



EXCERPT FROM THE PROCEEDINGS

OF THE
TENTH ANNUAL ACQUISITION
RESEARCH SYMPOSIUM
SYSTEM OF SYSTEMS MANAGEMENT

Identifying Governance Best Practices in Systems-of-Systems Acquisition

David J. Berteau, Guy Ben-Ari, Joshua Archer, and Sneha Raghavan
Center for Strategic and International Studies

Published April 1, 2013

Approved for public release; distribution is unlimited.
Prepared for the Naval Postgraduate School, Monterey, CA 93943.

Disclaimer: The views represented in this report are those of the authors and do not reflect the official policy position of the Navy, the Department of Defense, or the federal government.



The research presented in this report was supported by the Acquisition Research Program of the Graduate School of Business & Public Policy at the Naval Postgraduate School.

To request defense acquisition research, to become a research sponsor, or to print additional copies of reports, please contact any of the staff listed on the Acquisition Research Program website (www.acquisitionresearch.net).



ACQUISITION RESEARCH PROGRAM
GRADUATE SCHOOL OF BUSINESS & PUBLIC POLICY
NAVAL POSTGRADUATE SCHOOL

Preface & Acknowledgements

Welcome to our Tenth Annual Acquisition Research Symposium! We regret that this year it will be a “paper only” event. The double whammy of sequestration and a continuing resolution, with the attendant restrictions on travel and conferences, created too much uncertainty to properly stage the event. We will miss the dialogue with our acquisition colleagues and the opportunity for all our researchers to present their work. However, we intend to simulate the symposium as best we can, and these *Proceedings* present an opportunity for the papers to be published just as if they had been delivered. In any case, we will have a rich store of papers to draw from for next year’s event scheduled for May 14–15, 2014!

Despite these temporary setbacks, our Acquisition Research Program (ARP) here at the Naval Postgraduate School (NPS) continues at a normal pace. Since the ARP’s founding in 2003, over 1,200 original research reports have been added to the acquisition body of knowledge. We continue to add to that library, located online at www.acquisitionresearch.net, at a rate of roughly 140 reports per year. This activity has engaged researchers at over 70 universities and other institutions, greatly enhancing the diversity of thought brought to bear on the business activities of the DoD.

We generate this level of activity in three ways. First, we solicit research topics from academia and other institutions through an annual Broad Agency Announcement, sponsored by the USD(AT&L). Second, we issue an annual internal call for proposals to seek NPS faculty research supporting the interests of our program sponsors. Finally, we serve as a “broker” to market specific research topics identified by our sponsors to NPS graduate students. This three-pronged approach provides for a rich and broad diversity of scholarly rigor mixed with a good blend of practitioner experience in the field of acquisition. We are grateful to those of you who have contributed to our research program in the past and encourage your future participation.

Unfortunately, what will be missing this year is the active participation and networking that has been the hallmark of previous symposia. By purposely limiting attendance to 350 people, we encourage just that. This forum remains unique in its effort to bring scholars and practitioners together around acquisition research that is both relevant in application and rigorous in method. It provides the opportunity to interact with many top DoD acquisition officials and acquisition researchers. We encourage dialogue both in the formal panel sessions and in the many opportunities we make available at meals, breaks, and the day-ending socials. Many of our researchers use these occasions to establish new teaming arrangements for future research work. Despite the fact that we will not be gathered together to reap the above-listed benefits, the ARP will endeavor to stimulate this dialogue through various means throughout the year as we interact with our researchers and DoD officials.

Affