate for engines, they took used engines out of old planes and sent them to production plants so new aircraft could be deliver delivered. The rising costs and operational and maintenance issues, tied with the shortages, were the last straw needed to convince the USAF to launch a new engine development competition.

In 1979, the USAF awarded a development program to GE and P&W. The program funded GE development and demonstration of its engine and P&W improvements to the F100. While the P&W engine was improved as a result, it still exhibited high costs

[162] The Air Force and the Great Engine War, Robert W. Drewes, National Defense University Press, 1987.

and operational issues. The F100 was still an order of magnitude better than any previous jet engine, but the USAF (and USN) were ready for the next generation of jet engines.

Leading up to the RFP release, both producers unleashed major lobbying efforts on Congress, the DOD, and the general public. The threat of competition forced P&W to increase its efforts to improve its engine, address its costs, and conduct a major public relations campaign in the hopes of delaying or terminating the competition. Meanwhile, GE assertively highlighted the current engine's weaknesses and proclaimed its new engine's capabilities. In a major competition like this one, PMs will have no shortage of "help" from the competitors!

By 1982, the GE engine was well-tested and ready for production. The USAF released a DRFP to gather feedback from both parties on the acquisition strategy. At the same time, Congress and the press began scrutinizing DOD program costs to include spare parts—and one prime example was the P&W F100. This scrutiny provided even more USAF incentive to forge ahead with the competition.

On May 18, 1983, the USAF released the final RFP. It defined a best value source selection, covered full life cycle costs, and required pricing for a variety of quantities to include a range of dual sourcing splits. While both companies provided proposals, P&W provided an additional, unsolicited proposal for the whole program, offering a fixed-price, multi-year contract for 2,300 F100s that was potentially $3B cheaper than its prior contracts. While interesting, the USAF declined to accept or evaluate the proposal, instead continuing with its competitive acquisition strategy that it hoped would provide even more savings.

On February 3, 1984, the USAF announced a split award for a single lot buy in FY85 with 75% going to GE and 25% going to P&W. GE's proposal was considered superior based on LCC, warranty terms, and support. Additionally, GE had a better plan for spare parts which emphasized competition to keep prices low. The P&W price proposal was focused on a 100% win with increased cost as the P&W share declined. A few days after the announcement, the USN announced they would buy the GE engine to replace P&W engines in the F-14. This was a great buy for the USN since they did not have to fund the development and would be buying low cost engines at the end of the production run.

After the initial lot buy, the contractors were allowed to adjust their proposals (only if beneficial to the government) resulting in the buys shown in Table 6.[163]

[163] "The Air Force and the Great Engine War," Victoria Mayes, AFIT Thesis, 1988.

Table 6 Fighter Engine Dual Sourcing Results

FISCAL YEAR	GE	P&W
FY86	54%	46%
FY87	56%	44%
FY88	45%	55%
FY89	45%	55%

After FY89, the production buys decreased dramatically. At the time, it was estimated that each lot buy saved approximately $3-4B dollars over the previous P&W contract.

Conclusions

This is a case where production competition definitely lowered cost and improved the product and military readiness. It is unlikely that P&W would have made the investments, improvements, and cost reductions without the competitive pressure.[164] The competition produced the following program results:

- Reduced the shop visit rate per engine flight hours for both producers to half of the pre-competition level.
- Increased scheduled depot return from 900 cycles to 4,000 cycles.
- Produced a lower cost warranty from both producers compared to the original P&W warranty.
- Created dual lower-tier suppliers with the benefit of enhanced operational flexibility and an enlarged lower-tier industrial base.
- Protected against production disruption, like that experienced under P&W, through the use of dual sources.
- Improved the jet engine industrial base by re-establishing GE as a major engine provider for military jet fighters and a viable P&W competitor.

[164] "Effective and Ineffective Competition in Defense Acquisition," Gansler, Jacques, Competition in Defense Acquisition (DAU), September 18, 2012.

CASE STUDY – USN LITTORAL COMBAT SHIP (LCS)

On November 1, 2001, the USN launched the Future Surface Combatant Program aimed at acquiring a family of next-generation surface combatants. The new family of surface combatants would include three new classes of ships: a destroyer called the DD(X) (later designated the DDG-1000) for the precision long-range strike and naval gunfire mission; a cruiser called the CG(X) for the air defense and ballistic missile mission; and a smaller combatant called LCS to counter submarines, small surface attack craft, and mines in heavily contested littoral (near-shore) areas.[165]

LCS is a fast, agile, focused-mission platform designed to defeat asymmetric "anti-access" threats such as mines, quiet diesel submarines, and fast surface craft. As the name implies, this ship operates in shallow waters near shore and closer than other large naval ships can safely operate, yet it's also capable of open-ocean operation.

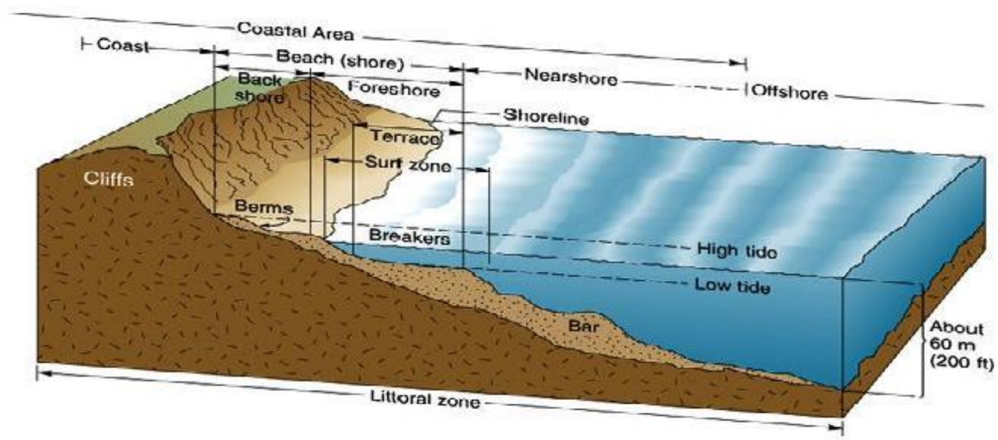

Figure 4 Littoral Seascape

LCS was to consist of two variants—Freedom and Independence. The sea frames were to be outfitted with reconfigurable payloads, called mission packages, which could be changed out quickly. Mission packages were to be supported by special detachments that deploy manned and unmanned vehicles and sensors to conduct mine, undersea, and surface warfare missions. The USN planned to procure 55 LCS sea frames and 64 LCS mission packages—(16 Anti-Submarine Warfare (ASW), 24 Mine Countermeasures (MCM), and 24 Surface Warfare (SUW).

On May 27, 2004, the USN awarded contracts to design one of two LCS versions to industry teams led by Lockheed Martin, with Marinette Marine as the shipbuilder, and General Dynamics, with Austal USA as the shipbuilder. The LCS designs were quite different. The Lockheed Martin design was based on a steel semi-planing monohull (with an aluminum superstructure), while the General Dynamics' design was based on

[165] "Navy Littoral Combat Ship Program: Background and Issues for Congress", Congressional Research Service, O'Rourke, Ronald, March 11, 2014.

an all-aluminum slender monohull, stabilized by two outboard hulls, creating a trimaran-like appearance.

The original budget assumed $220M cost per ship, in FY05 dollars, performed under cost-type contracts. However, costs and technical issues on the developmental ships rapidly rose. The USN unsuccessfully attempted to renegotiate the remaining options and instead restructured the program in 2007—cancelling the five remaining ships on the initial contract.

On September 16, 2009, the USN announced a proposed acquisition strategy whereby a competition, awarded as a fixed price contract, would select a single design for all LCSs procured in FY10 and beyond. The USN's down select decision was expected by December 14, 2010, the date when the two LCS bidders' prices would expire.

As part of this strategy, the USN specified that a company receiving the initial block buy contract under the original FY10 solicitation could not then compete for the second source contract under the later solicitation. General Dynamics, through its teaming arrangement with Austal USA, could have been the prime bidder on the initial competition, but would then be excluded from bidding its BIW component for the second source in the later competition. With that limitation in mind, General Dynamics decided to have Austal USA bid as the prime contractor on the original block buy, thus posturing BIW to bid on the follow-on, second source contract.

On November 3, 2010, while observers were awaiting the down-select decision, the USN notified congressional offices that it was prepared to implement an alternative dual-award acquisition strategy under which the USN would forego making a down-select decision and instead award each LCS bidder a 10-ship block buy contract for the six-year period from FY10 to FY15, in annual quantities of 1-1-2-2-2-2. The USN stated that, compared to the down-select strategy, the dual-award strategy would reduce LCS procurement costs by hundreds of millions of dollars.

The USN needed additional legislative authority from Congress to implement the dual-award strategy and stated that additional authority was not granted by December 14, 2010, it would proceed to announce the down-select decision under the September 16, 2009 acquisition strategy. On December 13, 2010, the two LCS bidders, at the USN's request, extended their bid prices to December 30, 2010, effectively giving Congress until then to decide whether to grant the authority needed for the dual-award. On December 14, 2010, the Senate Armed Services Committee (SASC) held a hearing to review the proposed dual-award strategy and subsequently approved it on December 22, 2010. On December 29, 2010, the USN implemented the dual-award strategy, awarding 10-ship, FPI block buy contracts to Lockheed Martin and Austal USA.

Table 7 LCS Strategies

Existing LCS acquisition strategy (January 2010)	Proposed LCS acquisition strategy (November 2010)
Contract with a single source on a fixed-price basis for up to 10 ships (2 ships awarded per year) from fiscal year 2010 through fiscal year 2014	Fixed-price contracts to two industry teams for up to 10 ships each (1 or 2 ships awarded per year) through fiscal year 2015 (total of up to 20 ships)
Second solicitation for up to 5 additional ships to be constructed at a separate yard with awards planned between fiscal years 2012 and 2014. • First source would provide the combat systems for the 5 additional ships constructed by the second shipyard	Program benefits, as identified by the Navy, that include: • stabilizing the program and the industrial base with award of 20 ships, • funding an additional ship in fiscal year 2012 to support operational requirements, • sustaining competition through the program, and • enhancing Foreign Military Sales opportunities
Navy estimates $1.9 billion in cost savings attributable to: • near-term competitive pricing pressures between the two current LCS shipbuilding teams, • economic order quantity purchases of key materials, • efficiencies associated with potentially moving to a single, common combat system, and • significantly reduced total ownership costs for the Navy	Navy estimates program benefits would generate approximately $1 billion in additional savings above those estimated under the existing strategy that are attributable to: • avoiding higher start-up costs (such as nonrecurring engineering and design costs) associated with awarding contracts to a second source starting in fiscal year 2012 and by • achieving greater labor efficiencies by constructing the ships at a higher rate
Navy estimates that the cost benefits would be offset, in part, by the start-up costs associated with introducing a second source in fiscal year 2012.	According to the Navy, these savings would be offset, in part, by an additional $842 million in total ownership costs, which the Navy equates to a net present value of $295 million.

When the USN opted, with congressional authority, to award block buy contracts to both of the original bidders, the plan for a second source competition was eliminated and General Dynamics' role as an LCS prime contractor ended with delivery of USS CORONADO (LCS 4).

Conclusion

This new dual sourcing approach (versus a down select to a single design and possibly a second source building that design) produced several benefits for the USN.[166]

- The USN had already invested substantial funds in standing up and qualifying both production facilities. This now provided opportunities—in this and future competitions—to apply competitive pressure and gain savings as both companies moved down their respective learning curves.
- Two sources were maintained. This allowed the USN to procure at a higher rate than from a single source. This approach also helped the USN develop a new shipyard and a new producer of Naval ships (Austal USA). Austal USA also won a major contract during this period to produce the JHSL. The USN

[166] Navy's Proposed Dual Award Acquisition Strategy for the Littoral Combat Ship, GAO, GAO-11-249R LCS Proposed Acquisition Strategy, December 8, 2010.

and Austal USA were able to leverage both programs to reduce facility and manufacturing costs.

- The builders had to provide TDPs to support future competitions. While it is unlikely the TDPs will ever be used, it provides a source of competitive pressure.
- While the O&S cost of maintaining two ship designs is higher, the USN believes it is small compared to acquisition savings. The USN also believes that each system is different enough that it reduces operational risks inherent with a single design.
- The FPI contract to award two block buys (10 ships each) produced significant savings. Under these two contracts, while all 20 ships will be congressionally authorized, the government is only contractually obligated for the ships that are appropriated each year. Unlike a multi-year procurement, there is no termination liability if the government decides not to fund the out-year ships.

CASE STUDY – USAF F-22 ADVANCED TACTICAL FIGHTER (ATF)

The USAF F-22 Advanced Tactical Fighter (ATF) program office was challenged to maintain competition throughout the EMD and production program. Traditionally, contractors kept much of the work in-house to preserve revenues and control production.[167] In the early 1960s, in-house production accounted for approximately 45% of the aircraft build.

In the late 1990s on the F-22 program, Lockheed Martin and its partner Boeing performed less than 38% of the manufacturing work—a significant drop from previous DOD aircraft production programs. Outsourcing and competition allowed them to exploit industry-wide economies of scale and technical expertise that would be very expensive to maintain in-house.

Approximately 45% of the build was awarded sole source on long-term contracts with established subcontractors. These are suppliers who have shared in major investments for key subsystems, parts, and materials that are not common to the industry and would be very expensive to obtain elsewhere. In these cases, Lockheed Martin and Boeing act much like the government, scrutinizing the cost and production data to obtain the optimal results.

Where multiple suppliers of services and materials exist, the team initiates regular competitions. This amounts to about 17% of the total production costs and does not include the additional competition for materials by its sole source vendors.

As shown in Figure 5, around 2007, Lockheed Martin kept 25% of the work in-house, gave 32% to Boeing, directly sole sourced 32%, and competed the remaining 11%. Boeing kept 38% of its share in-house (12% of total), then outsourced the rest to its sole source suppliers (14% of total) and competed the remainder (6% of total).

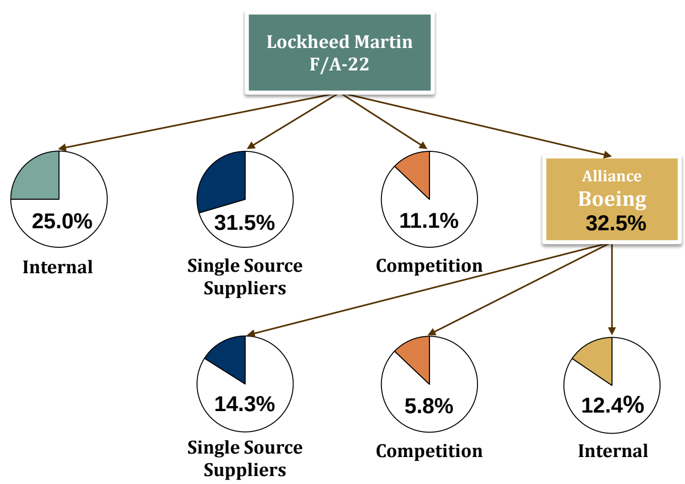

Figure 5 F-22 Contractor & Subcontractor Work Share (2007)

[167] "Analysis of Competition in the Defense Industrial Base: An F/A-22 Case Study;" D. King and J. Driessnack; Marquette University, January 2007.

Conclusions

- The majority of competition and expense occurs at the lower tiers of major weapon system programs as evidenced by the F-22 program.
- Single-source suppliers represent a large portion of lower-tier suppliers and should be a potential target for competition.

CASE STUDY – US ARMY INDIVIDUAL CARBINE COMPETITION

Unlike the USAF or USN, the Army primarily depends on its soldiers as its most lethal weapon system—and those soldiers heavily depend on their personal weapon. The Army continuously evaluates their fielded weapons and researches market substitutes used by other nations.

The Army developed a new family of carbines based on the original M-16 design. This effort resulted in the design and production of the M4 carbine in 1994. While an excellent weapon, years of actual combat use in Iraq and Afghanistan revealed several weaknesses that could be improved.

The Army had a two-path acquisition strategy[168] that investigated (1) improvements to the existing weapon, and (2) a competition incorporating existing commercial/military derivative weapons. Extensive market research and existing weapons testing determined that a relatively large number of promising weapons were currently in production. The Army labs and requirements staffs identified multiple weapon fixes and carefully assessed other weapons fielded by the major world armies. Several modifications are shown in Figure 6. At the same time, the Army developed and implemented a new type of ammunition for the weapon.

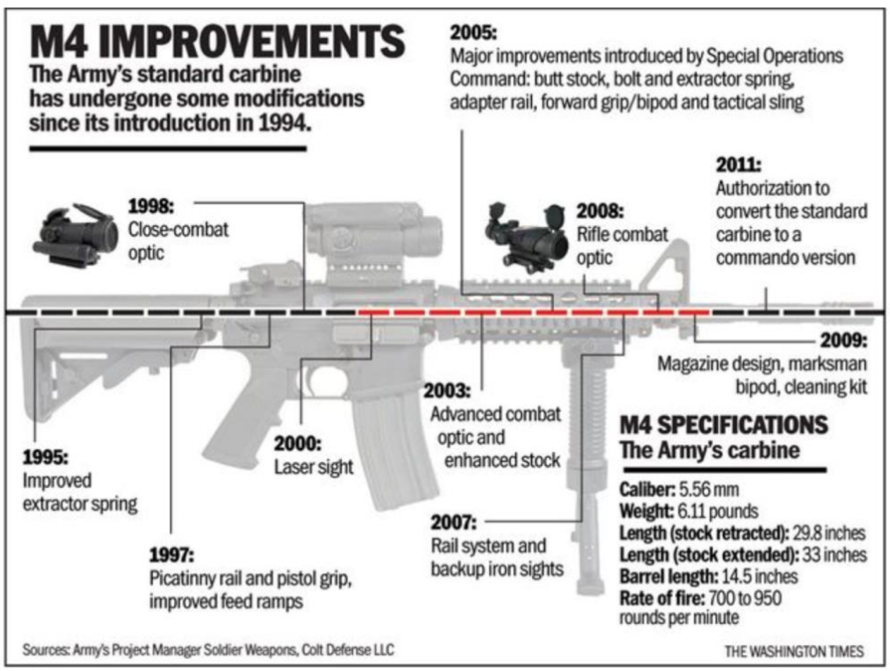

Figure 6 US Army M-14 Improvement

Development of the competition approach began in 2008 and resulted in funding and issuance of a DRFP in 2011 for the new Individual Carbine (IC) program. The IC program consisted of a three-phased competitive strategy to determine whether

[168] Individual Carbine Competition Concludes with No Winner," C. Todd Lopez, US Army Website, July 17, 2013.

industry could provide a best value, improved M4A1 carbine alternative. When the final RFP was released, the eight competitors included major weapon producers Beretta, Colt Defense, Fabrique Nationale, Heckler & Koch, and Remington, along with the smaller firms Adcor Defense, Lewis Machine & Tool, and Troy. Phase I consisted of vendor proposal reviews and non-firing evaluations of bid samples. All vendors successfully met Phase I criteria. In 2012, Phase II subjected IC candidates to rigorous evaluations that tested the extreme limits of weapon performance in such areas as weapon system accuracy, reliability, and durability.

For Phase III, the Army planned to award zero to three contracts for further environmental and operationally oriented soldier testing to competitors offering weapons meeting Phase II requirements. Upon completion of all testing, the Army planned to conduct a CBA of the top performing competitor and the M4A1 carbine (with improvements). Other than test and evaluation costs, there was minimal non-recurring cost to the Army to evaluate the eight state-of-the art weapons.

On June 14, 2013, Brigadier General Paul A. Ostrowski, PEO, announced that none of the eight competitors met the minimum requirements to proceed to Phase III. Without any viable candidates, the Army cancelled the remainder of the Phase III competition. In the debriefing to the press, the Army spokesman stated:

> *"At the conclusion of Phase II testing, however, no competitor demonstrated a significant improvement in weapon reliability — measured by mean rounds fired between weapon stoppages. Consistent with the program's search for superior capability, the test for weapon reliability was exceptionally rigorous and exceeded performance experienced in a typical operational environment…. In lieu of a new competition for an IC, the Army will continue fielding and equipping soldiers with the M4A1 carbine, which consistently performs well and has received high marks from Soldiers. Given limited fiscal resources, the Army's decision would free IC funding to address other high priority Army needs."*

With the cancellation of the competitive portion of the two-path acquisition strategy, the Army pressed ahead with the modification approach and issued an RFP in late 2013 to modify most of the existing M4 carbines to M4A1 carbines. On March 5, 2014, Colt Defense and Manroy USA were awarded a $54M contract for the M4 replacement barrel and front sight assembly for the M4 Carbine Product Improvement Program (PIP). The M4 replacement barrel is combined with other weapon components to form a single modification work order kit which converts fielded M4 carbines to M4A1 carbines.

Conclusions

In this case, the Army devised a dual-path strategy that allowed them to consider a competitive and low-cost approach to evaluate the best off-the-shelf weapons at the time, while also looking at modifying and upgrading the current weapon.

The Army used a decision matrix to carefully evaluate the proposed new weapons against the final version of the modified M4A1 weapon. This evaluation was fed into a real-time BCA that allowed the Army to consider other real world constraints.

The Army was facing a drawdown in 2013 as the Iraq and Afghanistan wars wound down and the large inventory of M4s could be upgraded to the M4A1 configuration at significant savings, while providing similar performance to the eight new competitor weapons.

5. Operations & Support

IMPLEMENTING COMPETITION

For Want of a Nail

For want of a nail the shoe was lost.
For want of a shoe the horse was lost.
For want of a horse the rider was lost.
For want of a rider the message was lost.
For want of a message the battle was lost.
For want of a battle the kingdom was lost.
And all for the want of a horseshoe nail.[169]

Author Unknown

[169] While variations of this proverb date to the 14th century, the earliest known reference to the full work cited here is believed to refer to the death of England's King Richard III at the Battle of Bosworth Field on 22 August 1485, reference Wikipedia, http://en.wikipedia.org/wiki/For_Want_of_a_Nail.

INTRODUCTION

Horses don't play much of a role for today's warfighter, but even small gaps in support can have disastrous impacts for modern warfighters. Synchronizing the complex network of logistics and sustainment activities necessary to maintain military readiness can be a daunting challenge. Careful planning, starting at the very beginning of a program, is the most important means to achieve success.

Ultimately, the goal of any weapon system acquisition program is to field militarily-effective operational capabilities. When weapons programs are successful, the DOD's acquisition process delivers modern systems that enable US Soldiers, Sailors, Airmen, and Marines to accomplish their operational missions in ways that dominate enemy forces across air, land, sea, space, and cyberspace domains. Achieving full operational capability is a major accomplishment for any program, but, as the introductory 14th century proverb highlights, military capabilities must be continuously supported to ensure sustained performance.

Goal of Operations and Support Phase

The goal of the O&S phase is to execute the product support strategy, satisfy the materiel readiness and operational performance requirements, and sustain the system over its life cycle (to include disposal).[170] The product support strategy and operational performance requirements are initially established early in an acquisition program (pre-MS A); then are updated, reviewed, and approved at each successive decision milestone. The strategy and requirements are documented in the system's LCSP, which becomes a guiding document for O&S. Policy prescribes numerous LCSP expectations and requirements. For purposes of this guide, the critical aspects of the LCSP at each milestone are:[171]

- MS A: focuses on sustainment metrics to influence design, product support strategy, and actions to be taken prior to MS B to reduce future O&S costs.
- MS B: focuses on (among other things) refining plans for competition of sustainment activities.
- MS C: includes a comprehensive description of the product support package elements (a discussion of the product support elements follows), competition, and fielding plans.
- Full-rate production decision or full deployment decision, as applicable: focuses on how sustainment is measured, managed, assessed, and reported; and on any adjustments to the product support package required to ensure continued competition and cost control.

[170] Interim DODI 5000.02, Operation of the Defense Acquisition System, Paragraph 5.d(14)(a), 26 Nov 2013.
[171] Interim DODI 5000.02, Operation of the Defense Acquisition System, Enclosure 6, Life Cycle Sustainment Planning, 26 Nov 2013.

- Post- IOC: updated as program changes occur, or every five years (whichever occurs first), to ensure the product support strategy is current and effective.

A weapon system's LCSP is the critical document governing the PM's support responsibilities during the O&S phase. The governing systems acquisition policy (DODI 5000.02, *Operation of the Defense Acquisition System*) emphasizes that planning for sustainment must begin early in the system's life cycle, continuously consider affordability, and thoroughly address how competition will be leveraged to help reduce O&S costs.

Impact of Prior Life Cycle Management Phases

The government's ability to implement competition during the O&S phase may be limited by the acquisition strategies and decisions made during earlier phases—especially if the government has no rights to the required technical data. Even if a competitive technique is used during the production and deployment phase, it may be impossible to craft a fully competitive O&S strategy. Also, when production contracts are phased over multiple years, product support efforts typically begin before the production phase is complete. In such cases, competition enablers, such as technical data and support equipment, may not yet be available. In many cases, prime contractors will be tasked non-competitively to provide interim contractor support (ICS) during this period. Given these limitations, it is virtually impossible to competitively acquire an all-encompassing system-level product support arrangement during LRIP or early production delivery periods. Competition is, however, quite feasible and expected to be aggressively pursued for some elements of product support (e.g., supply support, training and support, facilities, and infrastructure, etc.).

Experts generally agree, and recent defense budgets support, the conclusion that anywhere from 65% to 80% of a system's total LCC is incurred during the O&S phase.[172] This conclusion is supported by the relative values of the major funding categories included in the DOD budget. Funding available for R&D and system procurement capital (investment) generally total just over 30% of the DOD budget, while O&M funding hovers around 70% of the budget. A significant part of this O&M funding supports operating installations and other costs not directly attributable to weapon systems; but the costs of operating and maintaining weapon systems (considering energy costs, spare parts, repair and maintenance, and costs of personnel pay and benefits for those involved in operating and supporting systems) likely account for the lion's share of O&M expenses.

Decisions made during the development and production phases regarding system design and product support deliverables (e.g., technical data, support and maintenance equipment, facilities, etc.) can significantly impact O&S costs. Ideally, prior developmental efforts will have invested in designs and components that result in high

[172] "Driving Availability, Reliability, and Maintainability In," Dallosta, P. and Simcik, T., Defense Acquisition, Technology and Logistics, March-April 2012.

reliability and maintainability, thereby reducing O&S costs and improving life cycle affordability. Unfortunately, because R&D and system procurement funds are often constrained, trade-off decisions are routinely made during these phases that, while reducing development and production costs, potentially increase O&S costs.

The most critical decisions in regard to enabling competition during the O&S phase relate to the availability of technical data necessary to enable sources other than the OEM to provide support. The issue is not simply a matter of affordability of the technical data; the DOD is generally prohibited from requiring manufacturers to provide unlimited/unrestricted rights in technical data/software for products that were developed at private expense. If, however, the DOD fully funds the development of technology and product designs, then the DOD is entitled to obtain unlimited rights. In practice, however, most products are developed using a mix of government and privately funded technologies which complicates the issue of government rights in regard to technical data.

When lower-tier (subcontract) competition is encouraged or incentivized during the development and production phases, the government has an opportunity to sustain this competition during the O&S phase. If the government breaks out subsystems or components for direct procurement, the PM and product support manager (PSM) may use competitive procedures to directly acquire spare parts, repairs, or maintenance from competitive sources. If the subsystems or components continue to be supported by the prime contractor, support costs may be reduced based on competitive pressures at the subcontract level—but total costs to the government will include prime contractor costs to conduct these competitions, award necessary subcontracts, and manage subcontract performance. Some risk is associated with breaking out components or subsystems because the government assumes increased responsibility related to design changes and product quality that might otherwise be borne by the prime contractor. The PM/PSM must evaluate the costs and benefits of component breakout considering potential cost savings and any risks associated with such a strategy.

Competition Opportunities and Constraints

The O&S phase offers a very complex array of alternative approaches to securing product support because of the great variety of tasks involved, the length of time many weapon systems are kept in the military inventory, and the availability of both public and private providers. For this reason, the O&S phase also offers many creative opportunities to identify and package elements of product support that are suitable for competitive procurement. Though as noted previously, many support requirements in the O&S phase may offer no, or very limited, opportunities for competition due to the nature of the product and/or because of decisions and actions accomplished in prior life cycle phases.

The DOD's most common approaches for product support planning have changed over the years. In the first half of the twentieth century (pre-1980), DOD investment was driving technology advancements in many militarily relevant products.[173] As a result, the DOD typically acquired large amounts of technical data which was, in many cases, sufficient to enable competitive support strategies. These strategies often resulted in a wide diversity of suppliers providing support at tactical levels which, due in part to a lack of coordination and integration, did not yield the strategic military readiness levels required by the warfighter. Competition during O&S was much more common, but the outcomes at the system level sometimes failed to meet top-level performance goals.

Beginning in the latter part of the century (1980 and beyond), the DOD began to increasingly rely on commercial and privately developed products and technologies.[174] This resulted in increasing amounts of proprietary technical data and restricted software to which the government could only obtain limited rights. While leveraging NDI and commercial items benefited the DOD by reducing development and production risk and cost, it progressively led to vendors having a "lock" on sole source support, particularly for spare parts and maintenance.

This trend continued during acquisition reform efforts in the 1990s called Total System Performance Responsibility (TSPR). TSPR, in the interest of increasing support effectiveness through improved integration and use of system-level performance-based agreements, frequently embraced long-term, contractor-provided logistics support.[175] Generally, these agreements yielded the desired improved readiness, but caused shortfalls in meeting congressionally mandated levels of public depot workloads (the so-called 50/50 rule). In some cases, TSPR and TSPR-like arrangements grew increasingly unaffordable.[176] Unfortunately, this commitment to long-term CLS made early in the program's life cycle, resulted in decisions to not acquire data, equipment, and/or facilities that may have enabled competition during O&S—or at least provided for organic performance alternatives in the future.

Also during this time, weapon systems grew more complex due to greater internal/external integration and increasing reliance on embedded software processing. While these complex systems deliver incredible performance advantages, such systems are more challenging for third-party support providers to maintain. This competition impediment worsens when the OEM is frequently implementing software-driven performance upgrades. While public-sector depots, working in partnership with the OEM, can successfully perform software maintenance and upgrades, opportunities for competition to obtain such support are limited. In general, the less complex and more stable the design of a system, subsystem, or component; the more feasible it is to use competitive procedures to acquire support.

[173] "U. S. Military Technological Supremacy under Threat," Eaglen, M. & Pollak J., American Enterprise Institute, November 2012.
[174] "Buying Commercial: Gaining the Cost/Schedule Benefits for Defense Systems," Defense Science Board, February 2009.
[175] "Examining Military Acquisition Reform: Are We There Yet?" Hanks, C. et al., RAND Corporation Arroyo Center, 2005.
[176] "USAF Grapples with Rising Contractor Logistics Support Costs," Butler, Amy, Aerospace Daily and Defense Report, January 24, 2013.

The nature of competition in the O&S phase also differs from the earlier phases. In the EMD and production phases, the PM may consider engaging more than one contractor ***during*** the development and/or production of a system in order to preserve a competitive environment for future contracts—thereby enabling continued cost savings and innovation benefits that may not be present in a sole source, follow-on environment. During O&S, however, competition for award of new contracts usually does not create situations in which the winning contractor will become a sole source provider for follow-on efforts. Therefore, it is not necessary to engage more than one contractor to concurrently perform the same or similar work during the O&S phase. As a general rule, if competition can be successfully used to award a product support effort today, re-competition for follow-on periods of performance for the same kind of work will be possible in the future. However, re-competing and transitioning a complex sustainment contract can create performance disruption, so careful planning is required to ensure the introduction of, or transition to, a new supplier does not endanger warfighter readiness.

While not implementing competition ***during*** the O&S phase is the general rule, there is a notable exception. IDIQ MACs are often used to acquire product support when future deliverable requirements cannot be specifically quantified or defined. Under this type of contract, vendors compete to win contracts which provide for subsequent ordering of supplies or services. Then contract holders compete to receive task or delivery orders for specific work. Use of IDIQ MACs simultaneously enables competition both ***for*** a contract and ***during*** performance of the contract.

Today's PMs are challenged to maintain focus on top-level, performance-based weapon system support outcomes while effectively applying competition and using the best value product support providers (PSPs) and integrators (PSIs) (private, public, and/or partnerships) to achieve affordability goals. Because the DOD continues to rely on systems first developed 30 to 50 years ago,[177] product support opportunities and constraints may be heavily dependent on decisions made by PMs decades earlier. The bottom line is that PMs generally have to "play the hand they were dealt" when it comes to supporting a system during the O&S phase. In this "game," however, there can be opportunities to discard and draw a "new card" by creatively evaluating and packaging elements of product support in a manner that enables competition where none previously existed. Some of these approaches are presented in the following pages.

[177] For example, the Air Force's B-52 Bomber was first introduced in 1955, the Army's UH-1 Iroquois was introduced in 1959, and the Navy's recently retired USS Enterprise (CVN 65) Carrier was commissioned in 1961. The B-52 and UH-1 remain in operational use today.

Applicable Laws and Regulations

In addition to the laws, regulations, and policies related to competition introduced in earlier chapters, there are several additional requirements which are specifically related to the O&S phase. These rules clearly impact acquisition planning for this phase.

10 USC 2337 – Life Cycle Management and Product Support

In the National Defense Authorization Act (NDAA) for FY13,[178] Congress directed the Secretary of Defense to issue comprehensive guidance on life cycle management and product support for major weapon systems. Among other requirements, the law prescribed that guidance must encourage maximum competition and value to the DOD by making best use of available DOD and industry resources at the system, subsystem, and component levels.

10 USC 2464 – Core Logistics Capability

This law focuses on the identification and maintenance of DOD logistics capabilities necessary to ensure continuous military readiness. The law requires the Secretary of Defense to identify and maintain government-owned and operated core logistics capabilities to ensure a ready and controlled source of technical competence and resources necessary to provide effective and timely response to mobilization, national defense contingency situations, and other emergency requirements. Such core capabilities must be effectively employed to ensure cost efficiency and technical competence during peacetime, while preserving the surge capacity and reconstitution capabilities necessary to fully support strategic and contingency plans. Workloads identified as necessary to maintain specified core logistics capabilities may not be contracted for performance by non-government personnel and are, therefore, not available for competition.[179] DODI 4151.20 implements 10 USC 2464 requirements and prescribes the core capabilities determination process.[180]

10 USC 2466 – Limitations on Performance of Depot-Level Maintenance

This law focuses on sustaining DOD organic maintenance capabilities by limiting the amount of annual funding available for depot maintenance workloads that may be used to contract with private sector sources. This law, commonly referred to as the "50/50 rule," specifies that *no more than* 50% of the available funding in any fiscal year may

[178] These policies were original part of the FY10 NDAA (Public Law 111-84) but were not properly incorporated into US Code; they were deleted and reissued under the appropriate section (Title 10 United States Code, Section 2337) in the FY13 NDAA (PL 112-239).
[179] Title 10 United States Code, Section 2464(a) specifies these requirements and provides (in paragraph (b)(2)) for the possibility of waivers approved by the Secretary of Defense if the Secretary determines government performance is no longer required for national defense reasons.
[180] DODI 4151.20, Depot Maintenance Core Capabilities Determination Process, January 5, 2007.

be used to contract with the private sector and establishes that *more than* 50% of the funding will be used to fund work accomplished by DOD employees.[181]

The law establishes annual reporting requirements and permits the Secretary of Defense to waive the limitation, if necessary, for reasons of national security providing Congress is notified.[182] Compliance with this limitation is tracked at the department level; therefore, the Assistant Secretary of Defense for Logistics and Materiel Readiness (DASD(LMR)) issues an annual data call with reporting guidance to the military departments and defense agencies.

Based on this statutory requirement, PMs may be required to assign non-core depot repair and maintenance workloads to government depots in order to support compliance with department-level expenditure limitations. When such workload assignments are necessary, the workloads may not be available for competition.

10 USC 2469 – Contracts to Perform Workloads Previously Performed by DOD Depots: Requirement of Competition

Title 10 USC Section 2469 prohibits the DOD from changing the performer of any existing depot workload, valued at $3M or more, which is currently being accomplished by a DOD public depot, unless merit-based competitive procedures are applied.[183] The law specifically states that the public-private competition procedures set forth in Office of Management and Budget (OMB) Circular A-76 are not applicable to such place of performance changes,[184] which leaves the government with no practical, current method of complying with the implied requirement to conduct competitions among private and public entities. Finally, the law provides for a competition requirement waiver for situations involving public-private partnerships covered under 10 USC 2474.[185]

10 USC 2474 – Centers of Industrial Technical Excellence; Public-Private Partnerships

This law requires the Secretary of Defense to designate each DOD depot-level or arsenal facility as Centers of Industrial Technical Excellence (CITE) in recognition of their unique core competencies. The law further requires the DOD to establish policy encouraging the CITEs to re-engineer industrial processes and implement best practices such that the centers will become recognized leaders in their specific core competency areas.[186] To further these objectives, the law establishes an authority for CITEs to enter into public-private partnerships that may provide for public employees performing work in support of DOD contractors, or contractor employees performing work and/or using facilities and equipment at the CITE.

[181] Title 10 United States Code, Section 2466(a).
[182] Title 10 United States Code, Section 2466(b) & (d).
[183] Title 10 United States Code Section 2469(a) & (b).
[184] 10 USC 2469(d).
[185] 10 USC 2469(c).
[186] 10 USC 2474(a).

Partnership objectives include maximizing use of available capacity, reducing the DOD's cost of ownership, leveraging private investment, and/or reducing product costs. This partnership authority can also be used to increase the organic workload values accounted for in accordance with 10 USC 2466 and thus may influence acquisition strategy planning.

Weapon Systems Acquisition Reform Act of 2009

In addition to previously described content, WSARA specifies that source-of-repair decisions resulting in a plan to contract for major system maintenance and sustainment will ensure that, to the maximum extent practicable and consistent with statutory requirements, such contracts are awarded on a competitive basis and give full consideration to all sources (including sources that partner or subcontract with public or private sector repair activities).[187]

DODI 5000.02, Operation of the Defense Acquisition System

DODI 5000.02 emphasizes the importance of early planning for product support and prescribes LCSP requirements. The instruction identifies two important LCSP annexes. The first annex is a BCA or cost benefit analysis which details assumptions, constraints, and analyses used to develop the product support strategy. There is no standard content, format, or level of detail for a BCA. The PM should tailor the analysis to focus on the product support issues that are true concerns for the system being acquired. The goal is to enable an informed decision considering viable product support strategies.

The other key annex is the core logistics analysis which documents the basis for and describes the maintenance efforts determined as core logistics workload as required by 10 USC 2464.

DODI 5000.02 also requires that PMs effectively employ PBL planning, development, implementation, and management in developing a system's product support arrangement.[188] PBL approaches are encouraged as a means to incentivize supplier productivity and innovation. PBL strategies are executed through an agreement, usually long term, in which the provider is incentivized and empowered to meet top-level, customer-oriented performance requirements (e.g., availability, reliability, etc.) to improve product support effectiveness while reducing total ownership cost. PBL arrangements may be applied to contracts with private industry and inter-governmental agreements with public PSPs.

DODD 4151.18, Maintenance of Military Materiel

This governing maintenance regulation incorporates repair and maintenance requirements prescribed by the various laws discussed above and adds that DOD components will employ the full spectrum of maintenance support structures available

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[187] Weapon System Acquisition Reform Act of 2009, Section 202(d).
[188] DODI 5000.02, Enclosure 6, paragraph 2.a(3).

to sustain military materiel, including organic or unique military capabilities, PBL arrangements, commercial sector support, partnering, and competition, as applicable.[189]

The regulation also requires periodic reviews of field and depot maintenance workloads to identify opportunities for consolidation, regionalization, public-private partnerships, or other types of integrated support arrangements that may yield significant economies of operation while sustaining or improving responsiveness.[190] One such consolidation opportunity encourages the use of inter-service/joint depot activities in order to eliminate or reduce duplicative capabilities across the DOD. The regulation further emphasizes the importance of considering a wide range of alternative support approaches that contribute to the top-level O&S goals of using performance-based arrangements, while incentivizing improvements that reduce total ownership costs.

DODI 4140.01, Supply Chain Materiel Management Policy

The governing policy for DOD's supply chain directs DOD departments and agencies to employ strategic sourcing and acquisition practices to ensure performance-based, optimum, life cycle support solutions that balance support goals, total supply chain costs, and performance factors. The practices must include best value selection among organic and commercial support alternatives and seek to minimize LCC.[191]

This instruction is augmented by DODM 4140.01, which enumerates procedures and other guidance in 11 volumes. Volume nine of DODM 4140.01 describes a spare parts breakout program designed to screen spare parts related technical data to determine the feasibility of acquiring replenishment parts by competitive procedures and/or direct purchase from actual manufacturers.[192]

DOD Better Buying Power (BBP) 3.0 Policy Directive

In addition to the continuing emphasis on creating and maintaining competitive environments, the OUSD(AT&L) DOD BBP 3.0 memo[193] further encourages DOD acquisition professionals to increase the effective use of PBL arrangements. The policy also acknowledges the value of indirect competitive pressure, suggesting that even the prospect of a development program for a substitute or follow-on item/component can drive competitive-like responsiveness from an established sole source provider.

[189] DODI 4151.18, Maintenance of Military Materiel, Paragraph 3.1.7, 31 March 2004.
[190] DODI 4151.18, Para 3.3.6
[191] DODI 4140.01, DOD Supply Chain Materiel Management Policy, Enclosure 4, Procedures, Paragraph 3.a, December 14, 2011.
[192] DODM 4140.01, Volume 9, DOD Supply Chain Materiel Management Procedures: Materiel Programs, Enclosure 3, Procedures, Paragraph 3, February10, 2014.
[193] "Better Buying Power 3.0," OUSD(AT&L) White Paper, September 19, 2014.

Performance- Based Logistics Comprehensive Guidance

In November 2013, the Acting DASD(LMR) issued a memorandum providing expanded guidance for the BBP 2.0 initiative aimed at increasing the use of PBL arrangements for weapon system programs.[194] The memo defined PBL as being "synonymous with performance-based product support, where outcomes are acquired through PBL arrangements that incentivize PSPs to deliver needed reliability and availability to the warfighter at reduced total cost by encouraging and rewarding innovative cost reduction initiatives."[195] The guidance states these arrangements can take the form of contracts with industry or inter-governmental agreements and identifies the following attributes of effective arrangements:

- Objective, measurable work description that acquires a product support outcome.
- Appropriate contract length, terms, and funding strategies that encourage delivery of the required outcome.
- A manageable number of metrics linked to contract requirements that reflect desired warfighter outcomes and cost reduction goals.
- Incentives to achieve the required outcomes and cost reduction initiatives.
- Risks and rewards shared between government and commercial PSIs and PSPs.
- Synchronization of product support arrangements to satisfy warfighter requirements.

Training Resources

DOD's product support regulations, policies, and procedures have undergone significant changes during the past decade. Fortunately, there is a wealth of DOD and private sector reference and training resources available to help the PM and PSM update their knowledge and understanding of current best practices used within the DOD and commercial marketplace. The Defense Acquisition University (DAU) offers a variety of basic training courses and continuous learning modules focused on acquisition management and logistics.[196] DAU also maintains two helpful websites: an acquisition encyclopedia called *ACQuipedia*[197] and a knowledge sharing site called the *Acquisition Community Connection.*[198] These sites offer a wealth of information related to systems acquisition, life cycle logistics, product support, and supply chain management. Numerous DOD guides and handbooks are also available to assist the PM and PSM in complying with the many product support related laws, regulations, and policies; these are referenced in footnotes throughout this chapter and can also be found in Appendix B, Bibliography.

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[194] "Performance Based Logistics Comprehensive Guidance," DASD(LMR) Memo, November 22, 2013
[195] Ibid.
[196] See: http://icatalog.dau.mil/onlinecatalog/tabnav.aspx.
[197] See: https://dap.dau.mil/acquipedia/Pages/Default.aspx0.
[198] See: https://acc.dau.mil/CommunityBrowser.aspx.

PRODUCT SUPPORT ENVIRONMENT

Product support is much more than simply ensuring availability of spare parts, providing system maintenance, and periodically upgrading fielded systems. The Defense Acquisition Guide defines product support as the application of a "package of integrated product support elements and support functions necessary to sustain the readiness and operational capability of the system."[199]

Integrated Product Support Elements

The DOD's integrated product support (IPS) elements offer a great perspective for understanding the breadth of support processes to be planned and managed throughout the system's life cycle and brought to fruition during the O&S phase. Competitive procedures may often be used when acquiring an IPS package from commercial providers.

When successfully managed and integrated, each element contributes toward the effective sustainment of fielded operational capabilities. When any element is incomplete or deficient, product support problems may develop. The twelve IPS elements which encompass key PSM responsibilities are depicted in Figure 7 and are briefly summarized in following paragraphs.[200]

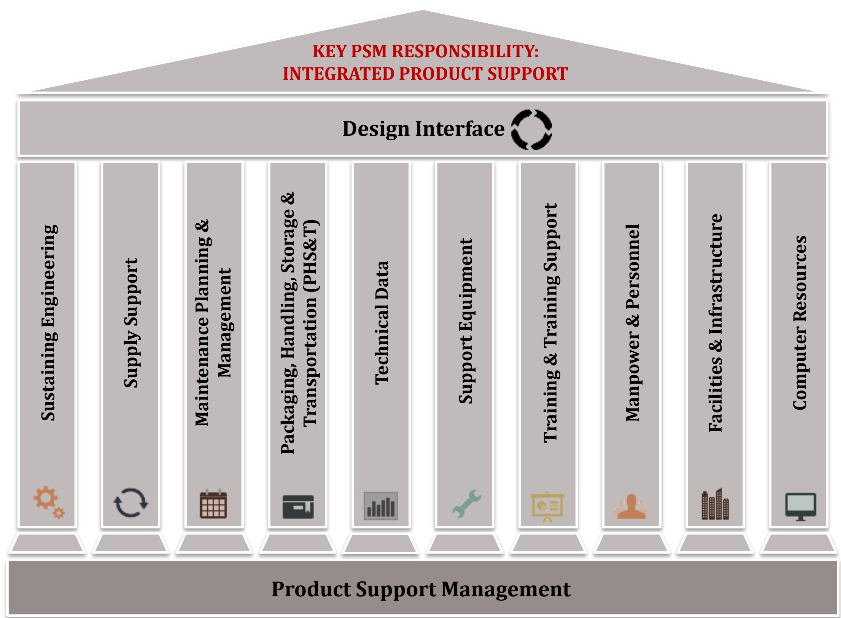

Figure 7 Integrated Product Support Elements[201]

[199] "Defense Acquisition Guidebook," Paragraph 5.1.1.1, Defense Acquisition University, current as of December 2013.
[200] Summary descriptions for product support elements are derived from: "DOD Product Support Managers Guidebook," April 2016. For detailed descriptions of the scope, deliverables, and activities of product support, see: "Integrated Product Support Element Guidebook," Defense Acquisition University, Dec. 2016.
[201] Figure adapted from: "DOD Life Cycle Management and Product Support Manager Rapid Deployment Training," Slide #32, Defense Acquisition University, June 2011.

- **Product Support Management**: As Figure 7 suggests, product support management is foundational—it encompasses the management and coordination of all the other product support elements. The objective of product support management is to plan and manage cost and system performance across the entire product support value chain.
- **Design Interface**: Figure 7 also depicts how design interface is an important cross-cutting and integrating aspect of product support. Design interface links the quantitative design and systems engineering aspects of the system (e.g., reliability, maintainability, etc.) with the functional elements of product support (the other 10 elements of product support shown as pillars in Figure 7). The primary concern of design interface is facilitating supportability through maximizing availability, effectiveness, and capability at the lowest total cost of ownership.
- **Sustaining Engineering**: Sustaining engineering involves technical tasks related to preventing the degradation of the system's technical performance over its life cycle. Sustaining engineering also includes engineering activities to improve or modify system performance to take advantage of technological advances or respond to changing threats.
- **Supply Support:** Supply support includes all management actions, procedures, and techniques necessary to acquire, catalog, receive, store, transfer, issue, and dispose of spares, repair parts, and other supplies. Support activities include initial support provisioning and managing replenishment inventories.
- **Maintenance Planning & Management**: Maintenance planning and management includes all efforts to identify, plan, resource, and implement system, subsystem, and component maintenance concepts and requirements to ensure required availability at the lowest possible total ownership cost. Maintenance planning and management includes both hardware and software aspects of fielded systems.
- **Packaging, Handling, Storage & Transportation (PHS&T)**: Packaging, handling, storage and transportation covers all actions necessary to identify, plan, resource, design, and acquire packaging/preservation, handling, storage, and transportation requirements to maximize availability and usability of materiel as required to support operational or training missions.
- **Technical Data**: Technical data includes all efforts to identify, plan, resource, and implement management actions necessary to develop, acquire, and manage technical information required to operate, install, maintain, and train on systems and equipment. The technical data element also includes management of information required to maintain configuration baselines and effectively catalog and acquire spare/repair parts, support equipment, and other supply classes.
- **Support Equipment**: Support equipment comprises all activities necessary to identify, plan, resource, and implement actions to acquire and maintain

equipment necessary to support the operation and maintenance of fielded systems.

- **Training & Training Support**: Training and training support includes all actions necessary to plan, resource, and implement a cohesive integrated strategy to train military and civilian personnel to maximize the system's operation and maintenance effectiveness throughout its life cycle. The element includes actions necessary to make available any training aids, devices, simulators, and/or simulation necessary to maximize effectiveness of personnel who use or sustain the system.
- **Manpower & Personnel**: Manpower and personnel includes the actions necessary to identify, plan, resource, and acquire personnel, civilian and military, at the grades and skill levels required to effectively operate, maintain, and support equipment over the system's life cycle.
- **Facilities & Infrastructure**: Facilities and infrastructure consists of efforts to identify, plan, resource, and acquire real property and other facilities required to enable training, operation, maintenance, and storage of systems and equipment. Activities include studies to define types of facilities or facility improvements, location, space needs, environmental and security requirements, as well as required capital equipment.
- **Computer Resources**: Computer resources encompasses efforts to identify, plan, resource, and acquire facilities, hardware, software, documentation, manpower, and personnel necessary to operate and support mission-critical computer hardware and software systems. Specific tasks include coordination and implementation of agreements necessary to manage technical interfaces and perform maintenance, as well as establishing, updating, and executing plans for periodic test and certification of computer resources required throughout the life cycle.

Product Support Business Model

Product support was not always planned and provided in the sort of holistic way as implied by DOD's IPS elements. In the past, support was often delivered by an unintegrated network of providers responding to requirements in a somewhat tactical and individual transactional manner. Recent changes in regulations and policy now place greater emphasis on planning for overall integrated support very early in the system's acquisition process and using metrics to drive performance outcomes which are directly linked to operationally-based metrics, such as system availability and affordability goals. To effectively plan and execute competitive support strategies, the PM must understand both work to be performed during the O&S phase as described by the twelve IPS elements, and the various participants involved in performing this work as defined by the DOD Product Support Business Model (PBSM).

DOD's PBSM defines a hierarchical framework for planning, managing, and executing product support across the system's life cycle. The model defines roles, relationships, responsibility, accountability, and business agreements among managers, integrators, and providers of product support. The model is depicted in Figure 8. Across the bottom, a variety of potential providers are shown including: public sector depots, the Defense Logistics Agency (DLA), established inventory control points (ICPs), distribution process owners (DPOs), OEMs, and others. The next level depicts one or more product support integrators (PSIs) which coordinate provider efforts through product support arrangements (PSAs), to ensure delivery of the outcomes required by the integrator's PSA with the PSM. Ultimately, the entire system is designed to deliver the performance outcomes required by the warfighter—typically expressed in terms of military readiness goals related to materiel availability, reliability, and ownership costs.

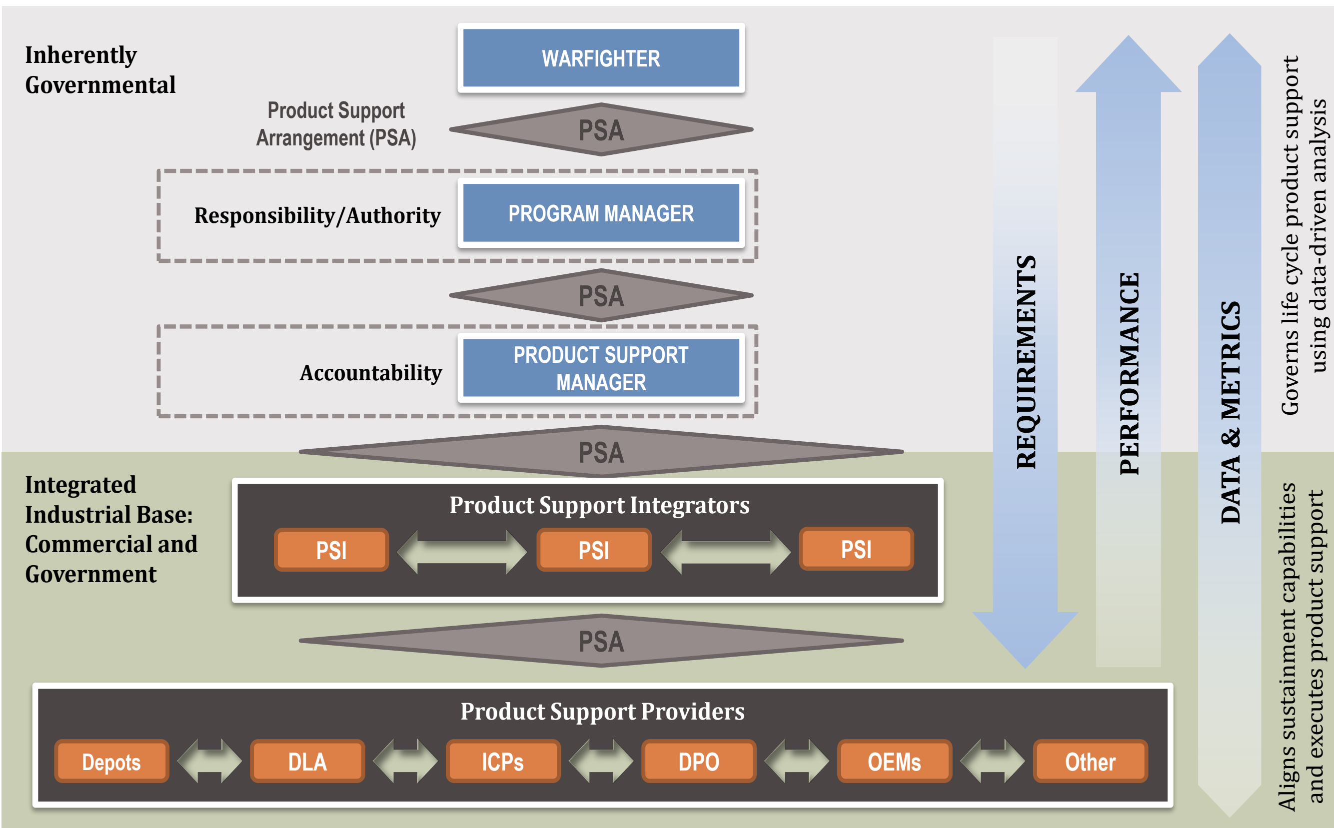

Figure 8 The Product Support Business Model[202]

A detailed discussion of the PSBM is beyond the scope of this guide,[203] but it is important to recognize two fundamental axioms inherent in the model:

- **Providers:** With rare exceptions, every product support strategy is dependent on both government organic (public) and commercial (private) industry support. The PSM's goal is to optimize the blend of public and private

[202] Figure adapted from: "DOD Product Support Managers Guidebook," Paragraph 2.1, Figure 4, DOD, April 2016.
[203] To learn more about the Product Support Business Model, see: "DOD Product Support Managers Guidebook," April 2016.

support capabilities in order to maintain operational readiness at affordable and predictable total ownership costs.

- **Outcomes:** The objective of any product support strategy is to ensure military operational readiness through effective integration of the relevant IPS elements. To achieve this objective, the PSM should determine appropriate performance metrics for the IPS elements that will, in aggregate, achieve top-level warfighter operational outcomes.

In short, except for certain inherently governmental functions,[204] product support will normally be provided by both public and private sources and support agreements with either type of provider should be structured to drive performance-based outcomes.

Figure 8 also highlights that the PM and PSM roles are always inherently governmental functions and may not be performed by contractors. An inherently governmental function is one so intimately related to the public interest so as to mandate performance by government employees. With regard to product support, this may include oversight/governance areas that require officials to exercise discretion related to the interpretation or execution of law and/or value judgments related to financial transactions or entitlements.

A variety of product support approaches are possible. Weapon systems can be supported at the system, subsystem, and/or component level and there is a continuum of possible PSPs and PSIs that includes not only public or private providers, but also public-private partnerships, where support is provided by both sectors performing in an integrated manner.

Figure 9 depicts the matrix of alternative approaches to product support and references specific programs as examples. In practice, it is unlikely that a complete system support strategy will fit cleanly into a single box. A comprehensive snapshot of a specific program strategy will include a strategy and matrix for each of the twelve IPS elements. Specific tasks within each element may be further subdivided across the continuums shown. For example, the Design Interface element may be an organic DOD-centric subsystem strategy, while the Supply Support element may be broken into both organic tasks (e.g., cataloging) and industry tasks (e.g., parts storage and issue) at the component level. Within each of the nine blocks of the matrix, there are usually further distinctions in terms of specific product support strategy solutions.

[204] "Performance of Inherently Governmental and Critical Functions," Office of Federal Procurement Policy, Policy Letter 11-01, September 12, 2011.

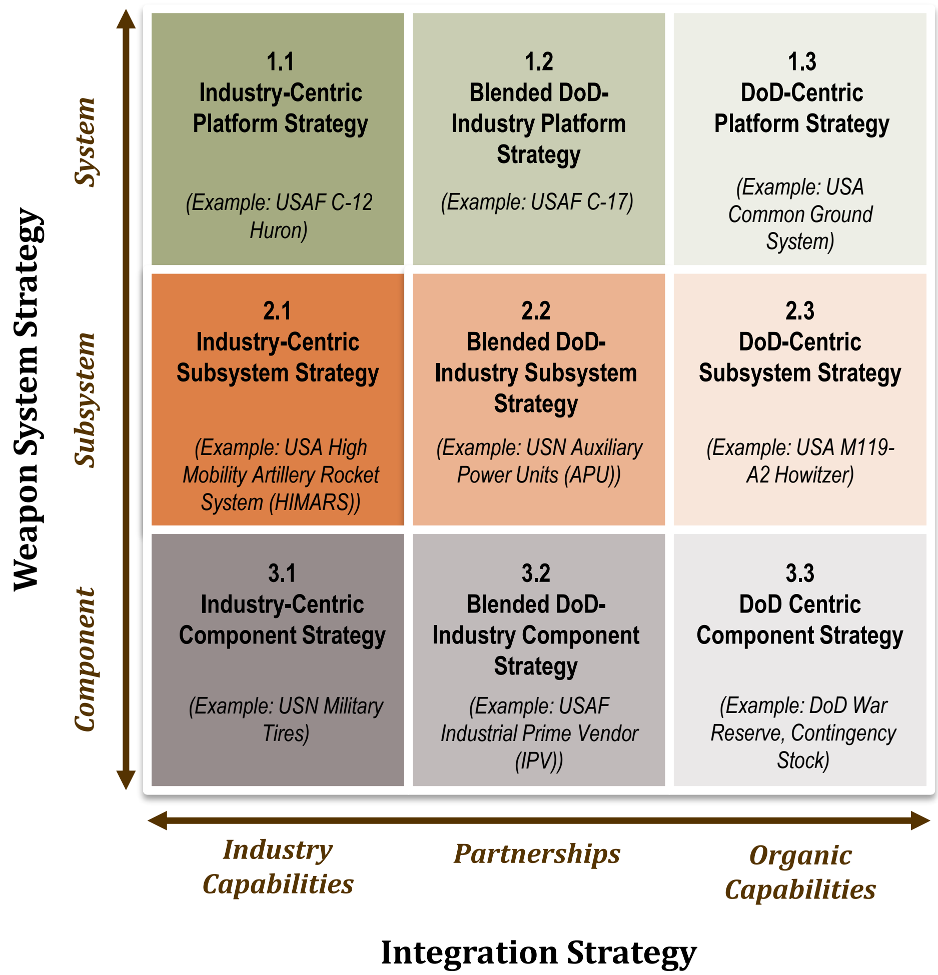

Figure 9 The Product Support Decision Matrix[205]

The important take-away is that each system's product support strategy will be unique and will, therefore, offer different opportunities to use competitive procedures. A specific product support strategy will depend on many factors including government decisions made much earlier in the system's life cycle, the nature of the technology being supported, the nature of the supplier market, existing government support capabilities, the degree of subsystem and component commonality with other products supported by the DOD, availability of required technical data, and many other considerations.

Product Support and Competition

The PM and/or PSM must understand the DOD product support environment when developing competitive strategies to provide support for DOD systems and equipment. The DOD places a high value on using competitive performance-based strategies to obtain product support for many of the reasons cited earlier in this guide—but most

[205] Figure derived from: "DOD Product Support Managers Guidebook," Section 1.3, Figure 2, DOD, April 2016.

importantly, for incentivizing required levels of performance and reducing total ownership costs.

Consider the following conditions and possible outcomes and their impact on the use of competition for acquiring product support:

- The PM will assign specific work within each IPS element to the best value provider/integrator, whether public or private. Evaluation of best value between public and private providers need not (and typically does not) rely on head-to-head competition between the public and private providers.
- Competitive strategies which rely on the private (commercial) sector may include any combination of the twelve IPS elements (or specific tasks within these elements) as part of solicitations and contracts, provided the government retains inherently governmental functions related to the oversight, authorization, and funding of product support activities.
- Strategies may designate performance of certain IPS elements (or tasks within the elements) by the public sector, while others are designated for performance by one or more private sector sources.
- Strategies may require or encourage public-private partnerships related to specific responsibilities within each of the IPS elements (this approach is used most commonly in depot maintenance activities).
- Qualified private-sector providers and integrators may compete against each other to offer required support services.
- Although rarely used, qualified public-sector providers and integrators may also compete against each other to provide required support services. Such public-public competitions are not subject to the federal acquisition contracting rules and may use any technique that fits the situation, as long as decisions are merit based.[206]
- Given current legislative restrictions, public-sector providers/integrators may not directly compete with private-sector providers/integrators without specific DOD and congressional approval.[207]
- The PSM performs appropriate analyses of the product support alternatives to inform the PM of costs, benefits, and risk implications of the alternatives. This analysis is not the sole determining factor for establishing the product support strategy, as other factors (such as statutory compliance, balancing organic and contractor support for a healthy industrial base, etc.) may influence decisions regarding final the product support strategy.[208]

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[206] 10 USC 2469(a)(1).

[207] OMB Circular A-76, Performance of Commercial Activities, establishes a preference that commercial activities be performed by the private sector and prescribes a structured approach for the conduct of public-private competitions to select the lowest cost provider for such activities. However, due to Congressional concerns regarding these types of competitions, the Omnibus Appropriations Act for Fiscal Year 2009 (Public Law 111-8) placed a government-wide moratorium on such competitions. At the time of this writing, the moratorium remains in place.

[208] "DOD Product Support Business Case Analysis Guidebook," DOD, April 2011.

- Finally, decisions regarding sourcing for product support efforts may create impediments or offer opportunities for using competitive procedures. It is incumbent upon the PM and PSM to package support requirements in a manner that supports the beneficial use of competition.

Frequently, due to a lack of technical data, proprietary items, or other impediments to competition, it is not possible to use competitive procedures to acquire product support. The PM may, in these cases, obtain competitive-like economic benefits through the effective use of PBL. Well-crafted PBL agreements can incentivize companies to compete against internal waste and quality challenges to drive up quality (thereby reducing demand) while simultaneously driving down process, labor, and material costs.[209]

Additional Guidance

To learn more about planning, developing, and implementing performance-based product support arrangements for your program, refer to the following additional sources of information:

- "Performance Based Logistics Comprehensive Guidance," Assistant Secretary of Defense for Logistics and Materiel Readiness, Memo dated November 22, 2013.
- "Performance Based Logistics: A Program Manager's Product Support Guide," Defense Acquisition University, March 2005.
- "Guide for Performance-Based Services Acquisition (PBSA) in the Department of Defense," Under Secretary of Defense for Acquisition, Technology & Logistics, December 2000.

[209] "Performance Based Logistics and Project Proof Point," Boyce, John and Banghart, Allen, OUSD(AT&L): Product Support Issue, March-April 2012.

SPECIFIC COMPETITIVE METHODS – SUSTAINMENT

The following sections describe specific competitive methods and techniques that have been applied to the acquisition of product support sustainment within the DOD during the O&S phase.

Competition to Select Product Support Integrators

A PSI is responsible for directing and managing the activities of one or more PSPs to deliver the specified outcomes for their area of responsibility. The government PSM, using an appropriate BCA of product support alternatives, assists the PM in determining whether PSIs will be used and how many will be involved in supporting the system. Generally, there are only four likely candidates to perform PSI responsibilities:

- Original manufacturer of the system or subsystem (original prime contractor or subcontractor).
- Government organic (public) agency or product or logistics command (e.g., DLA, military component ICP, military depot, etc.).
- PM's own logistics organization.
- Third-party logistics provider.

Due to current restrictions regarding public-private competition, only the fourth option offers the opportunity for competition between commercial sources.

A competition to select PSIs begins with a determination of the required PSI scope of work. The government acquisition team must then define the key performance-based outcomes, prepare a PWS, identify applicable government information required to support performance and can be provided to the contractor, and establish any special requirements with which the contractor must comply. The scope of work will vary greatly between different PSI contracts, depending on which PSP activities are being integrated. The only restriction is that a PSI contractor may not be assigned responsibilities which are inherently governmental and must be retained by the PSM. Normally, the government will only elect to use a third-party logistics provider if the required functions are commonly performed in the commercial sector. A PSI can be tasked to:

- Track/monitor system, subsystem, and/or components configuration
- Determine spare part quantities to be held in inventory
- Award and manage subcontracts to acquire spare parts
- Award and manage subcontracts to repair end items
- Manage warehousing and distribution of required materiel
- Receive and process customer requisitions
- Package and ship required items to end users

- Provide materiel support to a government depot
- Coordinate, plan, and manage field maintenance activities
- Perform other activities necessary to integrate efforts of other support providers

The PM or PSM determines what product support tasks will be included in a competitive solicitation for PSI support. Often PSI contracts combine efforts that may have been (or can be) contracted for with separate contracts. PSI efforts typically require closer integration with public-sector activities than more focused PSP efforts and, as a result, may include some form of public-private partnership. Given the broad scope of most PSI contracts, it is critical that contract performance is assessed using performance-based metrics that directly track to required operational outcomes. Most PSI contracts are long-term (at least five years in length, preferably longer, or include options to extend the term incrementally) to allow the contractor time to implement process improvements that increase effectiveness and reduce performance costs. Some PSI contracts are cross-cutting in nature in that they provide a particular type of support to multiple weapon systems; this sort of consolidation enables greater efficiency and cost savings.

DLA Tire Successor Initiative (TSI)[210]

DLA used competition to select a single PSI responsible for comprehensive management of DOD's tire supply chain.

Though Congress directed the privatization of DOD's wholesale supply, storage, and distribution functions for tires under the 2005 Base Realignment and Closure (BRAC) Law, the DLA successfully used competitive procedures to award a single follow-on contract for ground and aircraft tire support in 2011. The Tire Successor Initiative (TSI) program consists of the TSI contractor, SAIC, and multiple tire providers (manufacturers/dealers). SAIC provides logistical support services; global demand planning and forecasting; order processing and fulfillment; purchasing (from government-directed sources using long-term contracts); finance and inventory management; continental US (CONUS) storage and warehouse operations management; CONUS distribution and transportation, packaging, obsolescence management; data management; and customer support services. The contract also provides for tire disposal, recycling, and retread services. The contract covers a five- year period of performance and includes one two-year option. The estimated value, including the option, is over $1B.

[210] Information obtained from the DLA website at: http://www.landandmaritime.dla.mil/programs/TSI/ and the PR Newsletter website: http://www.prnewswire.com/news-releases/saic-awarded-contract-by-defense-logistics-agency-135017753.html, accessed March 10, 2014.

USAF Industrial Prime Vendor (IPV)

A competitively selected PSI improved supply availability for consumable items used during USAF depot maintenance.

The USAF, working through the DLA in Philadelphia, awarded a $750M contract for the third generation Industrial Prime Vendor (IPV) program.[211] The predecessor USAF IPV contract, awarded to Lockheed Martin Global Supply Chain Services in 2006, provided sourcing for approximately 96,000 consumable hardware items (e.g., screws, bolts, rivets, etc.), as needed, to support depot maintenance workloads at the USAF's three Air Logistics Complexes (ALCs) located in Georgia, Oklahoma, and Utah.[212] The IPV contractor requisitions most of the items from DLA, but approximately 20% of the items are sourced and priced commercially. The contractor is tasked to ensure 98% parts availability in nearly 300,000 parts bins required to support the USAF's organic depot workload including, aircraft, aircraft engines, avionics, airborne accessories, missiles, munitions, and other commodities. The IPV program significantly improved the availability of bench stock materiel at the ALCs, preventing delays and work stoppages during depot maintenance. Under the IPV contract, bin fill rates have averaged 99.77% (as compared to a low of 62% under the previous tactically-oriented organic management process) and reduced annual costs by $3.8M.[213] The second generation IPV contract had an estimated value of over $500M, including all options. Lockheed Martin won the third generation IPV contract and plans to introduce automated parts vending machines that can be accessed by maintenance technicians using their Common Access Cards (CACs). The new distribution method is expected to provide better accountability and control as a way of lowering costs and creating efficiencies.[214]

As the DLA TSI and USAF IPV program examples demonstrate, PSIs generally perform tasks broader than the manufacture, assembly, or maintenance of components or subsystems. Rather, they are accountable to ensure that materiel is available when and where required by the warfighter. To fulfill this requirement, they may requisition parts from government sources or directly order parts from other vendors. PSIs may, in some cases, perform a portion of the required manufacture, assembly, or maintenance tasks that they oversee and integrate. The PSI adds value by forecasting the need for and obtaining materiel, managing inventories, and/or delivering parts and services to the user when and where needed. PSIs can also be used to manage the return and maintenance of assets requiring repair or refurbishment.

Using Technical Data to Competitively Purchase Replenishment Spare Parts

As previously noted, DOD's supply chain guidance (DODM 4140.01) prescribes a spare parts breakout program. Under this program, supply chain engineers and managers regularly review technical data obtained under development and production

[211] "Lockheed wins $750M contract to manage spare parts via vending machines," Wakeman, Nick, Washington Technology, March 8, 2017.
[212] "Request for Information, DLA Solicitation Number SPM50005R0068, 100% Commercial Solution for IPV," Fed Biz Ops notice, August 28, 2012.
[213] "2012 Secretary of Defense Performance-Based Logistics Awards Selection," OUSD(AT&L) Memo, September 20, 2012.
[214] "Lockheed wins $750M contract to manage spare parts via vending machines," March 8, 2017.

contracts to identify opportunities to procure parts direct from the actual manufacturer or from competitive sources. The screening process assesses the adequacy of the technical data and the risk associated with purchasing parts from competitive sources. When data is adequate for competitive re-procurement, but design tolerances are critical, engineers may restrict purchases to specifically qualified sources or establish special qualification requirements, such as first article testing, before accepting products from new suppliers. Full and open competition is the preferred end result of breakout screening and efforts to remove competition impediments continue until no further actions are feasible or parts are approved for competitive procurement.[215]

While competition is an important goal, risks must be managed. In recent years, there has been increasing concern about counterfeit parts entering the DOD supply system. Everyone involved in replenishment parts procurement must remain vigilant in protecting DOD systems from the risk of counterfeit parts.

The 2005 BRAC Law transferred responsibility for procurement of most weapon system replenishment spare parts from the military departments to DLA. DLA is, therefore, responsible for the majority of spare parts purchasing efforts. DLA works with DOD PSMs to forecast requirements, develop strategies, and ensure the quality of delivered parts, as well as the integrity and safety of operational systems in which these parts are used. In the past, purchasing spare parts was often a very tactical activity with each contract or order issued based on individual purchase requests. DLA has aggressively pursued a more strategic and performance-based approach to purchasing spares through long-term corporate contracts and direct vendor delivery arrangements which require the contractor to maintain inventories of projected spare parts which are delivered to the customer in response to requisitions. DLA's focus has gradually shifted, from managing supplies to managing suppliers, to ensure that contract performance satisfies required warfighter outcomes. Most of these long-term corporate agreements are with sole source providers; however, some contracts group similar parts which are suitable for competitive procurement.

Reverse Engineering

When technical data is not available, the government may contract with a firm which specializes in reverse engineering items in order to have that firm produce the item or develop engineering drawings that can be used by others to produce the item. Reverse engineering involves taking apart an object to see how it works in order to duplicate or enhance it. The purpose is to deduce design decisions from an examination of end products with little or no additional knowledge about the procedures involved in the original production. The practice, adapted from its historical mechanical hardware focus, is now sometimes used on computer hardware and software. Software reverse engineering involves reversing a program's machine code back into the source code that it was written in, using program language statements.

[215] DOD FAR Supplement, Procedures, Guidance & Information (PGI) 217.7506, 1-104(a).

Reverse engineering for the purpose of copying or duplicating software programs may constitute a copyright violation. In some cases, the licensed use of software specifically prohibits reverse engineering. The government is obligated to comply with restricted license rights for acquired software subject to these restrictions. Reverse engineering is not a strategy than can be broadly used to develop competition for product support. Further, the approach can be difficult and costly, especially for complex electronic systems. For this reason, reverse engineering is used only on a limited scale for specific parts or components and is typically only an appropriate strategy when the original supplier no longer exists or supports the item. Given the extended operational use of many DOD systems, this sort of product obsolescence[216] may be frequently encountered during the O&S phase.

Competitive Contracts for Repair and Maintenance

Historically, the PSP efforts offering the greatest opportunity for competition are repair and maintenance workloads. The DOD commonly purchases technical data and data rights sufficient to support repair and maintenance by either public or private providers. This technical data is different from the type of data required to actually manufacture components and systems. For example, technical data used to perform field-level maintenance generally only includes recurring maintenance procedures (such as lubrication and replacement of wear surfaces), inspection, testing, fault diagnostics, and removal/replacement procedures.

There are two primary levels of maintenance for DOD systems. The first is **field-level maintenance**, which is further divided into two types:

- *Organizational-level maintenance* includes higher volume, more time-sensitive work accomplished in the field, on the flight line or shipboard, or at the system/equipment location.
- *Intermediate-level maintenance* includes more complex maintenance accomplished by the operating unit in back shops, base-wide activities, and/or consolidated regional service centers.

The second level is **depot-level maintenance** which involves the most complex and extensive maintenance that is often accomplished at the system level. Depot-level maintenance is completed less frequently, requires specialized skills and facilities, and is performed at DOD or contractor depots.[217] Reparable components removed and replaced at field level may also be sent to the depot or a contractor for repair. Components removed for overhaul/repair at the depot level may be repaired by either the DOD organic maintenance system or sent to a contractor.

[216] "Program Manager's Handbook: Common Practices to Mitigate the Risk of Obsolescence (Draft, Revision D)," Tomczykowski, Walter et al, Prepared by ARINC for the Defense Microelectronics Activity, May 31, 2000.
[217] "DOD Maintenance Fact Book," Deputy Assistant Secretary of Defense for Maintenance, 2012.

The use of competition to acquire field- and depot-level maintenance is discussed in the following sections.

Field-Level Maintenance

Field-level maintenance (encompassing both organizational and intermediate maintenance) is guided by Army/USN technical manuals or USAF technical orders acquired during system development and production. These documents provide step-by-step maintenance tasks that are commonly performed by the owner/operator of the equipment. The work may include inspections, servicing (preventative maintenance), diagnostic testing, and/or repair of systems/equipment. Repairs may be as simple as removing and replacing failed components, but may also involve more detailed teardown and repair efforts, depending on the nature of the item and the maintenance strategy.

When field maintenance is performed in or near combat locations, the work is frequently accomplished by military personnel—even though the technical data may be adequate to support competitive procurement. While the potential risks and unpredictability of maintenance in the combat environment may drive operational units to perform field-level maintenance using military personnel, but there is no prohibition on contracting for this kind of work. Also, it is fairly common to rely on contract maintenance for systems and equipment operated in non-combat environments, such as training systems and other non-deployable systems—even when the maintenance is performed on a military installation or ship.

Many activities use IDIQ MACs to provide rapid response, requirements flexibility, and continuous competition in the performance of field level inspection, repair, and maintenance. An IDIQ MAC provides for an indefinite quantity, within stated limits (set forth as a maximum number of units or as a dollar value), of supplies or services which may be ordered during a fixed ordering period.[218] The government conducts streamlined post-award competitions among contract holders to award task or delivery orders for specific work requirements. Under this approach, contract holders are only guaranteed to receive a specified minimum order value during the contract term. The contract SOW, specifications, or other task/product descriptions describe the general scope, nature, complexity, and purpose of the supplies or services the government will acquire in a manner that enables a prospective offeror to decide to submit an offer. Specific work requirements are set forth in task order requests for quotation (RFQs) issued by the government.

Each department operates a variety of IDIQ MAC programs that can be used to acquire field maintenance and associated engineering support. Some programs are focused on specific weapon systems; others are only available for use by certain organizations within the department, and some programs permit inter-departmental ordering.

[218] For more about ID/IQ contracts, see: Federal Acquisition Regulation (FAR) 16.504.

The Army's Field and Installation Readiness Support Team (FIRST) program[219] was developed to provide Army PSMs an efficient way to rapidly acquire 12 logistic services supporting: program management operations, quality assurance, logistic systems IT, training, transportation supply, kitting and parts assembly, and field maintenance. The Army awarded FIRST contracts in 2007 with a five-year period of performance ($9B contract ceiling) and two one-year options. FIRST prime contractors included 15 large and 18 small businesses, with representation of the various small business categories such as woman-owned, veteran-owned, small-disadvantaged, and historically underutilized businesses (HUB) zone.

The USN hosts the SeaPort Enhanced (SeaPort-e) program, a broad MAC, on the web. The program[220] provides access to 22 different services, including: engineering, technical, programmatic, and professional support services for all phases of ship and weapon system life cycle technology development, concept exploration, design, specification development, construction/production, test and evaluation, certification, operation, maintenance, improvement/modernization, overhaul and refueling, salvage, and disposal. Task orders are competed in one of seven geographic zones (Northeast, National Capital, Mid-Atlantic, Gulf Coast, Midwest, Pacific Northwest, and Southwest) based on the principal place of performance. The SeaPort-e program is periodically reopened to allow new contractors to join the program (rolling admissions). At present, there are hundreds of contractors, representing large business and all small business categories, participating in the program. The program's goal is to award prime contracts totaling 33% of obligated dollars to small businesses and require large businesses to subcontract a minimum of 20% of the obligated dollars to small businesses.

The USAF's Future Flexible Acquisition and Sustainment Tool (F^2AST) and Small Business Acquisition Sustainment Tool (SbAST) provided sustainment support for all USAF-operated weapon systems, support systems, subsystems, components, and related services, including repairs, maintenance, and modifications. Primary contract users were the Air Force Sustainment Center (AFSC), Air Force Special Operations Command (AFSOC) and the Air Force Life Cycle Management Center (AFLCMC).[221] The F^2AST contract included 12 large business prime contractors and nearly 400 subcontractors. The contract covered a 10-year ordering period with a $6.9B ceiling value. The SbAST contract included six small business prime contractors and 40 subcontractors; it covered a seven-year ordering period with a $420M ceiling value.

[219] "Field & Installation Readiness Support Team (FIRST) Multiple Award IDIQ – Ordering Guide, Revision 2," US Army, Mission and Installation Contracting Command, July 19, 2011.
[220] SeaPort Website, US Navy, Naval Sea Systems Command, http://www.seaport.navy.mil, accessed 25 February 2014.
[221] "Future Flexible Acquisition and Sustainment Tool (F2AST), Small Business Acquisition Sustainment Tool (SbAST), Design and Engineering Support Program (DESP III)," Enterprise Acquisition Branch briefing, Air Force Sustainment Center, Robins Air Force Base GA; 2013.

Enhanced Army Global Logistics Enterprise (EAGLE) Program

The EAGLE program provides robust competition and standardized support to the Army's logistics and sustainment organizations.

The Army Contracting Command-Rock Island and the Army Sustainment Command (ASC) crafted an innovative strategy to acquire an estimated $23B worth of supply, maintenance, and transportation support for 37 USA installations. Rather than using IDIQ MACs, the Enhanced Army Global Logistics Enterprise (EAGLE) program issued basic ordering agreements (BOAs) to 128 contractors who were then eligible to compete for EAGLE orders. Since BOAs are not actually contracts, individual BOA orders form the binding contract between the government and the supplier. BOA orders support a single logistics unit and cover a five-year period of performance, providing workload stability for the winner and continuity of support for the organization. All requirements estimated between $1M and $35.5M are automatically set-aside for small business BOA holders. Any work currently being performed by an 8(a) small disadvantaged business is automatically set-aside for competition among the qualified 8(a) BOA holders.[222] According to the EAGLE contracting office, the program is intended to find efficiencies and standardize contracting processes in order to save the government money, increase competition, and expand the role of small business. [223] Use of BOAs also allows the Army to release BOA holders upon request and add new suppliers to the program on a recurring basis.

Depot Maintenance

Depot-level maintenance technical guidance may provide very detailed step-by-step instruction, but the higher level of expertise available in the depot enables specialists to use a variety of technical data to accomplish the work, such as specifications and product design data and engineering drawings. Depot-level maintenance providers are usually capable of developing and documenting new repair procedures for previously unseen failures or improving existing procedures using the unique technical skills, knowledge, and equipment available at the depot.

The product support strategy must always require the acquisition of technical data and manuals for any workload determined to be Core (10 USC 2464) and may include acquisition of data to support organic performance when determined necessary to comply with 50/50 workload requirements (10 USC 2466). Technical orders/manuals should also be acquired to support field-level maintenance consistent with the system's maintenance concept. The acquisition of additional technical data depends on the particular system's product support strategy.

While possible to compete organic depot maintenance workload between military depots with similar expertise, this is fairly rare. It is much more common to consolidate similar joint workloads at one depot based on analysis demonstrating taking advantage of specialized facilities, skills, and support equipment is cost effective. Reliance on

[222] "EAGLE BOA Holders Meeting," briefing, Army Contracting Command – Rock Island IL, November 6, 2013.
[223] "EAGLE: lessons from the year and a focus on the future," Adrian, Liz, Army Contracting Command, http://www.army.mil/article/126864, May 28, 2014.

joint depots to manage consolidated workloads can reduce overall infrastructure investment costs by avoiding investments in duplicative capabilities.

Generally, if technical data is sufficient to enable organic maintenance, it will also be suitable for competitive procurement from contractors—unless the rights to use the data are limited or restricted. The government should almost always be able to acquire unrestricted technical data which is sufficient to enable owner/operator-performed maintenance. At a minimum, such data will provide test and fault isolation procedures to identify components or parts requiring repair or replacement and provide necessary removal and replacement instructions. Once a component or part is removed from a system, available technical data may, or may not, be sufficient to enable organic or competitive repair. At the lowest repair levels, the required technical data may be very similar to the technical data necessary to manufacture a part; at that detailed level, OEMs may hold legitimate proprietary rights. When technical data is not suitable for organic or competitive component maintenance (e.g., proprietary data), components removed in the field or during system-level maintenance are usually returned to the OEM for repair.

Focusing on non-Core depot maintenance workloads for which the government possesses sufficient technical data to enable competition, the PSM or PSI may still encounter impediments to implementing competition. Significant issues include:

- **Industrial base capabilities**: Maintenance and overhaul at the system-level for major systems often requires specialized facilities and equipment, such as runways, hangers, dry docks, industrial plants, cranes, heavy transport vehicles, and specialized support equipment. The significant investment necessary to acquire and maintain such facilities will limit the number of contractors capable of performing the work. The government may partially mitigate this impediment through provision of government-furnished support/plant equipment or government-owned, contractor-operated facilities.
- **Workload transition**: When a significant workload being performed by one contractor is re-competed, a new source cannot reasonably be expected to immediately begin production at the same rate as the incumbent contractor. A new contractor will require time to hire and train workers, establish production processes, and acquire necessary materials. Competitive procurements should therefore provide for a "ramp-down" and "ramp-up" period rather than a single-point stop and start. The government may also consider providing government furnished material to mitigate the impacts of the lead time required to procure parts and supplies necessary to support maintenance start-up.
- **Required capital investment**: In many cases a new source may need to make significant investments in plant equipment to undertake a new workload. General purpose plant equipment is usually not allowable as a direct contract cost because it may be used for other purposes. Contractors will depreciate this sort of property over time, thereby indirectly recouping

their investment cost. Contractors may be unwilling to make these investments if the proposed contract term is too short or if contract options for extended terms are too speculative—such conditions increase the risk of recouping the required investment. The government can mitigate this impediment by establishing contracts with longer periods of performance or by linking contract extensions by using an award-term contract, which makes it possible for a contractor to "earn" extended periods of performance based on meeting or exceeding measurable performance outcomes.[224]

- **Loss of progress/improvement curve gains**: While competition creates a powerful incentive for the incumbent contractor to continuously improve processes and implement other improvements that enable cost reductions, it may be difficult for a new source to realistically offer better pricing on work they have never done. In many cases, the incumbent's prior efforts will have allowed them to realize cost reductions attributable to worker learning and other gains associated with progress or improvement curves. This may give the incumbent a significant competitive advantage and there is nothing wrong with the incumbent winning a follow-on competition. However, in such cases, competition may not be effective and other companies may choose not to submit proposals because they don't believe they can win. Even when other bids are submitted, if the incumbent holds a truly significant advantage, the cost and price benefits of the competition may be greatly reduced.
- **Price realism**: In many cases, the previous contract price is known by other competitors and becomes the "price-to-beat." A new source may bid significantly lower prices expecting to absorb early losses on a fixed-price contract with an objective to aggressively pursue improvements over the life of the contract. If a new source bids too low and wins, performance problems and a contentious contractual relationship can result. A new source may also try to "buy-in" to win a new contract by bidding *below* cost, or with a very low profit rate, planning to recover any early losses over the duration of a fixed-price contract. The contracting officer may consider conducting a price realism analysis (normally used for cost-type contracts) solely to assess performance risk and responsibility.

There are actions the PSM can take when awarding to a new source to mitigate the risks of an ineffective competition and contract performance issues. First, during a periodic program re-compete, implement contract changes that expand or reduce the contract scope, change operating procedures, or make other programmatic improvements. If these changes can be made in a new solicitation, rather than modifying the incumbent's contract, all parties will prepare proposals for work that is

[224] The USAF pioneered this form of incentive contracting within DOD, which is similar to an award fee contract but, instead of increased fee contractors are incentivized to earn extended periods of performance. See: "Air Force Guide: Award Term / Incentive Options," Air Force Contracting – SAF/AQC, Version 1, January 2003; "The Incentive-Term Arrangement: A New Strategy for Creating Value," Owens, James G.; Contract Management, National Contract Management Association, December 2003.

not exactly the same as the prior contract. Even the incumbent will need to take a fresh look at the changed effort. Second, the contract period of performance is important—longer periods of performance help a new source achieve improvement curve benefits, potentially resulting in realistic competitive proposals and successful contract execution.

CF6-50 Aircraft Engine – Depot Maintenance

Competitive depot maintenance sources may exist for widely used commercial items.

The CF6 is a commercial family of high-bypass turbofan engines produced by GE Aviation. The CF6-50 model is used on the MD-10 commercial airliner and the KC-10 'Extender' tanker aircraft, a derivative of the MD-10. The engine is also used on the Boeing 747 (200 and 300 series) as well as the Airbus A300. Another military application is the E-4B, Advanced Airborne Command Post (a Boeing 747 derivative). Because the engine is so widely used, there are many vendors capable of maintaining it. When Northrop Grumman won the $3.8B KC-10 logistics support contract previously held by Boeing, they selected Chromalloy to provide engine and auxiliary power unit maintenance. Chromalloy serves commercial and military customers worldwide and has operations and sales offices in the US, Mexico, United Kingdom, Netherlands, Italy, Germany, France, United Arab Emirates, Israel, China, Singapore, Thailand, Japan, and Australia.[225] Chromalloy also performs other competitive aircraft engine maintenance, repair, and overhaul work under USAF contracts.

As discussed earlier, whenever possible, contracts for sustainment—including maintenance contracts—should be performance-based and focused on metrics that track directly to military operational readiness. Contracts for repair and maintenance should require or incentivize continuous process improvement as an important tool for achieving and sustaining materiel readiness and availability, while optimizing LCC. At a minimum, solicitations for major maintenance efforts should include evaluation criteria addressing contractor process improvement efforts. During source selection, the government can then select the best-value offer considering contractor proposals that propose improvement techniques such as:[226]

- **Lean Manufacturing**: A systematic approach to specify customer value, identify waste, focus activities on eliminating waste, and maximize (or make available) resources to satisfy other requirements by achieving uninterrupted value-added flow.
- **Value Stream Mapping**: A tool to capture and analyze process data (on variables such as processing time, error rates, or work in process). Value Stream Mapping is the foundation for Lean improvement methods and is an effective tool for implementing improvements designed to speed up processes and eliminate non-value-added activities and cost.

[225] "Chromalloy will provide engine, APU maintenance and parts support as a member of Northrop Grumman KC-10 Contractor Logistic Support Team," Chromalloy Press Release, October 5, 2009.
[226] "DOD Depot Maintenance Strategic Plan," Deputy Under Secretary of Defense (Logistics and Materiel Readiness), 2007.

- **Six Sigma (6σ):** Problem-focused analytical technique involves data collection and quantitative analyses to represent and characterize a process. Statistical tools designed to understand the fluctuation of a process are then used to identify improvements.
- **Theory of Constraints (TOC):** Methodology for logical thinking, scheduling and controlling resources, and measuring performance. By focusing on and eliminating constraints that impact overall process efficiencies, this method reduces maintenance flow time. The primary effects of TOC improvements are typically faster processes. Secondary effects generally include reduced inventory and waste and improved quality.

System/Subsystem-level Contractor Logistics Support

Sometimes the PM/PSM can acquire an integrated PSP effort in which a competitive contractor provides support that encompasses multiple IPS elements. Such efforts may include supply support, repair and maintenance, PHS&T, and some portion of infrastructure support. To preserve a competitive environment for the future, the government typically performs other product support elements in-house (e.g., product support management, sustaining engineering, technical data, etc.).

The USN successfully used competition to establish a major CLS arrangement for the T-45 Goshawk Jet Aircraft Trainer and Ground-based Training System (see box on next page). System-level support contracts are, however, often established non-competitively with the OEM because 1) the DOD lacks sufficient technical data, or 2) non-OEM sources lack access to the necessary facilities, supplies sources, and other resources to provide support at the system level. Competitive support agreements are more commonly focused on support of subsystems, major components, or parts. CLS contracts should be performance-based and focused on metrics which track directly to military operational readiness. Two effective performance metrics are materiel availability and logistics response time.

USN T-45 Goshawk Training System – Contractor Logistics Support (CLS)

Coupling a performance-based approach with subsystem breakout, the USN successfully competed the T-45 airframe and ground-based training system.

Boeing produced the USN's integrated T-45 training system, including the trainer aircraft, flight simulators, and a computer-assisted instructional program. Boeing provided CLS on a sole source basis for all elements of the system beginning with IOC in the early 1990s through 2003. Seeking to reduce program support costs, the USN pursued a strategy leveraging component breakout, competition, and PBL.

The CLS support contract was completely re-engineered to fully encompass reliance on performance-based requirements. This strategy resulted in two separate performance-based contracts: 1) a competitively awarded airframe/ground-based training system PBL contract awarded to L3 Vertex Aerospace, LLC, and 2) a sole source F405 engine "power-by-the-hour" commercial contract awarded to Rolls-Royce. The approach generated $144M in savings over the life of the two new contracts and produced notable improvements in system availability. The T-45 team received the Secretary of the Navy Competition and Procurement Excellence Award in 2004.[227]

While PBL contracts drive desired outcomes, evidence suggests that component-level PBLs are most effective in a continuously competitive environment, i.e., support opportunities are re-competed regularly to maintain competitive pressure on the contractor. Table 8 identifies performance improvements achieved on several USN programs in which traditional sustainment support for weapon systems was replaced using a competitively awarded PBL agreement.

Table 8 Availability & Response Time Pre-PBL & Post-PBL[228]

Program	Materiel Availability		Logistics Response Time	
	Pre-PBL	Post-PBL	Pre-PBL	Post-PBL
H-60 Avionics	71%	85%	52.7 days	8 days
F-18 Stores Mgt System	65%	98%	42.6 days	2 days CONUS 7 days OCONUS
Auxiliary Power Units	65%	90%	35 days	6.5 days

Breakout of Subsystems or Components

When the system's prime contractor establishes competitive sources for subsystems or components during development or production, the DOD may enjoy benefits attributable to the existence of supply multiple sources during the O&S phase. Ideally,

[227] "T-45 Team Gets SECNAV Award for Cost-Wise Readiness," Naval Air Systems Command Press Release, June 1, 2004.
[228] "Competition in Defense Acquisition," Gansler, Jacques S., Lucyshyn, William, and Arendt, Michael, Center for Public Policy and Private Enterprise, University of Maryland School of Public Policy, February 2009.

development and production contracts will incentivize the prime contractor to use subcontractor competition during those program phases. If more than one source was not developed earlier in the program, the PM can pursue contract incentives for developing a second source under system-level PBL support contracts. This strategy is generally only used for subsystems or components which have experienced availability, quality, or unreasonable cost growth problems. Introducing a second source in such cases creates competitive pressure to resolve performance problems and can also produce a viable second source of supply.

Even when only one subcontractor source exists, the government may still achieve significant cost savings by breaking out the subsystem or component and buying replacement parts and/or maintenance direct from the actual manufacturer.

The government assumes some risk when pursing component breakout, especially if the system design is unstable or the system is still in production. When the government elects to break out subsystems or components and provide them to the prime contractor as government furnished property during production and deployment, the government becomes liable for cost and schedule impacts if the items are delivered late or are otherwise non-compliant. While the risk of breaking out components during the O&S phase is considerably reduced, the government still bears some risk. Generally, however, breakout savings will outweigh potential risks at this point in the program's life cycle.

Important questions to consider before breaking out a subsystem or component include:

- *Will breakout of the subsystem or component generate net cost savings?* Ultimately, this is the first and most important question. If anticipated breakout savings do not exceed the costs of breaking out the item, it is not worth pursuing the action. The PSM should develop probable cost savings estimates that consider all offsetting costs such as increased costs of requirements determination and control, contracting, contract administration, TDP purchase (if required), material inspection, qualification or pre-acceptance testing, ground support and test equipment, transportation, security, storage, distribution, and technical support.
- *Is the item's design stable?* Does the government or contractor currently control the engineering design configuration? If the design is unstable and the baseline is not under government control, it may be wise to continue to rely on the prime contractor to manage the items.
- *Can component quality control and reliability problems be resolved without requiring OEM effort?*
- *Does the government possess the necessary technical data and expertise to manage the product without support from the system-level prime contractor?*
- *What impact will breakout have on related PBL contracts?* If the item is used on a system supported under a PBL contract, the government may need to segregate impacts to performance-based metrics that are attributable to any

shortfalls in the availability of the component(s) that were broken out and managed by the government.

The T-45 training system CLS program provides a good example of how breakout of a major subsystem (the engine) helped to produce significant cost savings for the USN during O&S. In this case, the USN used different performance metrics for the engine ("power-by-the-hour", i.e., paying the contractor based on the engine operational hours) than those used to assess performance of the rest of the system (availability metrics). This is one advantage of breaking out a subsystem or major component—performance metrics can be tailored directly to the subsystem. When the government engages directly with the contractor actually performing the work and specifically focuses contract performance requirements, the contractor will be more likely to aggressively pursue the process and quality investments (such as reliability improvements) intended to be incentivized by the performance measures. Contracting directly with the firm performing the work ensures the contractor will reap potential economic benefits that may not be guaranteed if the work is performed under a subcontract.

The T-45 training system case also provides a good example of the risks potentially associated with breaking out support of a system. No doubt, if the engine contractor (Rolls-Royce) failed to have fully capable engines ready to support the training mission, as required, the government would have been unable to hold the system contractor (L3 Vertex) responsible for any resulting gap in availability. When establishing inter-related support contracts, the government should carefully plan contract structures and mechanisms to ensure performance metrics and incentives remain viable should one contract negatively impact performance on the other.

Incentivizing Lower-tier Competition

In cases where the DOD establishes non-competitive system or subsystem-level PBL contracts with the OEM, the PSM should consider creating incentives to introduce lower-tier competition. Generally, these contracts fund an upfront investment which is then offset by future savings. The contractor and the government share in the cost savings for a period of time and the contractor is not "penalized" for reducing cost by a commensurate reduction in fee or profit. The key to this incentive is contractors must be able to earn the same or even increased profit—even though the cost of performance goes down. Otherwise, the contractor may have little real incentive to reduce cost.[229] If contractor efforts result in improved system supportability and affordability, and the contractor is able to share the benefits, it is usually in the government's best interest.

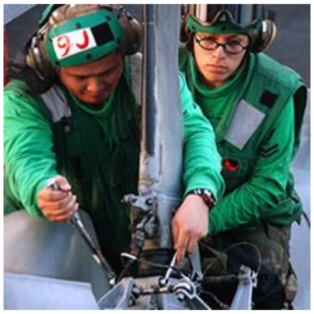
Incentives can be indirect, such as share-in-savings mechanisms that encourage contractors to identify and implement cost reduction initiatives. These can include organizational or management improvements, manufacturing process changes, design

[229] See: "Better Buying Power: Guidance for Obtaining Greater Efficiency and Productivity in Defense Spending," "Incentivize Productivity and Innovation in Industry: Reward Contractors for Successful Supply Chain and Indirect Expense Management," OUSD(AT&L) Memorandum for Acquisition Professionals, September 14, 2010.

changes, introduction of lower-tier competition, or any other action which has the potential to reduce the support costs of .

Incentives can also be specifically focused on introducing competition for certain subcontracts. As noted in the breakout discussion, it makes sense to focus on subsystems or components that have experienced availability, quality, or unreasonable cost growth problems. Conduct some form of analysis to evaluate whether potential benefits will offset the added costs of developing a new source. Focusing on “problem” subcontracts increases the potential that the benefits will offset the investment required. The government should work with the prime contractor to identify potential candidate subsystems or components and determine the most effective approach for the circumstances. Alternatives include establishing the source development effort as a direct task to be performed under the contract (and therefore part of the contract price) or establishing an economic incentive to motivate such behavior under the terms of the contract. If the government fully funds the investment, the cost savings should flow directly to the government and not be shared by the contractor.

SPECIFIC COMPETITIVE METHODS – MODIFICATIONS



There are a variety of specific competitive methods and techniques that have been applied to the acquisition of product modifications within the DOD during the O&S phase. Major system modifications are often treated as stand-alone acquisition programs which are accomplished following the same acquisition life cycle management phases as discussed in this handbook. Minor modifications may be integrated within the O&S phase. These methods apply to major and minor system modifications because both types must be installed on operational systems. Modification installation is often accomplished in conjunction with depot maintenance or major system repair and overhaul.

Definitions of Modification

Various DOD organizations define the term *modification* in a number of ways. Some definitions include:[230]

- DAU Glossary: A configuration change made to a previously produced configuration item. Any modification that is of sufficient cost and complexity that it could itself qualify as an ACAT I or ACAT IA program will be considered as a separate acquisition effort for management purposes.
- Army Regulation 750-10: The alteration, conversion, or modernization of an end item or component of investment equipment that changes or improves the original purpose or operational capacity in relation to effectiveness, efficiency, reliability, or safety of that item.
- AFI 63-101: Changes to the form, fit, function, or interface of an in-service, configuration-managed USAF asset. A configuration item is a hardware, firmware, or software component, or combination thereof, that satisfies an end use function and is designated for separate configuration management.
- SECNAVINST 5000.2D: Any configuration change to a produced configuration item regardless of cost or test requirements (e.g., ECPs, pre-planned product improvements, upgrades, or technology enhancement). A modification to a program or system that is no longer an active ACAT program (i.e., a program that has achieved at least 90% of total deliveries or has expended 90% of total cost) should be treated as a separate program with its own assigned ACAT or Abbreviated Acquisition Program (AAP) designation.
- DOD 7000.14-R Financial Management Regulation, Volume 2A, Chapter 1, Para 0102 Funding Policies: A change to a weapon system or component to correct a known safety issue or deficiency, extend a service life, change original design parameters, or expand system performance.

[230] From: "ACQuipedia: Modification Management," Defense Acquisition University, https://dap.dau.mil/acquipedia/Pages/ArticleDetails.aspx?aid=dc45b209-ec73-48be-ad61-65c798396a75, accessed March 20, 2014.

- DOD 7000.14-R Financial Management Regulation, Volume 2A, Chapter 1, Para 010224, Glossary of Terms, Procurement: The alteration, conversion, or modernization of an end item of investment equipment which changes or improves the original purpose or operational capacity in relation to effectiveness, efficiency, reliability, or safety of that item.

Technical Data-enabled Competition

In cases where the government possesses technical data (engineering drawings, specifications, parts lists, technical orders, etc.) and the rights to use the data, competition can be used to acquire system modifications. Technical data provides potential offerors with an appropriate level of knowledge about the existing system so that sources other than the OEM can design and implement the necessary changes.

USAF A-10 Thunderbolt II Aircraft Re-wing

Using a combination of technical data and performance-based requirements, the USAF competitively acquired new A-10 aircraft wings.

The A-10 was developed for close air support of ground forces; it is used to attack tanks, armored vehicles, and other ground targets with limited air defenses. The aircraft was produced by Fairchild-Republic from 1978 to 1982 and was designed for a 6,000-flying-hour life, but was later extended to 8,000 hours. By 2006, the average aircraft had clocked 9,000 hours and repairing fatigue cracks developing in the wings had become increasingly difficult. The USAF issued a competitive solicitation calling for the production of replacement wings to be installed by a USAF depot. The solicitation included technical data from the Fairchild "thick wing" design used on later production aircraft. The data was provided for reference only—the contractor was responsible to design replacement wings that mated with the existing aircraft and were engineered to extend useful aircraft life to the year 2040. Three major defense aircraft manufacturers submitted proposals. In 2007, the USAF awarded a $2B contract to Boeing. Boeing and their partner, KAI, produced the new wings at Boeing's facility in Macon, GA. The first re-winged A-10 was rolled out at Hill AFB in February 2012.[231]

In addition to technical data, the government will often provide access to an existing end item during the design and development effort and will dedicate the use of an end item for installation and test purposes. Even if the technical data is partially incomplete, providing access to a representative end item allows contractors to physically examine the existing configuration. As part of the design and development effort, the modification contractor should be tasked to update/replace technical data to represent the new configuration.

Performance-based Modifications

In order to maximize competition, innovation, and interoperability, and enable greater flexibility in capitalizing on commercial technologies to reduce costs, DOD policy

[231] "A-10 Thunderbolts Getting New Wings at Hill Air Force Base," Asay, Jasen, The Standard Examiner, Ogden UT, February 17, 2012.

requires acquisition managers to consider and use performance-based strategies for acquiring and sustaining products and services whenever feasible. For products, this includes not only new procurements, but also major modifications.[232] Defining the desired outcomes in terms system performance capabilities, instead of specific designs, increases the potential of obtaining competition.

Performance-based approaches can sometimes be used when detailed technical data is not available—but the government may need to provide access to the system or equipment to be modified or an appropriate test environment, such as a software integration laboratory (SIL). A rigorous developmental test and evaluation program, similar to the contractor and government testing conducted during the EMD phase, is usually performed to evaluate the first modified system(s) before proceeding with the modification of additional quantities.

USMC Light Armored Vehicle (LAV) Service Life Extension Program (SLEP)

Despite restricted technical data, the USMC effectively used competition to execute a SLEP for the LAV program.

The Light Armored Vehicle (LAV), manufactured in the 1980s by GM Defense of Canada, is an eight-wheeled USMC reconnaissance and combat vehicle. It is capable of traveling across rugged terrain, cruising at more than 60 mph on roads, and crossing rivers, streams, and lakes in amphibious operations. By the late 1990s, the LAV required a Service Life Extension Program (SLEP) to permit the system's use through 2015. Recognizing that the LAV TDP was proprietary, the LAV PM still decided to pursue competition for the program because of the potential benefits of lower cost and increased access to advanced technologies. To increase competition effectiveness, the PM accomplished several tasks: (1) conducted a detailed market survey which indicated strong commercial interest; (2) offered to loan vehicles to potential offerors (three loans were executed); (3) made vehicles available for viewing at sites across the country for offerors not interested in formal loans; (4) released all available non-proprietary information on a CD-ROM; and (5) used a draft solicitation and bidders conference to encourage comments on methods to increase competition. Metric Systems Corporation of Florida, then a subsidiary of Integrated Defense Technologies, Inc., won the contract to develop the SLEP and produce modification installation kits.[233]

Form, Fit, and Function Technology Insertion

In some cases, a system can be modified by inserting a replacement subsystem or component to both improve and replace the existing item. Through introduction of newer technologies, replacement items may offer significant improvements, such as increased reliability, maintainability, supportability, or affordability—even though the new item performs exactly the same functions as the existing item.

The approach can also be used to introduce new functionality that is self-contained within the new item and does not impact the interface with other items (e.g., adding

[232] DODI 5000.01, Paragraph E1.1.16, "Performance-Based Acquisition."
[233] "Application of Acquisition Reform Initiatives during Service Life Extension Program (SLEP)," MARCORSYSCOM, PM-LAV, From: ASN(RD&A), Best Practices and Lessons Learned, undated.

built-in self-test or active performance monitoring functionality). The form, fit, and function technology insertion approach works well with mechanical items, such as actuators, pumps, structural components, or other mechanisms. Many modern electronic items, however, have significant embedded software and there can be system integration issues related to software processing and timing which can make insertion of replacement electronic systems more challenging.

In this sort of competition, the government defines subsystem or component performance requirements and provides detailed form, fit, and function specifications, including size, weight, power, input/output signals, internal and external functions, etc. To some degree, the A-10 re-wing effort (summarized previously) was a form, fit, and function replacement. The replacement wing was required to have the same external form as the existing wing, properly fit when attached to the existing aircraft, and provide the same aerodynamic lift and control functions. The contractor had flexibility regarding the internal wing design provided that it met performance and durability requirements.

The advantage of using this technique is that new products can be developed entirely independent of the internal design of the item to be replaced. The only technical data the government must provide is information regarding any limitations on the form and fit (specifically design interface specifications) and functional performance requirements.

Open Systems Architecture Software Upgrades

The benefits of using OSA in system design and development were discussed earlier in this guide.[234] The essence of OSA is an organized decomposition of system functions, using carefully defined execution boundaries, layered onto a framework of software and hardware shared services resulting in a well-documented modular design. The modular design of software functions enables modification of individual modules, often minimizing changes required in other modules. Essentially, OSA enables a kind of form, fit, and function technology insertion for software-intensive systems because the interfaces between—and the functions performed within—modules are well-defined and documented.

The government may use system OSA documentation as the key technical data to enable competition for development and integration of new products and/or functions to be inserted into an existing system.

[234] See “Technology Maturation and Risk Reduction Phase” chapter, “General Competitive Methods and Techniques.”

USN Acoustic Rapid Commercial-off-the-Shelf Insertion (AN/BQQ-10)

Introducing OSA to existing sonar processing enabled the USN to leverage COTS performance and cost benefits and facilitated competitive modification.

The USN's Acoustic Rapid commercial-off-the-shelf (COTS) Insertion (A-RCI) program, designated AN/BQQ-10, was a four-phase effort to transform three legacy submarine sonar systems to a single system using a more capable and flexible COTS/modular OSA approach. Through the use of OSA, the program enabled a competitive environment by lowering switching costs for continuing system modifications. The modernization effort capitalized on rapid improvements in COTS processing performance and decreasing computer hardware costs. Using existing sonar arrays and incorporating COTS state-of-the-art systems and advanced signal processing algorithms, the USN improved their capabilities to exploit much quieter acoustic signatures of modern submarines, while at the same time reducing system development and support costs. A-RCI's open architecture concept also makes it easier to integrate future sensors, providing a dual-track improvement option for the submarine fleet.

Through 2004, A-RCI enabled a 10-fold increase in system throughput and an 86% reduction in hardware cost per billion floating point operations per second over a six-year period. More importantly the increased reliability and maintainability of COTS processors dramatically improved system capability and availability.[235]

Separating Development from Production & Installation

Programs will often separate design and development from production and installation of a system modification on fielded systems. In cases where only the OEM is capable of designing/developing a system modification (due to proprietary technical data, unique facilities or capabilities, etc.), this approach can be used to competitively acquire the effort to produce installation kits and/or install the modification on the system or subsystem. In some cases, installation must be performed separately from production because installation is accomplished during regular maintenance performed by an organic depot, contractor depot, or field maintenance activity.

In this situation, one contractor receives a contract to perform the design, development, testing, and verification effort to establish a baseline modification kit, including installation instructions and any post-installation test and verification processes. The government, after validating the equipment and installation instructions meet requirements, uses competition to select another contractor to produce modification kits and/or install the modification.

The government assumes some integration risk and responsibility using this approach because the contractor that simply replicates or installs kits produced by another contractor cannot be held accountable if there is a defect in the kit design or installation procedures. In addition, if the modified system fails to meet specified performance requirements, the government must determine which contractor is at fault. As with most competitive strategies, it is appropriate for the PM to assess the costs, benefits,

[235] "Commercial-Off-The-Shelf (COTS): Doing It Right," Gansler, Jacques S. and Lucyshyn, William; Center for Public Policy and Private Enterprise, School of Public Policy, University of Maryland; September 2008.

and risks associated with a decision to separate the design/development from the installation of a system modification.

Cost-effective Product Substitution

In some cases, a component or subsystem may only be minimally integrated with the overall system. In such a situation, it may prove economically advantageous to completely replace the item rather than modify the existing product.

USN Emergency Escape Breathing Device (EEBD)

The USN used competition to replace EEBDs originally built to a government specification with a commercial item.

The Emergency Escape Breathing Device (EEBD) gives a sailor 10 minutes of air to escape a fire scene and exit to an exterior deck. The USN fielded over 300,000 EEBDs manufactured to a USN specification in the early 1980s. These units had a 16-year service life which ended in the mid-1990s. The USN sought to purchase a commercial device that would be smaller, lighter, and quicker to put on.

The acquisition team conducted several years of testing and market research on units found in aeronautical and mining industries. Based on this research, the team developed a commercial item description requiring that the EEBD have approval from the National Institute of Occupational Safety and Health (NIOSH) which validated the device had already undergone rigorous test and evaluation—thereby streamlining the acquisition process. Anticipating competitors would use different technologies, each with its own strengths and weaknesses, best value criteria were used to select the winning offer. The solicitation also provided for direct vendor delivery eliminating USN inventory management costs and minimizing lost shelf life by shipping the EEBDs directly to users, as required. The USN awarded a five-year $55M contract to Ocenco, Inc. of Kenosha, WI, whose offer represented the best value to the government. [236]

This substitution strategy is more likely to be effective when the cost of the item is relatively low and little or no development effort is required due to existing NDIs which may be suitable. Before deciding to pursue an acquisition strategy calling for the modification of an existing item, market research should always be conducted to determine if it is feasible to replace the existing item with an NDI.

Credible Threat of Product Substitution

Direct competition is ideal, but when that is not viable or affordable, indirect effects of competition can be obtained when the current supplier or service provider believes the government has the potential to introduce competition. The PM and/or PSM should remain open to considering alternative strategies when, at first look, it may appear that the government has no other option than to return to the OEM to accomplish system modifications. Greater effort should be invested in exploring alternative courses of action and examining methods to eliminate impediments to competition in those cases where the current supplier is failing to control cost growth or experiencing quality and

[236] "Emergency Escape Breathing Device Source Selection," ASN(RD&A), One Source, Best Practices and Lessons Learned, undated.

other performance problems. Simply beginning to take visible actions to introduce competition will usually get the incumbent's attention and drive greater effort to remain competitive.

Indirect effects of competition (the threat) can be realized by taking steps to decrease the "switching costs" of going from one source or service provider to another. For example, the government can:

- Include options in the incumbent's contract to purchase technical data that can be used to facilitate competition. The requirement need not specify detailed design data for every item. Consider buying only data relevant to "problem" items and whether form, fit, and function specifications can be used, or establish a triggering mechanism that requires acquisition and delivery of such information when a problem item trips a performance or cost trigger.
- Enter into a contract with the OEM to convert existing integration specifications to one based on OSA. Even if the new architecture is not used to enable competition, it offers the potential to reduce the cost and time necessary to implement future upgrade modifications executed by the current supplier.
- Introduce competition to produce or install modifications which are designed and developed by the existing sole source supplier.
- Conduct market research to investigate the potential to compete dissimilar products (substitutes) which may be capable of performing similar functions.
- Take other actions specifically focused on identified impediments to competition.

BEST PRACTICES

There is a wealth of unique acquisition strategy approaches available to the PM and PSM during the O&S phase. Unlike earlier phases, the variety of products and services acquired during O&S almost always affords some competitive opportunities. There are a few important best practices and lessons learned which warrant highlighting.

Technical Data is Critical

During O&S, the concern is supporting or modifying a fielded product with an established configuration. It will be difficult, if not impossible, for competitive sources to provide this support without access to some technical information that provides insight into the existing product configuration. The type and level of detail of technical data depends on the specific product support effort to be performed. It is rarely necessary to have comprehensive technical data that will allow the non-OEM to actually manufacture the entire system since sustaining a system is different than producing the system. Sometimes all that is necessary is a parts list reflecting part numbers and manufacturers. In other cases, only technical orders or manuals that detail maintenance processes are required. Finally, it may be possible to modify a system with only form, fit, and function specifications for a particular component. To plan a competitive strategy, the PM needs to know what technical data is available, how current and accurate it is, and what rights the government has to permit others to use it.

Ideally, PMs responsible for system EMD and production will have placed a priority on deployment, operations, and support planning. In that case, sufficient technical data should be available to support some level of competition during the O&S phase. It is clear, however, that insufficient technical data is the most significant and common impediment to implementing competition during O&S.

Importance of Market Research

Market research is important in acquisition strategy development during any phase of the acquisition life cycle, but it is especially valuable when planning product support strategies for three reasons. First, understanding the capabilities of potential competitors will help the PM and PSM plan/design PSPs that are realistically suitable for competitive performance, helping to ensure a successful competition. Secondly, understanding customary and proven practices (in both the commercial and defense markets) for the specific type of work to be acquired, aids in the development of solicitation terms and conditions which leverage those practices to enable competition. Finally, understanding commercial and non-developmental products that may be suitable for the implementation of modifications, may enable the use of competition when, at first look, it appears to be impractical. The better an acquisition team understands the marketplace for particular work, the easier it is to structure a solicitation resulting in a successful competition.

Carefully Consider Alternative Strategies

Market research helps identify alternative approaches that are likely to result in a successful competition; but there are other sources of helpful information the PM and PSM can use. While no two programs are exactly alike, it is helpful to know how other acquisition teams have structured competitive product support efforts within the PM and PSM's immediate organization, the program's department or agency, and in other DOD departments/agencies. Despite numerous attempts to share best practices and lessons learned, summary reports often end up in a rarely used database, making it difficult to find relevant, comparable programs. Consider making personal contact with other program offices with similar systems in the O&S phase to discover what approaches they have used. The DOD Peer Review process[237] (mentioned in Chapter 1) can also be a source of insight and advice that leverages the experience of other programs.

As stated earlier, O&S offers a very complex array of alternative approaches to securing product support because of the variety of tasks involved and the availability of both public and private providers. In the pursuit of a successful competition that delivers the required performance outcomes in an affordable manner, the acquisition team should carefully consider the widest possible range of alternative approaches and incentives and assess the costs, benefits, and risks associated with each.

Duration of Contract Performance Periods

While FAR 17.204(e) generally limits the contract term for supplies and services to not more than five years, including options, there is considerable precedent and a wealth of analysis and opinion that long-term sustainment contracts offer many advantages.[238] Most importantly, a long-term, fixed-price contract provides an incentive for the contractor to introduce product improvements that increase reliability and thereby reduce maintenance demand, generating savings that first benefit the contractor and later the DOD. In fact, there is a preponderance of evidence that longer-term contracts which ensure revenue streams and contain well-crafted cost and performance incentives drive predictably positive outcomes for the DOD.[239] In addition, when the workload transitions to a new contractor, a longer period of performance allows the new contractor time to increase performance efficiency, which helps the company recoup start-up costs. In recognition of the potential benefits of long-term contracts, DFARS 217.204 authorizes task and delivery order contract terms of up to 10 years (including options). The responsible DOD department/agency Senior

[237] DOD FAR Supplement, Procedures, Guidance and Instructions (PGI) 201.170-1, Objective of Peer Reviews, Revised October 28, 2011.

[238] See: "Performance-based-Logistics: A Primer for the New Administration," Goure, Daniel, Lexington Institute, April 2009 and "Balancing Government Risks with Contractor Incentives in Performance-Based Logistics Contracts," Gardner, Christopher P., Captain, USAF, Air Force Institute of Technology; March 2008.

[239] "Performance Based Logistics and Project Proof Point," Boyce, John and Banghart, Allen, OUSD(AT&L): Product Support Issue, March-April 2012.

Procurement Executive (SPE) may also approve contract periods exceeding 10 years based on exceptional circumstances.

Some supply chain experts argue that the norm performance period for PBL contracts should be five years with an option to extend an additional five years.[240] Others suggest that long-term contracts increase risk for both the government and the contractor. And some have expressed concern that if major product support efforts are not regularly re-competed, the number of qualified competitive sources may diminish. It is clear the performance period for major product support contracts has an impact on both competition effectiveness and performance results under the contract. Accordingly, the acquisition team should carefully consider the performance period for sustainment contracts as part of the acquisition strategy process.

Extent of Competition

Full and open competition means that "all responsible sources are permitted to compete" but FAR Part 6.101 acknowledges that the competitive procedure(s) used should be those "best suited to the circumstances of the contract action and consistent with the need to fulfill the government's requirements efficiently." Ultimately, the goal is to conduct an effective competition which results in contracts that deliver the required results at a fair and reasonable price.

Several DOD IDIQ MACs were referenced in the discussion of field-level maintenance. While these contracts can be a great way of obtaining required flexibility, there is valid criticism that some of these contracts are awarded to too many contractors. In some cases, many of the contractors who receive a basic contract never win task or delivery orders (beyond the minimum order) and the large number of contractors complicates and delays the contract administration and ordering process.[241]

The basic contract scope of work can also impact the effectiveness of a competition. When planning an acquisition, it is possible to consolidate too much work into a single contract such that only a few contractors are capable of assembling the team necessary to accomplish the work. Such consolidation limits the effectiveness of the competition and increases overhead costs by requiring pass-through work to a large number of subcontractors.

Consolidation of previously separately awarded contracts may also constitute "bundling" if the aggregated requirement precludes participation of small businesses.[242] Bundling is defined as consolidating requirements previously provided under separate smaller contracts, into a single contract that may then be unsuitable for award to a small business concern due to: (1) the diversity, size, or specialized nature

[240] "Performance-Based Logistics Redefines Department of Defense Procurement," Vitasek, Kate and Geary, Steve; World Trade, June 2008.
[241] "Effective ("Smart") and Ineffective ("Dumb") Competition in Defense Acquisition," Gansler, Jacques J., presented at Defense Acquisition University conference: "The Limits of Competition in Defense Acquisition," Fort Belvoir, VA, September 18, 2012.
[242] See FAR Part 2.101, "Definitions" and Part 19.202-1, "Encouraging Participation by Small Businesses."

of the work; (2) the aggregate dollar value of the anticipated award; (3) the geographical dispersion of the contract performance sites; or (4) any combination of the above factors.

Alternatively, it is equally inefficient to fragment the work so as to increase the number of competitors for each task because that approach unnecessarily increases the program office's administrative workload. Aim to scope the contract requirements based on market research such that two or more sources will be independently capable of submitting priced offers to perform the full scope of work with a small or modest number of subcontractors. Once again, this issue underscores the importance of understanding the supplier market through market research.

Planning for Flexibility

Regardless of the contract term, one can almost guarantee the initial workload expectations will not match the actual work required during contract execution. Many factors drive workload demands—the most significant being the magnitude of operational use which can vary significantly as military forces are called on to respond to various contingencies. Additionally, aging weapon systems may experience previously unseen failures due to military operations driving extensions beyond the originally planned life cycle. Today's dynamic budgetary challenges are also forcing the DOD to downsize its inventory of ships, airplanes, and vehicles, which obviously impacts planned product support efforts. Contracts for support should be designed with this sort of demand variability in mind; to the extent feasible, the contract should be capable of accommodating changes within its own terms and conditions without requiring a new competition or a complex contract restructure.

Planning for Transition

Competitively awarded recurring product support contracts must always consider the procedures and mechanisms that will be used to transition work from one contractor to the next. In most cases, if the follow-on contract is awarded to a different contractor, suppliers will need a ramp-down period as the contract ends and ramp-up period for the follow-on contract,. Acquisition planning should address inventory and/or government furnished property transfers and any other plans to phase in workload quantities during a contract start-up period. The goal is a smooth contract transition providing uninterrupted support to the operational user. It is frequently appropriate to make effective transition planning an important subfactor in the source selection evaluation criteria.

CASE STUDY – USAF KC-135 PROGRAMMED DEPOT MAINTENANCE (PDM)

Introduction and Program Overview

The KC-135 is an aerial refueling aircraft produced by Boeing for the USAF between 1954 and 1965. It remains the workhorse of the USAF tanker fleet pending the development and production of the new KC-46 Pegasus aircraft under a contract awarded to Boeing in 2011. To update the aircraft and ensure it remains safe to fly across 50 years of operational use, the system undergoes periodic programmed depot maintenance (PDM) which involves a thorough inspection and repair of the aircraft structure and onboard mission systems. To minimize aircraft downtime, both major and minor system modifications, which are not time sensitive, are also installed during the PDM process. A KC-135 tanker typically requires PDM every five years.

Because the KC-135 airframe was based on the commercial Boeing 707 aircraft, the USAF was able to procure sufficient technical data to enable depot-level refurbishment, similar to the work customarily performed by the commercial air carriers on their own fleets. Both commercial and government maintainers also developed and documented new repair procedures to address previously unseen failures during the aircraft's extended life cycle. When the KC-135 was upgraded, the USAF procured modification kits and technical orders to facilitate the installation of aircraft modifications. As a result, the USAF possessed extensive, unrestricted technical data which was suitable for organic and contractor depot maintenance.

Acquisition Strategy Implementation

In the early 1990s, PDM was performed by two organic depots (Sacramento Air Logistics Center, McClellan AFB, CA and Oklahoma Air Logistics Center, Tinker AFB, OK) and a contractor (Pemco Aeroplex, Birmingham, AL). Pemco had performed KC-135 PDM under multiple contracts beginning in 1969. When the 1995 BRAC decision resulted in the closure of McClellan AFB, the USAF elected to bundle and compete the Sacramento KC-135 PDM workload and other work at the center (including component repair, ground radar support, and F-111 and A-10 maintenance).

Pemco lacked the expertise to take on the added workload and lost the KC-135 work to Boeing, which had teamed with Ogden Air Logistics Center, Hill AFB, UT. Although Boeing was the KC-135 OEM, Boeing had never performed depot maintenance on the KC-135, preferring instead to focus corporate resources on building new airplanes. As sales of new aircraft slowed in the mid-1990s, Boeing started to pursue a greater role in aircraft maintenance. Boeing began performing the PDM work at their facility in San Antonio, TX and Ogden transferred the non-KC-135 workload to its facilities in Utah. As the existing Pemco contract was coming to an end, Boeing had not yet attained full PDM production capacity, so the USAF executed a 36-aircraft extension to Pemco's contract (extending performance into 2001) to supplement Boeing's capacity.

The transition of workload from Sacramento and the stand-up of the Boeing facilities, coupled with increased depot field team workload, led to an increase in maintenance cycle time which resulted in depot-possessed aircraft increasing from about 100 to 176—reducing the number of aircraft available for operational use. To increase depot maintenance throughput, Boeing subcontracted with Pemco to perform part of the KC-135 work.[243] Pemco and Boeing worked together to perform KC-135 PDM into 2006, when the contract issued to Boeing was scheduled to end and a re-competition was planned. Working together, the two companies successfully reduced flow time and increased aircraft availability by reducing the number of depot-possessed aircraft.

In 2005, as the new competition took shape, Pemco and Boeing announced they would enter into a Memorandum of Agreement (MOA) to jointly bid the PDM workload. The contract, then scheduled for award in 2006, included five base years with five, one-year options. The first full year of work under the program was expected for FY07. The total value of the KC-135 repair agreement over the 10 years was anticipated at approximately $2B.[244]

In 2006, the USAF amended the KC-135 PDM solicitation, significantly reducing the planned quantity of aircraft to be inducted under the proposed contract. Boeing realized that it would no longer be profitable for them to maintain the agreement with Pemco and terminated it. The decision left Pemco with no option but to compete against their former partner; but it was late in the process and they were unprepared to submit a proposal. Pemco requested, and the USAF granted, a proposal due date extension to allow them time to find a new partner and prepare a competitive proposal. Ultimately, Boeing, Pemco, and a third contractor submitted proposals. Despite Pemco's acknowledged superior past performance, the USAF awarded the new contract to Boeing. The primary reason for the selection was that Boeing's proposed price was substantially less than Pemco's (about $15M less on a total program value of about $1.2B).

The loss devastated Pemco, a small business, which had little other work to replace the KC-135 PDM workload. The company alleged that Boeing had used their proprietary pricing information obtained when they planned to submit a proposal as a team. A series of protests were filed by Pemco at the GAO. The first resulted in USAF corrective action—completing a price realism and proposal risk analysis of the Boeing offer. A second protest was denied and Boeing's contract was permitted to continue.[245] For a short period, Pemco, then called Alabama Aircraft Industries (AAI), continued to perform some KC-135 PDM as a subcontractor to Boeing under the new contract, but they reportedly lost money performing this work. In February 2011, AAI filed for

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243 "Programmed Depot Maintenance Capacity Assessment Tool: Workloads, Capacity, and Availability," Loredo, Elvira N., et. al., RAND Project Air Force, 2007.
244 "Pemco to Team with Boeing for KC-135 PDM Re-Competition," Business Wire, June 13, 2005.
245 "Decision in the Matter of Pemco Aeroplex, Inc.;" File B-310372.3; Comptroller General of the United States; June 13, 2008.

bankruptcy and several months later closed their hangar operations in Birmingham, AL. Open contracts were acquired by Kaiser Aircraft.

Conclusions

The USAF later announced that beginning in 2014, all KC-135 PDM will be performed organically at Tinker AFB, ending over 45 years of contractor performed depot maintenance.[246] The decision was no doubt influenced by the declining number of aircraft in the USAF inventory and the need to comply with the workload requirements of 10 USC 2466 (50/50).

This case demonstrates how changing the scope of work of an existing contract can disrupt long-term incumbent competitive advantages. The consolidation of dissimilar work, as was done by the USAF in this case, is certainly not recommended because it may overly restrict the competitive field. The case also highlights how fiercely competitive very large maintenance contracts can be and suggests risks that contractors undertake when they agree to work in partnership with their competitors.

[246] "KC-46 Program Update;" Briefing presented by Major General John Thompson, Air Program Executive Officer for Tankers, to National Defense Industrial Association Luncheon, Dayton OH, March 4, 2014.

CASE STUDY – USN F-14D NAVIGATION GUIDANCE SYSTEM (NGS) REPLACEMENT

The Naval Inventory Control Point (NAVICP) Navigation Guidance System (NGS) PBL team awarded an innovative $4.9M, performance-based, best value contract to Marconi Astronics Corporation for the acquisition and life cycle logistics support of an advanced fiber optic NGS.

This new production system was acquired through full and open competition to replace the sole source navigation system previously flown on F-14D and T-45A aircraft. In addition, the Marconi contract was structured to allow for mission growth of the new system into other aircraft platforms, as well as use by other DOD services and FMS customers.

The NGS team developed this competitive acquisition strategy after identifying the existing sole source F-14D and T-45A navigation system as a poor performing system that utilized outdated technology, had high support costs, and experienced low reliability (an average mean time between failure (MTBF) of only 200 hours). The team recognized that it needed an affordable replacement system that incorporated state-of-the-art commercial fiber optic technology.

The team developed a performance specification for a form, fit, and function plug-in replacement to the old navigation system, creating a competitive situation whereby the full range of private sector technical solutions could be offered. In addition, the team maximized its competitive leverage by including PBL life cycle support as one of the source selection evaluation factors. The team felt it was imperative to ensure supportability costs and concerns were addressed during the competitive acquisition process, as opposed to after selection of the successful offeror.

The end result was a contract for a high quality, highly reliable, operationally superior system that utilizes the latest commercial non-developmental technology. In addition, the contract's PBL clauses require the contractor to provide logistics support, while maintaining contractor responsibility for introducing innovations and efficiencies that help to further reduce total LCC.

The primary PBL metrics incorporated into the contract were reliability and availability guarantees. The reliability guarantee required the contractor to maintain an average system MTBF of 11,200 hours throughout the system's life cycle. The availability guarantee required the contractor to ensure that, upon receipt of a customer electronic requisition, the fleet user will receive a replacement system at a CONUS site within two business days.

In order to ensure success of this PBL program and provide an incentive for the contractor to meet the performance metrics, a "loaner spares" provision was also included. In the event the contractor does not meet the performance metrics, it must provide temporary loaner spares at no cost to the government, thus ensuring continued operational readiness.

Of special note is that the USN neither buys nor holds any wholesale inventory. Responsibility rests completely with the contractor to determine and stock the levels of inventory it must maintain in order to meet the contract availability requirement. In addition, the contractor is responsible for repairing or replacing all failures for 15 years (at no additional charge) and has complete obsolescence management responsibility. These features provide a built-in incentive for technology insertion. The USN expects to realize a ten-year cost savings of $23.6M as a result of this effort.[247]

[247] "Applying Performance Based Acquisition and Logistics to Navigation Guidance Systems;" ASN(RD&A), One Source, Best Practices and Lessons Learned; undated.

6. Competition Decision Framework

IMPLEMENTING COMPETITION

"On an important decision one rarely has 100% of the information needed for a good decision no matter how much one spends or how long one waits. And, if one waits too long, he has a different problem and has to start all over. This is the terrible dilemma of the hesitant decision maker."[248]

Robert K. Greenleaf

[248] Servant as Leader, Greenleaf, Robert K., Robert K. Greenleaf Center, 1982.

EVALUATION OF COMPETITION

A major challenge for PMs at program inception, and then at each milestone review, is to evaluate all relevant competitive opportunities that may be presented. This chapter details an approach to evaluate the competitive state of the immediate market to identify opportunities, evaluate competitive strategies using a cost benefit analysis, and finally document the full process.

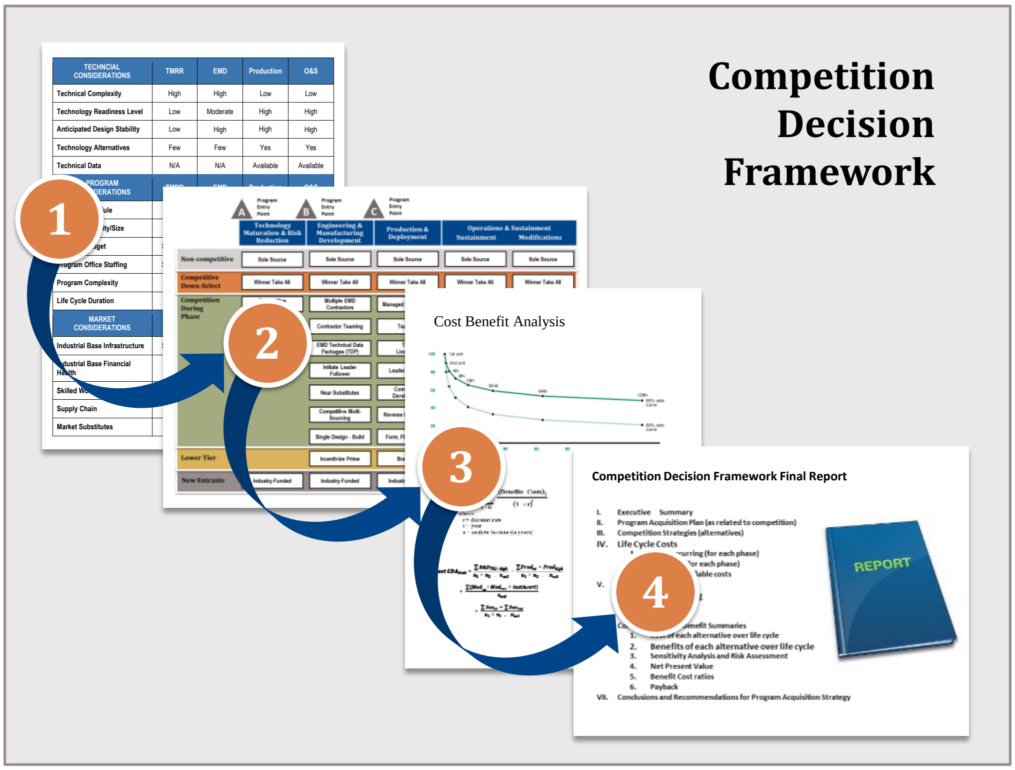

Figure 10 Competition Decision Framework

Competition Decision Framework

The CDF is a tool to evaluate the quantitative and qualitative costs and benefits of different competition strategies across the life cycle of an acquisition program. At the top level, it is not a detailed analytical spreadsheet or simulation type model. Rather, it is a method that program office management can use to evaluate key program areas which will guide development of competition strategies. The program office determines the appropriate level of analysis (from top level rough-order-of-magnitude (ROM) estimates to detailed cost models) needed to develop and analyze their competition strategy and acquisition program plan. This guide's bibliography contains multiple, in-depth references that cover all areas of analysis to support the CDF.

The CDF includes four steps which are depicted in Figure 10. First, assess the technical, programmatic, and market considerations to determine whether a competitive strategy is feasible. Second, determine the most appropriate competition strategy for the program's life cycle. Third, complete a CBA to determine whether any added costs necessary to implement competition are greater or less than the estimated value of the benefits. Finally, document the results of steps 1-3. This documentation forms the basis for the competition decision.

When taking a top-level view of the CDF, there are several things that should always be considered[249]

- Evaluate the utility of competition at each phase either at the program, major subsystem, or lower-tier levels.
- Pay close attention to the industrial base and how continued consolidation of the defense industry may impact the program. Within the law, consider global markets to expand the industrial base solution set.
- Allow all potential competitors to participate in the acquisition process. The more the competitors know about the government's requirements and program needs, the better industry proposals will be. The program office must inform and educate competitors on when, where, and how to compete successfully.
- Encourage and support contractor investments in DOD-related research for systems acquisition and O&S.
- Support the SBIR program. This area of producer investment is a critical portion of the DOD program office's efforts to develop new suppliers and technologies.
- Within the law, be open to competition opportunities between the government and private industry.

[249] "Competition in Defense Acquisitions", Gansler, Lucyshyn, and Arendt. Center for Public Policy and Private Enterprise, School of Public Policy, University of Maryland. February 2009.

COMPETITION DECISION CONSIDERATIONS

Develop the CDF in detail for the first decision on entering the acquisition system and then review and update it, as needed, at later milestones or other major program decision points. Step one of the CDF is to evaluate technical, programmatic, and market considerations to determine if conditions are favorable for competition. This step essentially takes a "snapshot" of the program environment and evaluates it from a competitive viewpoint. The evaluation identifies elements that support program competition and potential roadblocks or impediments, thus providing the program office with an opportunity to alleviate or mitigate these competition obstacles.

Overview of Considerations

Step one of the CDF is represented in Table 9. The purpose is to assist the program office in conducting a preliminary screen of the program at each phase, looking at the key considerations (elements) that may support continued competition in that and future phases. The rows of the table are essentially a "checklist" version of the various competition elements and each column represents a phase of the system's life cycle. The cells contain subjective descriptors of when the use of competition is favorable for that element within that program phase.

To begin, the program office staff should compare their program to the descriptors shown in each cell. If their program description matches what is shown in the cell, that element is rated "Favorable." This indicates either the environment supports the use of competition or competition will be beneficial in overcoming or mitigating a related risk. If their program description does not match what is shown in the cell, the element is rated "Unfavorable," which indicates lack of support for competition in that phase. After evaluating and rating each element for each phase, the staff should then take a broad look at the ratings to determine whether or not to invest in competition.

The value of this model is the program office can set the level of detail needed to evaluate each cell. This allows the team to perform an initial, quick evaluation to see if competition is even feasible and then repeat the process with more detailed analysis and research, if required.

The program office is expected to complete a detailed, documented analysis and evaluation of each of the three major areas—technical, program, and market considerations. Each program is different and therefore each analysis will be different. At a minimum, the program office must research, collect, and evaluate sufficient qualitative and quantitative data to make an informed decision on each cell of the matrix.

The actual rating for each element is a somewhat subjective program office decision. While this guide only discusses a simple favorable-unfavorable approach, other approaches are possible using numerical scales, color coding, or other adjectival ratings. Be forewarned; more complex, numerical approaches also require a more detailed model supported by a repeatable process, weighted elements, and other quantitative techniques that may be difficult to validate.

As an example, looking at technical complexity in the table, competition is considered favorable in TMRR if the technical complexity is judged to be high. However, during the production phase, competition is only favorable if technical complexity is rated as low. If the program under consideration is deemed technically complex, it would be rated as unfavorable for competition during the production phase.

Table 9 Favorable Conditions for Competition during Life Cycle Phases

TECHNCIAL CONSIDERATIONS	TMRR	EMD	Production	O&S
Technology Complexity	High	High	Low	Low
Technology Readiness Level	Low	Moderate	High	High
Anticipated Design Stability	Low	High	High	High
Technology Alternatives	Few	Few	Yes	Yes
Technical Data	N/A	N/A	Available	Available
PROGRAM CONSIDERATIONS	**TMRR**	**EMD**	**Production**	**O&S**
Program Schedule	Short	Long	Long	Long
Program Quantity/Size	Large	Large	Large	Large
Program Budget	Sufficient	Sufficient	Constrained	Constrained
Program Office Staffing	Sufficient	Sufficient	Sufficient	Sufficient
Program Complexity	High	Moderate	Low	Low
Life Cycle Duration	Long	Long	Long	Long
MARKET CONSIDERATIONS	**TMRR**	**EMD**	**Production**	**O&S**
Industrial Base Infrastructure	Sufficient	Sufficient	Sufficient	Sufficient
Industrial Base Financial Health	Good	Good	Good	Good
Skilled Workforce	Available	Available	Available	Available
Supply Chain	N/A	Good	Good	Good
Market Substitutes	No	Yes	Yes	Yes

Technical Considerations

The technical consideration portion of the model looks at five key technical areas: complexity, readiness level, design stability, alternatives, and data availability. All five of these elements combine to define the program's technical risk at each of the life cycle phases.

As a PM considers competition, he or she must analyze technical considerations at each phase. The purpose of early acquisition phases is to reduce technical risk. So it is sensible to engage multiple contractors in performing TMRR efforts because having multiple contractors focused on these efforts increases the probability of success within the time period planned for the early phases. The presence of competition also creates an increased incentive for the contractors to innovate and find alternative solutions. This competition forces competitors to fine tune their designs using their unique research and human capital.

In later phases, the program office wants to avoid engineering technical risk as final designs are competed for production. At this point, competition should be focused on production approaches and reducing unit cost, not continued system and technology development. By the O&S phase, there should be little to no competition focus in regard to technical risk—rather competition should be focused on normal sustainment efforts.

Technology Complexity

A program that has many high technology components and subsystems will be difficult to compete since the developer/producer is likely the only provider that has the technology and detailed knowledge. Competing firms will require similar, high levels of in-house engineering and manufacturing capability to replicate this technology. If the government requires the same level of technology or manufacture as the primary developer/producer, it is unlikely sufficient competition will exist without extensive investment in technology transfer, infrastructure investment, and/or training. A less expensive approach is for firms to form teams to provide high technology solutions with an eye toward future competition. Competition is always preferred to lower risk. To reduce technical risk, the program office should definitely favor competition in cases where technical complexity is high during TMRR and EMD phases.

Establishing a second source for a high or new technology system can be quite expensive. The second source may have significant start-up costs for infrastructure, tooling, and new, highly trained personnel. It is also unlikely that the second source will be able to deliver products with a lower recurring cost. Start-up issues can also cause schedule delays that make early unit costs significantly higher. The initial units will cost more than the incumbent's due to learning curve effects of low unit numbers. Unless the second source has a more cost-effective technical solution or production approach, it is difficult—without government investment support—to become competitive on a high technology product.

In the worst case, there may be no sources that produce or use this type of technology. Mentoring and supporting a new company to develop and educate themselves on a new technology can be very expensive and is normally not worthwhile unless developing long-term competition or expanding industrial capacity is the goal. If, by the time the program reaches production, the system is still highly complex, competition may not be the best approach due to the high costs of establishing and supporting a second source.

Technology Readiness Level

Technology maturity, or technology readiness level (TRL), changes as the program moves through its phases. For new programs employing new technologies, the TRL of targeted technologies is low. The risks associated with advancing technology to higher readiness levels are likely greater and, therefore, it will be beneficial to have more than one contractor competing to solve the problem. Later, as the program nears production, high TRLs are desired, representing a low risk for production and allowing multiple sources, other than the original developer, to compete.

For reasons similar to those for technology complexity, the program should definitely favor competition early in the life cycle (TMRR and EMD) to encourage multiple design approaches that will mature key technologies. By production, technologies need to be mature (high TRL) in order to support competition in production and O&S.

Anticipated Design Stability

If the product's design is likely to change frequently (low stability), especially during subsequent life cycle phases, it may be beneficial to have more than one contractor available to propose and execute design changes. Every design change drives a potential need to adjust (upward or downward) the contract price to reflect the impacts of the change. This makes competition highly favorable during TMRR if design stability is low.

The presence of competition creates a powerful incentive for contractors to minimize the cost of changes. Absent competition, a sole source contractor could use design changes as an opportunity to increase the contract price to make up for any losses associated with bidding low to capture the original contract. Highly stable designs offer fewer requirements to negotiate changes to the contract and therefore, fewer opportunities for a sole source to "get well" through contract changes.

If significant system changes and redevelopment are planned, it is often an excellent time to implement competition. This can be done through a WTA or leader-follower approach. Depending on the change, there may be an opportunity to compete the changed subsystems and the subsystem modification. When major system changes are anticipated, it is unwise to execute an early system buy-out which will eliminate the opportunity for competition.

Competition works best when design stability is high beginning with EMD and continuing throughout the life cycle. If the design is unstable, a second source will be highly dependent on continuing technical support from the lead contractor. If the design is changing due to evolving mission requirements and each source has their own design, the cost of changes is doubled due to continuing development.

Technology Alternatives

When there are no, or few, existing technology alternatives available during the early program phases, engaging competing contractors to perform the required efforts can potentially generate substitutes. Alternative technologies and products can possibly create direct or indirect competitive pressures during later phases of the program. If many potential technical substitutes already exist, indirect competitive pressures can be used, even if only one source performs TMRR efforts. Where there are viable technical substitutes, it is feasible that adequate competition will be present for the EMD phase, even if only one contractor participates in TMRR efforts. By production, technology alternatives may permit new competitors if the system requirements are relatively broad enough. Thus, competition should be considered and encouraged during TMRR and EMD if there are few alternatives. By production and O&S, competition is most favorable when multiple technology alternatives can be leveraged.

Technical Data Availability

In most complex DOD systems, it is impossible to compete the production of an existing system without full data rights from the original developer/manufacturer that can be received as technical data in a timely fashion. Technical data availability is the single most important enabler of competition in later phases. At each phase, a decision must be made about the level of detail required in the TDP and how much budget to invest. Most well informed suppliers know the best barrier to competition is to *not* sell or provide a detailed TDP to the government. From the very start, the PM must decide: 1) whether to buy full technical data rights, and 2) how to maintain the currency of the data across multiple phases as the program approaches production and sustainment. The data must be acquired prior to the desired competitive program phase and validated to ensure it is sufficient to support competition in whatever form is chosen. TDPs are not needed during TMRR since the PM is still researching multiple technical and design approaches; so acquiring data has no effect on competition. TDPs are usually acquired during the EMD phase. TDP is not a major issue going into EMD, but it is a significant exit issue that has a major impact on production competition. TDPs are essential during production and O&S and must be available to support competition.

Production and development program costs are often difficult to accurately estimate, but the PM can normally determine a reasonable expected cost. Data rights costs, on the other hand, are a totally different concept. The price of data rights does not equate to a set amount of materials, direct and indirect labor, and/or overhead and profit. Many PMs mistakenly believe the cost of technical data is just the cost of the engineering design work and reproduction. This couldn't be further from the truth. Rather, a PM is requesting that the company sell detailed manufacturing data that will allow someone else to build their product and potentially deny them the revenue and business opportunities that accompany those future sales. From a company viewpoint, a full data set means they are potentially giving up the total revenue stream from several years' worth of production. Thus, a company may price the data as the present value of the total revenue stream it expects to lose. Obviously, this may make the cost of competition prohibitive. At a minimum, a company will want the present value of the lost profit stream, including the potential production, spare parts, overhaul, modification, and other sustainment opportunities.

The cost of purchasing technical data is also very dependent on which party funded the associated technology and product development. If the government bore the full development costs, it is generally entitled to obtain unlimited rights to use, and permit others to use, the data. In this case, the costs beyond actual development should be limited to the cost to produce the data. On the other hand, if the contractor fully or partially funded product development, the government may have to agree to an on-going licensing cost to use the data—if rights can be obtained at all. Refer to Chapter 2 for more information regarding planning for and managing IP rights.

Program Considerations

Program considerations primarily focus on those elements that drive program cost and resources, which combined, form key elements of the CBA.

Program Schedule

During TMRR, short schedules support competition with multiple winners due to lower program costs and the ability to consider a larger group of technologies and design approaches. Competition during TMRR when the schedule is aggressive provides strong incentives for firms to deliver on time to remain viable for further program participation. Starting with EMD, longer schedules mean a smaller number of firms can perform government or privately funded development work in order to become qualified for production. Long schedules also equate to stable revenue streams that entice more competitors.

It often takes years of preparation and technical data transfer to get a second source ready to effectively compete for production. This usually means multiple firms participated in TMRR and EMD or were established as second sources prior to production. The more time the PM has available prior to the start of production; the more competition options are available. Thus, longer program schedules for EMD, production, and O&S are favorable for competition.

Program Quantity & Size

Bigger is always better in terms of production quantity as it provides more opportunities to allocate infrastructure and other non-recurring investment costs over the production run and enables savings as the units advance on the progress curve. Large quantities also attract more competition as they potentially provide more revenue and profit to the winners. Thus, larger quantity programs are more favorable for competition during all phases.

Program Budget

Program funding and funding stability are critical elements for successful competition. Funding instability can create significant challenges for implementing and sustaining competition. Programs must invest a significant amount to carry two or more competitors from early development through production. This early investment will normally exceed the budget for a sole source or early WTA strategy. Any interruption in the budget will signal to industry that they can't count on a long-term production run to recoup their in-house investments. The program must have a sufficient budget to support competition during the TMRR and EMD phases.

Constrained funding will force program offices to discontinue competition efforts, on-going dual-development programs, or other competitive productions efforts. Short-term, myopic program views often cause leadership or Congress to cut the budget to obtain current savings at the expense of significant life cycle savings that completion may have delivered. If the program office can take a long-term view for the competition decision, constrained budgets provide a favorable condition for competition strategies to lower production and O&S costs in order to live within tight budgets.

Program Office Staffing

One of the often overlooked elements of a successful competition program is the availability of sufficient and trained personnel. A major competition may be the equivalent of running two full programs at the same time. Evaluating, planning, and then executing competition on a major program requires a relatively large and well trained program staff. While potential competition savings on a large program may dwarf the cost of additional program staff, there is normally no direct funding connection between future savings and the immediate budget for the PM's staff. The staff required to manage and oversee two or more major technology demonstration or development programs is significantly greater than that required to manage a single contractor. The PM must carefully evaluate his staffing needs before undertaking a significant competition effort. Robust competition requires skilled professionals in the contracting and legal fields, so advanced manpower planning must be completed and funded prior to starting any major competitive efforts.

Compared to a WTA competition, any type of dual sourcing or multiple awards places additional demands on program office staff:

- Technology transfer issues must be resolved on a legal, contractual, and management level. These negotiations are often schedule- and manpower-intensive.
- With multiple producers, oversight and quality control must be provided to two or more programs.
- Multiple awards will likely double the contractual actions required.

Sufficient program office staffing is required during all program phases if competition is to be pursued.

Program Complexity

Many issues can drive program complexity including:

- Multiple customers, such as joint and international programs
- Management processes requiring special monitoring or reporting
- Specialized facilities or equipment
- High degree of subcontracting
- Supply chain restrictions
- High-level security requirements
- Special quality control requirements
- Public-private partnering

As complexity increases, the number of qualified suppliers will often decrease—eventually to the point where only one source is capable of performing the work. Large, complex programs benefit greatly from competition during the TMRR phase, and to some degree during EMD, as it forces the competitors to reduce their risk and costs if they want to continue. By production and O&S, this same high complexity makes it difficult and expensive to maintain competition between multiple sources without significant government investment. Programs with low complexity are more favorable for production and O&S competition.

Program Life Cycle Duration

As with a larger production quantity, a long program life cycle offers more opportunities to accrue cost savings that can offset added costs attributable to implementing competition. A program with a longer life cycle may also create greater industry interest (thus increased competition) which can potentially be leveraged during TMRR or EMD to obtain greater technical data rights, thereby enabling increased competition during the sustainment phase. Savings from competitive sustainment efforts over the life cycle of a system that remains in active use for decades can provide greater economic support for up-front investments required to implement competition during the TMRR phase. A long life cycle is favorable for competition during all phases.

Market Considerations

At the top level, a PM must determine if there are sufficient qualified and willing competitors for their program to support a competition. If not, the PM must decide if future savings justify the expense to create it. A typical PM lacks the resources or authority to make major decisions about the health and adequacy of DOD industries, but he or she does need to assess industry's capability and financial health as it relates to the program. During periods of shrinking budgets, there is not much a PM can do to prevent losing firms from leaving the market. Senior leadership can direct DOD-level strategies that limit reduction in procurement quantities to maintain some level of development or production competition. DOD-level strategies can also direct an approach which hedges the production of a highly capable system with a high technology operational advantage against a current or near-term threat, forming a basis to build out larger production runs, if necessary, while preserving critical industrial base human, manufacturing, and technical capabilities.

The measure of the industrial base focuses solely on whether there are enough producers to compete for the appropriate phase. In TMRR, the program office will want multiple sources to investigate new technology and approaches to designing and building the new weapon system. By production, or even by EMD, the number of sources may be smaller. O&S has very different requirements which are often found in the commercial market, so a much larger number of sources may be available to compete.

Industrial Base Infrastructure

Competition in all acquisition phases requires sufficient industrial base infrastructure and resources. PMs must evaluate the market capacity at the prime and major subsystems levels. The first concern is whether the industry has the capacity and or capability to produce the systems in quantities to meet the desired schedule. Depending on the system, this may require minor facility upgrades or multi-billion dollar investments (such as developing a new shipyard). Such large investments become competition limiting as the industry shrinks to one or two facilities with the capacity to produce the system. For large, complicated systems, the PM will have limited resources to establish new industrial capacity. PMs should consider strategies that can leverage commercial facilities and industries. Single or limited sources also restrict the ability to ramp up production in times of war or conflict. Finally, with limited industrial capacity, the DOD is at risk of disruptions from any actions (e.g., terrorist attacks, labor union activities, and acts of God) that can impact plant sites.

Industrial Base Financial Health

The PM must consider financial information when evaluating competitive strategies that require significant competitor financing or investment.

When evaluating competitors, the PM must ensure there are a sufficient number of competitors with the financial resources to invest, bid, and then execute their proposals. This is a key element required in all acquisition phases for potential competitors. The financial viability of the defense industry is essential to executing successful competitive acquisition strategies. The financial health of prospective firms should be evaluated using ratios, trends, and other analyses of:

- Solvency (Z-score trend, quick assets/total assets ratio, etc.)
- Profitability (net profit margin, interest coverage ratio, return on assets, etc.)

- Operating performance (total asset turnover, inventory turnover, growth, etc.)

In the early 1990s, the Naval Center for Cost Analysis (NCCA) conducted a financial health analysis of every major Department of Navy (DON) contractor.[250] This analysis was performed in response to the USN Comptroller's demand for a financial health indicator in support of DON acquisition program milestone decisions. Analysis was conducted for each of the major firms in six industry segments, including: automated data processing (ADP), aircraft, electronics, missiles, ships, and space. A notable output was the Z-score, a measure of overall firm health computed using an NCCA-developed, Z-score model geared specifically to the defense industry.

Skilled Workforce

A skilled workforce is one of the most important elements needed to make a company competitive. As the industry continues to consolidate, many of the senior, skilled workers may be laid off or retired. To be competitive, the firms must attract a skilled, motivated, diverse, and engaged workforce to ensure they have a pipeline of talent to meet ongoing business requirements for future competitive opportunities. With the post-2010 industry recession, DOD producers saw their revenue drop, programs cut or eliminated, and much of their workforce disappear. This also caused issues in attracting new talent to the industry.

The program office should examine the potential competitors to determine if they have sufficient workforce capacity to meet program requirements for the upcoming phase. This includes an evaluation of their ability to hire or transfer new employees onto the weapon system project. Knowing whether a sufficient, skilled workforce exists (or can be developed) is a requirement for competition in all acquisition phases.

Supply Chain

Competition does not end at the prime contractor; rather most competition occurs in the supply chain with subcontractors and service providers. Just like at the prime level, a robust suppliers' market allows for rigorous competition and program LCC savings. The prime competitors must have the capability and resources to establish long-term relationships with required suppliers. Supply chain is not essential for TMRR competition, but becomes essential once programs move into EMD and beyond.

Market Substitutes

During TMRR, the program office is attempting to develop new sources, so market substitutes are not a major issue for competition at this phase. However, the availability of substitutes enables competition in the later phases.

As mentioned earlier, competitive market theory assumes that all products are perfect substitutes and thus a guaranteed pool of acceptable competitor designs exists. In

[250] Dagel, H.W. and Pepper, R., "A Financial Distress Model for DOD Hardware Contractors," Journal of Parametrics, Volume X Number 1, February 1990.

reality, there are few substitutes for and relatively few producers of military equipment and systems. Few substitutes exist in this market because it is driven to produce the best possible systems, resulting in very detailed and rigorous weapon system requirements. This necessity may exclude potential substitute technologies and approaches. PMs can significantly increase competition and lower cost if they can gain support from the requirements and user communities to broaden acceptable system candidates. This allows more of the existing providers to compete and opens the door for outside producers to enter the DOD market.

COMPETITION DECISION STRATEGIES

Once the competition environment analysis is complete and it indicates that competition is possible, the second step of the CDF is to consider what strategies to pursue. Chapters 2 through 5 provide detailed discussions of typical strategies used in DOD programs. Figure 11 summarizes those strategies across the weapon system's life cycle. Each phase has its own unique strengths, weakness, and risks that must be evaluated based on the program being pursued. Program staff should develop a strategic plan for the entire life cycle, while also considering options or off-ramps at various program milestones or major decision points.

	A Program Entry Point	B Program Entry Point	C Program Entry Point		
	Technology Maturation & Risk Reduction	**Engineering & Manufacturing Development**	**Production & Deployment**	**Operations & Sustainment: Sustainment**	**Operations & Sustainment: Modifications**
Non-competitive	Sole Source	Sole Source	Sole Source	Sole Source	Sole Source
Competitive Down-Select	Winner Take All	Winner Take All	Winner Take All	Winner Take All	Winner Take All
Competition During Phase	Competitive Severable Tasks	Multiple EMD Contractors	Managed Competition	Competitive PSI	Performance-Based
	Competitive Similar Tasks	Contractor Teaming	Teaming	Competitive CLS	OSA Upgrades
	Competitive Prototypes	Acquire Technical Data Package (TDP)	TDP/ Licensing	TDP Spare Parts	TDP Enabled
		Initiate Leader Follower	Leader Follower	TDP Repair & Maintenance	Form, Fit, Function
		Near Substitutes	Commercial Development	Reverse Engineering	Substitution
		Competitive Multi-Sourcing	Reverse Engineering		Separate Production/Install
		Single Design - Build	Form, Fit, Function		Credible Threat
Lower Tier		Incentivize Prime	Breakout	Breakout	Breakout
New Entrants	Industry-Funded	Industry-Funded	Industry-Funded	Industry-Funded	Industry-Funded

Figure 11 Competitive Strategy Alternatives

COMPETITION DECISION COST BENEFIT ANALYSIS

Always consider competition because it offers the opportunity for better schedule performance, better technical solutions, support of the industrial base, and lower LCC. This section focuses on the life cycle costs and benefits of competition. Keep in mind, competition may not always be possible and lower total LCC. Despite investing significant schedule, budget, and political capital, a PM may still end up with a sole source provider for their weapon system.

The biggest challenge for PMs early in the life cycle is that competition usually increases costs during the TMRR and EMD phases in order to realize production and long-term O&S savings. Unfortunately, DOD decision processes are sometimes short-sighted, resulting in early program frugality at the expense of long-term savings. The PM must keep the total LCC in mind when developing competition strategies, despite the constant pressure to reduce budgets each year.

Before pursuing competition, the PM must understand the total costs in order to compare them against the expected savings and benefit streams. A thorough CBA can provide insight into potential cost and savings streams to determine if competition makes sense from an economic viewpoint.

For this CBA, the program office should look at all potential benefits, not just cost savings, to make a best value decision regarding the competition strategy. The program office must examine technical risk reduction, schedule risk, improved performance, and other non-cost-related benefits (and costs) of engaging in the competition.

Cost Benefit Analysis

From an economic perspective, the important question is whether competition will yield cost savings that are greater than the costs of implementing and executing the competition. Simply stated, will there be a positive ROI if the government pursues a given competition strategy? If it costs the government more to implement competition than any savings or other benefits achieved through that competition (i.e., there is a negative ROI), competition does not make economic sense. Competition may, in these cases, still be a smart strategy from a technical perspective because of risk reduction and innovation benefits. However, the PM is not likely to continue competition into follow-on phases of the program.

A program CBA must consider the cost and benefit impacts of all viable alternative strategies. There is a wealth of research that clearly demonstrates there is no simple or standard answer to the question of how much can be saved through competition.[251] The bottom line is that potential savings vary greatly depending on the type of technology, the nature of the market, the size of the program, the quantity produced, the production

[251] “A Review of the Literature: Competition Versus Sole-Source Procurements;” Washington, William N.; Acquisition Review Quarterly, Spring 1997.

rate, design stability, existence of proprietary data, general economic factors, and many other considerations.

In addition, the analysis should also consider ranges of possible outcomes rather than single point estimates. Given the somewhat speculative nature of such forward-looking analysis, it is also important to clearly document all relevant assumptions and conduct a sensitivity analysis to develop the range of values.

CBAs must also consider the time-value aspect of money. The standard criterion for deciding whether a government program is economically justified is *net present value* (NPV). NPV is the discounted monetized value of expected net benefits (i.e., benefits minus costs). NPV is computed by assigning monetary values to benefits and costs, discounting future benefits and costs using an appropriate discount rate, and subtracting the total discounted investment costs from the total discounted benefits. Discounting benefits and costs transforms gains and losses occurring in different time periods to a common unit of measurement.[252] Programs with positive NPV yield quantifiable benefits estimated to exceed the costs necessary to produce the benefits and are generally preferred. Programs with a negative NPV should generally be avoided.

The CBA should consider the following for all strategy alternatives:

- Life cycle costs across all phases
  - Non-Recurring
  - Recurring
  - Non-Quantifiable Costs
- Benefits
  - Non-Recurring
  - Recurring
  - Non-Quantifiable Benefits
- Comparative Analysis (as appropriate)
  - Costs of each alternative over life cycle
  - Benefits of each alternative over life cycle
  - Sensitivity Analysis and Risk Assessment
  - NPV
  - Benefit Cost ratios
  - Payback

[252] OMB Circular A-94, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs;" paragraph 5a, "Net Present Value and Related Outcome Measures;" October 29, 1992.

An excellent guide for performing CBAs is the US Army Cost Benefit Analysis Guide (Version 3.1, April 24, 2013) prepared by the Office of the Deputy Assistant Secretary of the Army (Cost and Economics).

Competition Costs

Non-recurring Costs

Non-recurring costs include those required to perform basic and advanced technology research, industrial base development, program office staffing, and acquisition of technical data. Several preliminary activities are required by a typical competitor to eventually qualify for a MS C production decision. Non-recurring costs also include the cost to qualify a second source for production. This includes the additional costs invested in order to get a second competitor ready to produce or maintain a weapon system. The theory is that competition created with a new second source will drive the recurring costs (production and or maintenance) to lower levels that will recoup the investment costs in a reasonable time period.

Qualifying a second source for production can be as simple as providing technical data or as complex as providing funding for a new manufacturing facility, hiring and training new employees, and qualifying the team (and its supply chain) for production. By far, these non-recurring costs are the largest cost in developing a second competitive production source.

If the competitive strategy requires significant, privately-funded, contractor investment, the approach will be unsuccessful if the contract length is insufficient to recoup these investment costs. Most companies will not pursue contracts that cause them to lose money. Companies must earn sufficient revenue and profit to gain a reasonable ROI. In addition, too-frequent competition signals to industry that innovation is not rewarded and will result in minimal innovation or investment. Competition will not be effective when the competitors analyze the acquisition strategy and determine they can achieve a better economic return by losing (such as in some leader-follower arrangements) or by leaving the market and pursuing other competitions. A lack of competitors should be a clear sign to the PM that their competitive strategy has failed, most often because the required non-recurring investment costs can't be recouped.

Most modern weapon systems are sufficiently complex and focused on a specific military mission such that there are no commercial applications. This usually means few customers outside of governments—and few producers as a result. If PMs want to maintain competition, they must pay for it by bringing on multiple sources that are carried as far into the program's acquisition process as possible.

Applied Technology Research

Applied technology research includes the additional cost of carrying multiple competitors through TMRR and EMD. Program technical risk can be reduced by having multiple companies researching new technologies and building prototypes.

Industrial Base Development

Industrial base development is the cost of fully preparing a second source to produce a competitive weapon system in a separate production facility. This involves infrastructure investments in land, building, and equipment and training personnel. The DOD rarely pays these costs as a direct expense.

DOD Program Office Costs

The PM must understand that competition may require significant investments. In cases where there is a robust market with multiple suppliers and buyers, competition is as simple as issuing an RFP as though purchasing commodities. This requires minimal preparation and upfront investment. For most weapon systems, this is not the case.

The PM must first consider the cost of acquiring and training the program management team that will develop the acquisition strategy, perform market research, run industry days, plan and execute the source selection, and finally manage the one or more eventually awarded programs. Insufficient personnel may be an impediment to implementing competition.

As mentioned earlier, dual sourcing large programs places a major work burden on the program office. Basically, the PM is running two or more programs at the same time. This means all activities are doubled, including contracting and legal actions, systems engineering, reviews, testing, budget execution, cost and schedule reporting, and source selection work. Managing multiple competitor contracts also creates proprietary data issues, the need for firewalls, and other additional work to prevent the release of competitive program data.

Technical Data Package Costs

A significant part of non-recurring costs is the TDP. As reiterated throughout this guide, failure to obtain the required TDPs can severely reduce future competition opportunities and significantly increase non-recurring costs.

OEMs usually do not, and will not, sell all technical data rights. They do not want the government, or anyone else, to have the ability to reproduce their systems or parts in an attempt to establish a second source for their product. OEMs will, for a price, provide technical data which allows for normal organizational and depot maintenance, but does not allow the DOD to reproduce any of the OEM or sub-OEM parts. The OEMs realize that a program's sustainment tail can produce more revenue than the initial procurement costs. Aggressively defending technical data rights effectively deters entry to their market by outside manufacturers or the government. When the OEMs do consider selling data rights, it is often only at a price that is more profitable than if they had produced the parts or performed the proprietary processes themselves.

Recurring Costs

The primary savings obtained through competition is a reduction in recurring costs incurred during the production and O&S phases. Recurring costs, in this case, are the costs of producing the systems (unit costs) and maintaining and modifying the systems once deployed. These savings can be attributed to better manufacturing processes, lower labor and material costs, improved design features directly related to lowering recurring costs, and improved maintenance and operational costs.

Savings result from simple competitive pressure which forces competitors to lower profit margins, reduce overhead allocations and labor rates, and invest in new production technologies in order to provide a lower competitive bid. In most cases, the producer with the lowest price wins a majority of the production, sustainment, and system upgrade contracts. Unless the potential competitors all have existing designs or data, along with active production facilities, significant start-up costs will be incurred prior to actual production.

In traditional competitive production models, PMs focus on learning curve theory to study and model reductions in manufacturing costs.[253] These are also sometimes referred to as progress curves, Boeing curves, or cost improvement curves. The theory is quite simple—improvement occurs because, as a process is repeated, workers tend to become physically and mentally more adept at the work. Improvements in unit cost can also come from plant investment, worker education, design changes, plant layout optimization, and supply chain improvements. The theory assumes that most producers desire to reduce costs if only to increase profit margin. With the addition of outside competition, the producers must find actual ways to reduce costs even more which results in a shift or rotation of the learning curve.

In observing production data (e.g., manufacturing labor hours), early analysts noted that labor hours per unit decreased over time. This observation led to the formulation of the learning curve equation $Y = AX^b$ and the concept of a constant learning curve slope (b) that captures the change in Y given a change in X. Note that b = log (slope) /log (2).

[253] GAO Cost Estimating and Assessment Guide, Chapter 11, March 2009 GAO-09-3SP.

The unit theory is defined below:

> As the quantity of units produced doubles, the cost to produce a unit decreases by a constant percentage. This relationship can be defined by the equation:

$$Y_x = A\,x^b$$

Where: Y_x = the cost of unit x (dependent variable)

A = the theoretical cost of unit 1 (also T_1 or Y_1)

x = the unit number (independent variable)

b = a constant representing the slope (Slope = 2^b)

(Note: The cost of a unit can be expressed in dollars, labor hours, or other units of measurement.)

The unit formulation states that "as the number of units double, the cost per unit decreases by a constant percent." In other words, every time the total quantity doubles, the cost decreases by some fixed percentage. This relationship is shown in the graph of two different production streams at different rates of improvement (Figure 12).

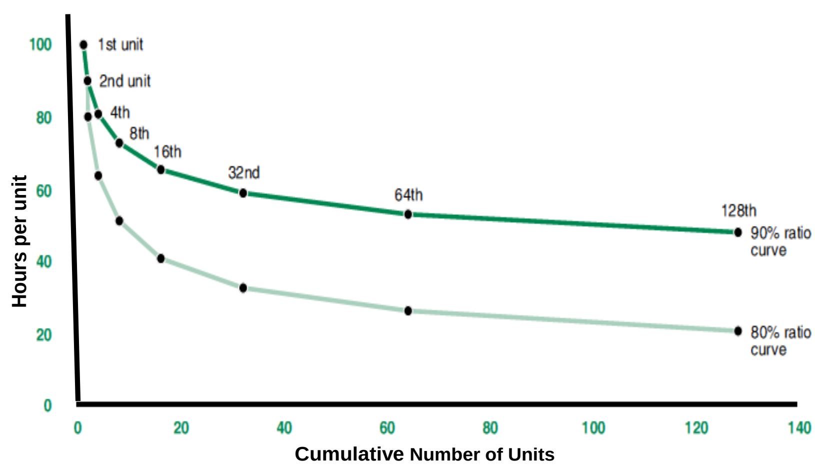

Figure 12 Typical Production Learning Curves

What does this mean to a PM? On most programs, production costs on a per unit basis drop as more units are produced, i.e., with each additional unit ordered, the cost per unit drops. Note that as more total units are produced, the additional savings become less and the curve eventually flattens out. If a PM brings on a second source and splits the buy between two producers; the competition must realize savings sufficient enough to overcome the fact that two producers will not get to the same place on the cost improvement curve as quickly as a single producer.

If both suppliers maintain the same curve, then each provider only moves halfway down the curve (each produces half of the total units) and thus <u>the total cost to the PM</u>

may be higher than if the system was procured from a single source. A PM hopes for the situation in Figure 13. In this case, a second source is brought on to build the identical unit as the first source. In theory, the competition will cause the first source to reduce their costs significantly and steepen their learning curve for future production. Because of competition, the second source will also produce on a curve that is better than the original program learning curve— and in the best case, this equals the new curve of the original supplier.

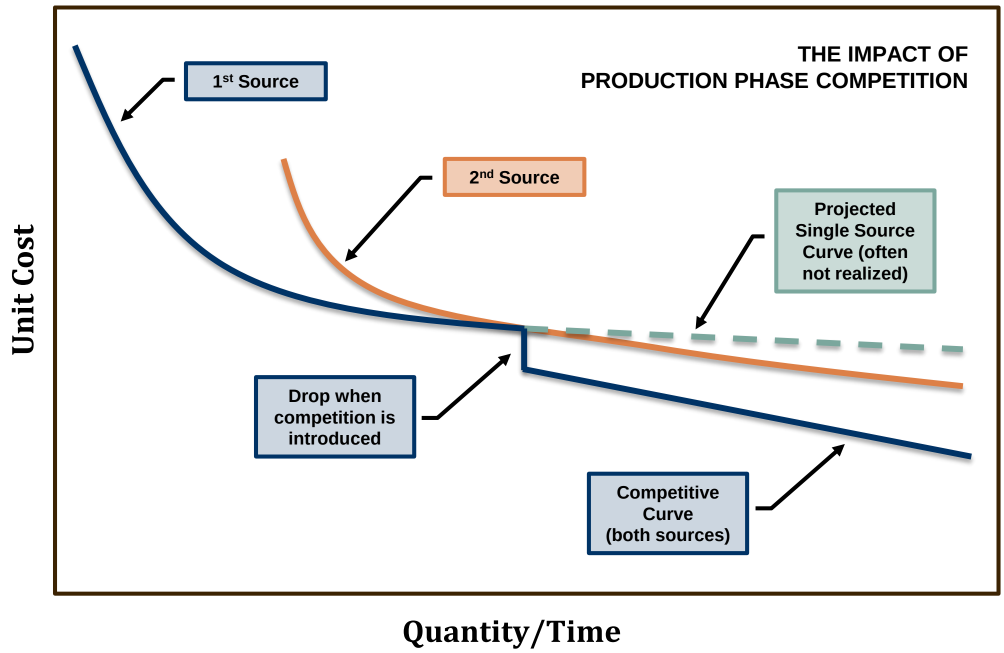

Figure 13 Impact of Competition on Production Learning Curves

Here, the learning curve shifts downward (drop) and rotates (steepens). This competitive scenario often requires a major program office investment to bring on the second source (e.g., facility costs, training, early production higher prices, data rights, etc.). In theory, this competitive threat will cause the incumbent to evaluate their current processes and make needed investments to lower their production labor costs, buy and use material more efficiently, and control (or reduce) overhead and indirect costs.

In addition to these direct improvements, other circumstances can cause different changes in the improvement curve:

- If the first source believes the new competitor is serious and willing to invest significant funds, the incumbent's price will drop significantly and the improvement curve will shift. If the competitor is not seen as a credible threat, there will be little change to the first source's improvement curve.
- Depending on when the competition occurs, the first source may be less willing to make major changes. Early competition may be risky if the program has significant technology and production issues—resulting in little

price change due to the risk. Late program competition after the learning curve has flattened, will result in little, if any, change.

- If the first source has already reduced costs to the minimum (already in the flat portion of the curve) early in production—little trade space is left for the new competitor to beat their pricing and recoup non-recurring start-up costs.
- If the first source is suffering major cost overruns, then applying competitive pressure may force them to deal with the cost problems (versus automatically passing the cost increases onto the government).
- If the first source had to make major capital and facility investments, it's unlikely the competitor can make the same investments and then produce at a lower cost to provide a significant ROI on the effort. The government may step in and fund the investment if there are significant issues other than cost driving the need for competition.
- If the initial learning curve is relatively steep and the program quantities are small, a second source will never produce sufficient quantity to catch up.
- If the first source is tied to its vendor base with long-term agreements and unique products or services, it may be difficult for a competitor to build a robust supply chain to enable it to reduce unit costs.

The basic challenge for the PM is to evaluate 1) if the total investment (by the government) can encourage/develop a competitor to compete against the first source; and 2) if the cost of the entire production buy is sufficient to offset the additional non-recurring development costs. PMs may achieve leverage over the first source by the threat of competition if the first source sees the threat as viable.

Operating and Support Costs

So far, this section has focused on the non-recurring and recurring costs associated with development and production; however, the largest program costs typically occur in the O&S phase. Once the weapon system is built, the competitive environment can totally change. Depending on the system, there are often multiple contractors who have the capability and resources to provide maintenance and sustainment for a military system or subsystem—especially if the system is a commercial derivative. This often provides the PM with opportunities to enhance warfighter support at reduced cost.

In both the DOD and commercial markets, customers often consider O&S costs in their evaluation of which product to purchase. For example, in selecting a new car to buy, a buyer may consider fuel efficiency, reliability, warranties, and average repair costs. Unlike the other phases, where almost all competition is between commercial firms, O&S decisions must also consider government sources. DOD regulations require specific analysis using a PS BCA process.[254] A PS BCA is a decision support document that identifies alternatives and presents business, economic, risk, and technical arguments for selecting an option to achieve organizational or functional missions and

[254] DoD Product Support Business Case Analysis Guide, 2011.

goals. At a minimum, PS BCAs must address LCC and key performance parameters such as system availability. The DOD is always interested in the best value solution which maximizes performance at the least cost—not necessarily just the lowest cost solution.

Non-Quantifiable Costs

Non-quantifiable are costs associated with alternative strategies that the program office may not be able to quantify or estimate. These costs should be considered as part of the top-level CBA. An example is improved military readiness resulting from maintenance schedule reductions stimulated by competitive pressures.

Competition Benefits

Competition benefits are the quantifiable and non-quantifiable benefits that are associated with each alternative. They range from unit cost savings in production to quality and performance improvements delivered to operational units. These benefits are considered as part of the top-level CBA. An example of quantifiable benefits was presented in the Great Engine War case study (Chapter 4). Dual sourcing of aircraft engines not only reduced prices, but dramatically improved cycle time between repairs, eliminated supply disruptions, and strengthened the jet engine industrial base.

Comparative Cost Benefit Analysis

In this part of the CBA process, costs are compared against the benefits to determine if the overall benefits exceed the costs. There are standard financial metrics that can be considered:

- Cost of each alternative over life cycle
- Benefits of each alternative over life cycle
- Sensitivity analysis and risk assessment
- Net present value
- Benefit-cost ratios
- Payback

In a typical CBA, there is an underlying assumption that all costs and benefits have been captured in the data which allows for a quantitative analysis and decision. The primary analysis focuses on whether the lifetime savings stream exceeds the investment costs, by how much, and in what time period. There are other significant, non-economic benefits involving operational performance metrics (lethality, reliability, availability, etc.) which may be more important than the common financial metrics discussed above. The analytical process must be broadly based and consider all relevant costs and benefits, including both qualified and quantified attributes.

COMPETITION ANALYSIS CASE STUDY EXAMPLE

This following is a short example of how this competitive approach can be used in a quantitative PS BCA. This example combines a modified version of the current USAF PS BCA approach using a weighted utility score (WUS) methodology and the competition modeling approach presented in this guide.

A BCA is a structured methodology and document that aids decision making by identifying and comparing alternatives by examining program mission and business impacts (both financial and non-financial), risks, and sensitivities. BCAs may be somewhat different from other decision support analyses because of the emphasis on stakeholder and decision maker's enterprise-wide perspective and the assessment of the decision's holistic impacts. In this case, the risk assessment will be supplemented with additional competition elements.

At its simplest, a sustainment BCA is a comparative analysis between several feasible and executable alternatives. Each alternative is evaluated based on an assessment of cost, benefit and risk. The cost estimate is just the LCC within a defined program life. The benefits are usually key performance metrics or assessments by subject matter experts and stakeholders. In a WUS approach, each of the three criteria (cost, benefit, risk) is determined, normalized, and weighted to allow for a combined quantitative score. It is not an exact science, but does provide one method to evaluate and rank order alternatives.[255]

The CDF approach should be used as follows:

- First, conduct a subjective assessment of all relevant competitive elements for all alternatives. This may be a relatively simple assessment that will allow the selection team to eliminate candidates while documenting the decision process.
- The next level of evaluation is a quantitative analysis using a WUS model.

Competitive Sustainment Case Study

For this example, assume there is an incumbent sustainment provider who was also the original developer and OEM. This OEM had been the sustainment provider for many years under a traditional, transactional approach through a sole source contract. Recent USAF and DOD policy encourages PMs to consider PBL and competition as a means of improving system performance and availability, while reducing sustainment cost.

The decision tree (Figure 14) shows a top-level decision to compete or sole source to the OEM or government. Since competition is desired, the right branch is not

[255] This is but one of many methods that can be used to evaluate alternatives in a BCA. Analysts should consider multiple approaches and crosschecks as part of any credible study.

considered. The left side of the decision tree includes competitive decision nodes for the PSI (contractor or government) and for all sub-elements other than the PSI.

The CDF enters this process since there was previously no competition or recent competitive analysis and a new services approach (PBL), that may or may not be feasible as part of a competitive strategy, is desired.

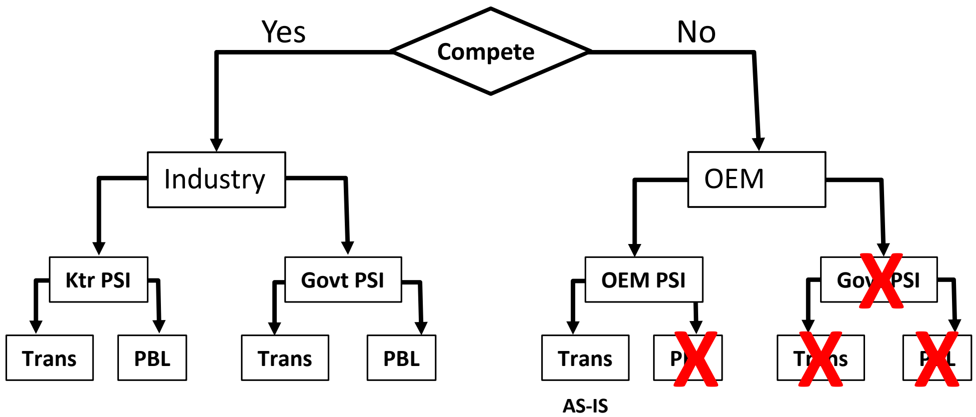

Figure 14 Competitive Alternatives

For this study, the government program office should evaluate all aspects of a competitive strategy as part of their initial strategy research.[256]

Step 1: Develop Draft Competitive Alternatives

For this exercise, there are four potential competitive strategies that will be compared against the status quo (OEM PSI transactional approach). Each strategy is developed at a sufficient level of detail to allow a subjective and objective evaluation.

Step 2: Develop Life Cycle Cost Estimate for Each Alternative

In step two, the standard program elements, as well as the non-recurring competitor costs for development, stand-up, facilitation, and personnel training and acquisition (and any other relevant costs) are estimated, along with learning curve effects.

Step 3: Develop a Technical Evaluation of the Alternative Description

Step three involves a detailed objective and subjective technical evaluation of the alternative approaches and expected output service metrics. A key challenge is developing the performance metrics and subjective evaluation of new competitors who may have minimal, relevant experience.

[256] Much of this is similar to the USAF PS BCA guidelines.

Step 4: Develop a Weighted Competitive Utility Score Model

The WUS model is the same approach as used in a PS BCA with the addition of competitive assessment criteria that are added to the risk evaluation. This requires:

- Adding the key competitive assessment items listed previously.
- Determining the relevant weights for those competitive items.
- Combining all into a final total assessment score.
- Carefully evaluating the final assessment score against the subjective evaluation and basic alternative data inputs.

The evaluation team members must understand that these quantitative results only provide a relative ranking and not absolute scores. A detailed example of this is shown in Table 10. In this case, four new competitive alternatives are compared against the As-Is OEM transactional approach. This detailed model includes the stakeholder evaluation data of risk and benefits, the actual LCC for each alternative, normalization of that data, weighting factors, and the final WUS calculations. Here, the OEM approach is evaluated as slightly better than the new competitive alternatives.

Table 10 Competitive Weighted Utility Score Approach

						Wt	Wtd	Wtd	Wtd	Wtd	Wtd	Wt					
Cost	Govt/Trans	Govt/PBL	KTR/TRANS	KTR/PBL	PSBCA		GPSI/Trans	GPSI/PBL	R/TRANS	KTR/PLB	PSBCA		GPSI/Trans	GPSI/PBL	KTR/TRANS	KTR/PLB	PSBCA
SW Mx	$ 33	$ 34	$ 53	$ 60	$ 50	n/a	$ 33	$ 34	$ 53	$ 60	$ 50						
Config Mgt	$ 138	$ 196	$ 124	$ 84	$ 80	n/a	$ 138	$ 196	$ 124	$ 84	$ 80						
DMS	$ 194	$ 202	$ 175	$ 195	$ 185	n/a	$ 194	$ 202	$ 175	$ 195	$ 185						
ETS	$ 35	$ 21	$ 32	$ 37	$ 35	n/a	$ 35	$ 21	$ 32	$ 37	$ 35						
Tech Refresh	$ 404	$ 311	$ 364	$ 368	$ 350	n/a	$ 404	$ 311	$ 364	$ 368	$ 350						
Wholesale Supply	$ 140	$ 140	$ 140	$ 140	$ 140	n/a	$ 140	$ 140	$ 140	$ 140	$ 140						
PSI/PSP	$ 51	$ 89	$ 51	$ 76	$ 80	n/a	$ 51	$ 89	$ 51	$ 76	$ 80						
HW Mx	$ 14	$ 17	$ 14	$ 14	$ 15	n/a	$ 14	$ 17	$ 14	$ 14	$ 15						
Total LCC	**$ 1,010**	**$ 1,011**	**$ 953**	**$ 974**	**$ 935**		**0.93**	**0.93**	**0.98**	**0.96**	**1.00**	42.9%	**0.397**	**0.397**	**0.421**	**0.411**	**0.429**
Benefits	GPSI/Trans	GPSI/PBL	KTR/TRANS	KTR/PLB	PSBCA	wt	PSI/Trans	GPSI/PBL	R/TRANS	KTR/PLB	PSBCA			GPSI/PBL	KTR/TRANS	KTR/PLB	PSBCA	Hybrid
PSE																	
SW Mx	0.542	0.583	0.500	0.667	0.917	*17.42%*	0.094	0.102	0.087	0.116	0.160		0.040	0.043	0.037	0.049	0.067
Config Mgt	0.417	0.583	0.500	0.708	0.958	*13.56%*	0.057	0.079	0.068	0.096	0.130		0.024	0.033	0.028	0.040	0.054
DMS	0.375	0.583	0.500	0.792	0.958	*12.42%*	0.047	0.072	0.062	0.098	0.119		0.020	0.030	0.026	0.041	0.050
ETS	0.542	0.583	0.750	0.875	0.917	*10.46%*	0.057	0.061	0.078	0.092	0.096		0.024	0.026	0.033	0.038	0.040
Tech Refresh	0.333	0.583	0.458	0.792	0.958	*9.44%*	0.031	0.055	0.043	0.075	0.090		0.013	0.023	0.018	0.031	0.038
Wholesale Supply	0.583	0.625	0.708	0.792	0.958	*7.90%*	0.046	0.049	0.056	0.063	0.076		0.019	0.021	0.023	0.026	0.032
PSI/PSP	0.542	0.583	0.625	0.875	1.000	*4.44%*	0.024	0.026	0.028	0.039	0.044		0.010	0.011	0.012	0.016	0.019
HW Mx	0.542	0.667	0.708	0.750	0.917	*4.34%*	0.024	0.029	0.031	0.033	0.040		0.010	0.012	0.013	0.014	0.017
Value Attributes																	
Minimize Depot Downtime	0.458	0.833	0.500	0.958	0.958	*5.00%*	0.023	0.042	0.025	0.048	0.048		0.010	0.017	0.010	0.020	0.020
Limit Simultaneous Configs	0.375	0.625	0.458	0.833	0.958	*5.00%*	0.019	0.031	0.023	0.042	0.048		0.008	0.013	0.010	0.017	0.020
Leverage Govt/Ktr Capabilities	0.542	0.792	0.667	0.792	0.958	*5.00%*	0.027	0.040	0.033	0.040	0.048		0.011	0.017	0.014	0.017	0.020
Reduce Mgmt Complexity	0.292	0.542	0.625	0.708	0.958	*5.00%*	0.015	0.027	0.031	0.035	0.048		0.006	0.011	0.013	0.015	0.020
	-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
Total Benefits	**0.462**	**0.632**	**0.583**	**0.795**	**0.951**	100.0%	**0.463**	**0.613**	**0.566**	**0.775**	**0.947**	*41.9%*	**0.194**	**0.257**	**0.237**	**0.325**	**0.397**
Risk	GPSI/Trans	GPSI/PBL	KTR/TRANS	KTR/PLB	PSBCA	wt	PSI/Trans	GPSI/PBL	R/TRANS	KTR/PLB	PSBCA	SI/Trans		GPSI/PBL	KTR/TRANS	KTR/PLB	PSBCA	Hybrid
PSE																	
SW Mx	0.250	0.333	0.417	0.500	1.000	*16.32%*	0.041	0.054	0.068	0.082	0.163		0.006	0.008	0.010	0.012	0.025
Config Mgt	0.417	0.583	0.500	0.667	1.000	*12.71%*	0.053	0.074	0.064	0.085	0.127		0.008	0.011	0.010	0.013	0.019
DMS	0.250	0.417	0.417	0.667	0.917	*11.65%*	0.029	0.049	0.049	0.078	0.107		0.004	0.007	0.007	0.012	0.016
ETS	0.583	0.667	0.750	0.750	1.000	*9.81%*	0.057	0.065	0.074	0.074	0.098		0.009	0.010	0.011	0.011	0.015
Tech Refresh	0.417	0.583	0.542	0.583	0.917	*8.85%*	0.037	0.052	0.048	0.052	0.081		0.006	0.008	0.007	0.008	0.012
Wholesale Supply	0.500	0.583	0.750	0.750	1.000	*7.41%*	0.037	0.043	0.056	0.056	0.074		0.006	0.007	0.008	0.008	0.011
PSI/PSP	0.500	0.417	0.667	0.667	1.000	*4.16%*	0.021	0.017	0.028	0.028	0.042		0.003	0.003	0.004	0.004	0.006
HW Mx	0.583	0.667	0.833	0.833	1.000	*4.07%*	0.024	0.027	0.034	0.034	0.041		0.004	0.004	0.005	0.005	0.006
Market Considerations																	
Industrial Base Infrustructure	0.833	0.750	0.792	0.792	1.000	*1.00%*	0.008	0.008	0.008	0.008	0.010		0.001	0.001	0.001	0.001	0.002
Industrial Base Financial Health	0.917	0.875	0.875	0.875	1.000	*1.00%*	0.009	0.009	0.009	0.009	0.010		0.001	0.001	0.001	0.001	0.002
Skilled Workforce	0.833	0.833	0.833	0.833	1.000	*1.00%*	0.008	0.008	0.008	0.008	0.010		0.001	0.001	0.001	0.001	0.002
Supply Chain	0.833	0.917	0.917	0.875	1.000	*1.00%*	0.008	0.009	0.009	0.009	0.010		0.001	0.001	0.001	0.001	0.002
Market Substitutes	0.958	1.000	1.000	1.000	1.000	*1.00%*	0.010	0.010	0.010	0.010	0.010		0.001	0.002	0.002	0.002	0.002
Technical Considerations																	
Technical Complexity	0.458	0.542	0.542	0.625	0.917	*1.00%*	0.005	0.005	0.005	0.006	0.009		0.001	0.001	0.001	0.001	0.001
Technical Readiness Level	0.792	0.792	0.833	0.833	1.000	*1.00%*	0.008	0.008	0.008	0.008	0.010		0.001	0.001	0.001	0.001	0.002
Anticipated Design Stability	0.500	0.542	0.542	0.625	0.917	*1.00%*	0.005	0.005	0.005	0.006	0.009		0.001	0.001	0.001	0.001	0.001
Technology Alternatives	0.917	0.958	1.000	1.000	1.000	*1.00%*	0.009	0.010	0.010	0.010	0.010		0.001	0.001	0.002	0.002	0.002
Technical Data	0.500	0.417	0.625	0.542	1.000	*1.00%*	0.005	0.004	0.006	0.005	0.010		0.001	0.001	0.001	0.001	0.002
Program Considerations																	
Program Schedule	0.500	0.500	0.583	0.667	1.000	*1.00%*	0.005	0.005	0.006	0.007	0.010		0.001	0.001	0.001	0.001	0.002
Program Quantity/Size	0.708	0.792	0.792	0.833	0.917	*1.00%*	0.007	0.008	0.008	0.008	0.009		0.001	0.001	0.001	0.001	0.001
Program Budget	0.667	0.750	0.667	0.625	0.833	*1.00%*	0.007	0.008	0.007	0.006	0.008		0.001	0.001	0.001	0.001	0.001
Program Office Staffing	0.417	0.583	0.708	0.958	1.000	*1.00%*	0.004	0.006	0.007	0.010	0.010		0.001	0.001	0.001	0.001	0.002
Program Complexity	0.375	0.500	0.583	0.625	0.750	*1.00%*	0.004	0.005	0.006	0.006	0.008		0.001	0.001	0.001	0.001	0.001
Life Cycle Duration	0.750	0.833	0.750	0.875	0.917	*1.00%*	0.008	0.008	0.008	0.009	0.009		0.001	0.001	0.001	0.001	0.001
Economic Considerations																	
DOD Program Office Costs	0.500	0.583	0.625	0.625	0.833	*1.00%*	0.005	0.006	0.006	0.006	0.008		0.001	0.001	0.001	0.001	0.001
Infrastructure Investment (NR)	0.417	0.542	0.417	0.625	1.000	*1.00%*	0.004	0.005	0.004	0.006	0.010		0.001	0.001	0.001	0.001	0.002
Labor Force Investment (NR)	0.250	0.417	0.375	0.792	1.000	*1.00%*	0.003	0.004	0.004	0.008	0.010		0.000	0.001	0.001	0.001	0.002
Certification/Qualification (NR)	0.708	0.792	0.708	0.792	1.000	*1.00%*	0.007	0.008	0.007	0.008	0.010		0.001	0.001	0.001	0.001	0.002
Program Quantity/Size	0.500	0.625	0.500	0.625	0.750	*1.00%*	0.005	0.006	0.005	0.006	0.008		0.001	0.001	0.001	0.001	0.001
Program Length	0.583	0.792	0.583	0.792	0.917	*1.00%*	0.006	0.008	0.006	0.008	0.009		0.001	0.001	0.001	0.001	0.001
Progress Curves	0.458	0.667	0.458	0.667	1.000	*1.00%*	0.005	0.007	0.005	0.007	0.010		0.001	0.001	0.001	0.001	0.002
Contractor Capacity	0.667	0.667	0.625	0.625	1.000	*1.00%*	0.007	0.007	0.006	0.006	0.010		0.001	0.001	0.001	0.001	0.002
Technical Data Cost	0.542	0.458	0.417	0.417	0.833	*1.00%*	0.005	0.005	0.004	0.004	0.008		0.001	0.001	0.001	0.001	0.001
Total Risk	**0.578**	**0.648**	**0.655**	**0.726**	**0.952**	100.0%	**0.454**	**0.553**	**0.586**	**0.672**	**0.969**	*15.2%*	**0.069**	**0.084**	**0.089**	**0.102**	**0.147**
							Final Evaluation Score						**0.660**	**0.738**	**0.747**	**0.839**	**0.973**

COMPETITION DECISION DOCUMENTATION

A competition plan should be considered for every program acquisition strategy plan and the outcome of the CDF must be documented and included. There is no standard format or content for a competition plan. The following competition decision support documentation is recommended:

1. Executive Summary
2. Program Acquisition Plan (as related to competition)
3. Competition Strategies (alternatives)
4. Life Cycle Cost
    a. Non-recurring (for each phase)
    b. Recurring (for each phase)
    c. Non-quantifiable costs
5. Benefits
    a. Non-recurring
    b. Recurring
    c. Non-quantifiable (i.e., risk, schedule, performance, etc.)
6. Comparative Cost/Benefit Summaries
    a. Cost of each alternative over life cycle
    b. Benefits of each alternative over life cycle
    c. Sensitivity Analysis and Risk Assessment
    d. NPV
    e. Benefit Cost ratios
    f. Payback
7. Conclusions and Recommendations for Program Acquisition Strategy

Appendices

IMPLEMENTING COMPETITION

APPENDIX A – ACRONYMS

A-RCI	Acoustic Rapid Commercial-Off-The-Shelf (COTS) Insertion
AAI	Alabama Aircraft Industries
AAP	Abbreviated Acquisition Program
ACAT	Acquisition Category
ACTD	Advanced Concept Technology Demonstration
ADP	Automated Data Processing
AFB	Air Force Base
AFIT	Air Force Institute of Technology
AFLCMC	Air Force Life Cycle Management Center
AH-	Attack Helicopter
AIM	Air Intercept Missile
ALC	Air Logistics Complex
AMDR	Air and Missile Defense Radar
AMRAAM	Advanced Medium-Range Air-to-Air Missile
AMST	Advanced Medium STOL (Short Take-off and Landing) Transport
AOA	Analysis of Alternatives
ASN/RD&A	Assistant Secretary of the Navy for Research, Development, and Acquisition
ASTOVL	Advanced Short Take-Off/Vertical Landing
ASW	Anti-Submarine Warfare
AT&L	Acquisition Technology and Logistics
ATA	Advanced Tactical Aircraft
ATD	Advanced Technology Demonstration
ATF	Advanced Tactical Fighter
ATK	Alliant Techsystems
B	Billion

BBP	Better Buying Power
BCA	Business Case Analysis
BIW	Bath Iron Works
BOA	Basic Ordering Agreement
BRAC	Base Realignment and Closure
C-	Cargo Aircraft
C3I	Command, Control, Communications & Intelligence
CAIV	Cost as an Independent Variable
CAS	Cost Accounting Standards
CBA	Cost Benefit Analysis
CD	Concept Development
CDA	Commercial Derivative Aircraft
CDD	Capability Development Document
CDF	Competition Decision Framework
CDR	Critical Design Review
CH-	Cargo Helicopter
CICA	Competition in Contracting Act
CID	Capabilities Integration Directorate
CIRCM	Common Infrared Countermeasures
CITE	Center of Industrial Technical Excellence
CLS	Contractor Logistics Support
CMMR	Certified MIDS Manufacturer's Register
COEA	Cost and Operational Effectiveness Analysis
CONUS	Continental United States
COTS	Commercial Off-the-Shelf
CPFF	Cost-Plus-Fixed Fee

CPIF	Cost-Plus-Incentive Fee
CRDA	Cooperative Research and Development Agreements
CRS	Congressional Research Service
CSAF	Air Force Chief of Staff
DAF	Department of the Air Force
DARPA	Defense Advanced Research Agency
DASA	Daimler-Benz Chrysler Aerospace
DASD(LMR)	Deputy Assistant Secretary of Defense (Logistics and Materiel Readiness)
DASD(SE)	Deputy Assistant Secretary of Defense (Systems Engineering)
DAU	Defense Acquisition University
DDG-	Guided Missile Destroyer
DESP	Design and Engineering Support Program
DFARS	Defense Federal Acquisition Regulation Supplement
DLA	Defense Logistics Agency
DLS	Data Link Solutions
DMS	Data Management Strategy
DOD	Department of Defense
DODD	Department of Defense Directive
DODI	Department of Defense Instruction
DODM	Department of Defense Manual
DON	Department of the Navy
DPAS	Defense Priorities and Allocations System
DPO	Distribution Process Owner
DRFP	Draft Request for Proposal
EA-	Electronic Warfare/Attack Aircraft

EADS	European Aeronautic Defence and Space Company
EAGLE	Enhanced Army Global Logistics Enterprise
ECP	Engineering Change Proposal
EDM	Engineering Development Model
EEBD	Emergency Escape Breathing Device
EMD	Engineering and Manufacturing Development
EOD	Explosive Ordinance Disposal
EOQ	Economic Order Quantities
ESC	Electronic Systems Center (US Air Force)
F-	Fighter Aircraft
F/A-	Fighter-Attack Aircraft
F^2AST	Future Flexible Acquisition & Sustainment Tool
F3	Form, Fit, and Function
FAA	Federal Aviation Administration
FAR	Federal Acquisition Regulation
FCS	Future Combat System
FDL	Fighter Data Link
FFP	Firm Fixed Price
FIRST	Field and Installation Readiness Support Team
FMS	Foreign Military Sales
FPI	Fixed Price Incentive
FPIF	Fixed Price Incentive Firm
FSD	Full Scale Development
FSR	Field Service Representative
FY	Fiscal Year
FYDP	Future Years Defense Program

GAO	Government Accountability Office
GCV	Ground Combat Vehicle
GDLS	General Dynamics Land Systems
GE	General Electric
GFE	Government Furnished Equipment
GPS	Global Positioning System
HMEE-I	High-Mobility Engineer Excavator (Type I)
HMMWV	High Mobility Multi-Purpose Wheeled Vehicle
ICD	Interface Control Document
ICP	Inventory Control Point
ICS	Interim Contractor Support
IDA	Institute for Defense Analysis
IDIQ	Indefinite-Delivery/Indefinite-Quantity
IED	Improvised Explosive Device
IFARA	Integrated Fleet Aerial Refueling Assessment
IFV	Infantry Fighting Vehicle
IMU	Inertial Measurement Unit
IOC	Initial Operating Capability
IP	Intellectual Property
IPO	International Program Office
IPS	Integrated Product Support
IPV	Industrial Prime Vendor
IT	Information Technology
ITAR	International Traffic in Arms Regulations
JASSM	Joint Air-to-Air Standoff Missile
JAST	Joint Advanced Strike Technology

JATAS	Joint and Allied Threat Awareness System
JCTD	Joint Capability Technology Demonstration
JHSV	Joint High-Speed Vessel
JLTV	Joint Light Tactical Vehicle
JPATS	Joint Primary Aircraft Training System
JROC	Joint Requirements Oversight Council
JSF	Joint Strike Fighter
JTIDS	Joint Tactical Information Distribution System
JTRS	Joint Tactical Radio System
JUONS	Joint Urgent Operational Need Statement
KAI	Korea Aerospace Industries, Ltd.
KC-	Air Refueling/Cargo Aircraft
KPP	Key Performance Parameter
LAS	Light Air Support
LAV	Light Armored Vehicle
LCC	Life Cycle Cost
LCS	Littoral Combat Ship
LCSP	Life Cycle Sustainment Plan
LMR	Logistics and Materiel Readiness
LRIP	Low Rate Initial Production
M	Million
MAC	Multiple Award Contract
MCM	Mine Countermeasures
MCSC	Marine Corps Systems Command
MDA	Milestone Decision Authority
MDAP	Major Defense Acquisition Program

MECV	Modernized Expanded Capacity Vehicle
MGV	Manned Ground Vehicle
MH-	Special Operations Helicopter
MIDS-LVT	Multi-Functional Information Distribution System-Low Volume Terminal
MOSA	Modular Open Systems Approach
MRAP	Mine Resistant Ambush Protected (vehicle)
MRF	Multi-Role Fighter
MRG	Main Reduction Gear
MS	Milestone
MSA	Materiel Solutions Analysis
MTBF	Mean Time Between Failures
MV-	Multi-Mission VTOL (Vertical Take Off and Landing)
NATO	North Atlantic Treaty Organization
NAVICP	Naval Inventory Control Point
NDAA	National Defense Authorization Act
NDI	Non-Developmental Item
NDRI	National Defense Research Institute
NGS	Navigation Guidance System
NGT	New Generation Trainer
NIOSH	National Institute for Occupational Safety and Health
NPS	Naval Postgraduate School
NSIAD	National Security and International Affairs Division (GAO)
O&M	Operations and Maintenance
O&S	Operations and Support
DASD(SE)	Deputy Assistant Secretary of Defense for Systems Engineering
OEM	Original Equipment Manufacturer

OFPP	Office of Federal Procurement Policy
OMB	Office of Management & Budget
OSA	Open Systems Architecture
OSD	Office of the Secretary of Defense
OSJTF	Open Systems Joint Task Force
OT	Other Transaction
OUSD	Office of the Under Secretary of Defense
P&W	Pratt & Whitney
PBA	Price Based Acquisition
PBL	Performance Based Logistics
PBSA	Performance Based Services Acquisition
PBSM	Product Support Business Model
PC-	Basic/Advanced Trainer Aircraft
PDM	Programmed Depot Maintenance
PDR	Preliminary Design Review
PDRR	Program Definition and Risk Reduction
PEO	Program Executive Officer
PFP	Powered Flight Program
PHS&T	Packaging, Handling, Storage & Transportation
PIP	Product Improvement Program
PM	Program Manager
PRO	Profit Related to Offerors
PS BCA	Product Support Business Case Analysis
PSA	Product Support Arrangement
PSI	Product Support Integrator
PSM	Product Support Manager

PSP	Product Support Provider
PWS	Performance Work Statement
R&D	Research and Development
RDT&E	Research, Development, Test & Evaluation
RFI	Request for Information
RFP	Request for Proposal
RFQ	Request for Quotation
ROI	Return on Investment
ROM	Rough-Order-of-Magnitude
RR	Rolls Royce
SAIC	Science Applications International Corporation
SAR	Selected Acquisition Report
SbAST	Small Business Acquisition Sustainment Tool
SBIR	Small Business Innovative Research
SDD	System Development and Demonstration
SES	Senior Executive Service
SFR	System Functional Review
SHP	Shaft Horse Power
SIL	Software Integration Laboratory
SLAM-ER	Standoff Land Attack Missile – Extended Range
SLEP	Service Life Extension Program
SNC	Sierra Nevada Corporation
SOO	Statement of Objectives
SOW	Statement of Work
SPAWAR	Naval Space and Warfare Command
SRR	System Requirements Review

SSPO	Strategic Systems Project Office
STOL	Short Take-off and Landing
STTR	Small Business Technology Transfer
SUW	Surface Warfare
T-	Trainer Aircraft
TACOM	Tank-Automotive and Armament Command (US Army)
TAMP	Trainer Aircraft Master Plan
TD	Technology Development
TDP	Technical Data Package
TINA	Truth in Negotiations Act
TMRR	Technology Maturation and Risk Reduction
TOC	Theory of Constraints
TRL	Technology Readiness Level
TSI	Tire Successor Initiative
TSPR	Total System Performance Responsibility
UAV	Unmanned Aerial Vehicle
UH-	Utility Helicopter
UK	United Kingdom
US	United States
USAF	United States Air Force
USAFA	United States Air Force Academy
USC	United States Code
USD	Under Secretary of Defense
USD (AT&L)	Under Secretary of Defense for Acquisition, Technology and Logistics
USMC	United States Marine Corps
USN	United States Navy

V&V	Validation & Verification
WSARA	Weapon Systems Acquisition Reform Act
WTA	Winner Take All
X-	Experimental Aircraft
YC-	Prototype Cargo Aircraft

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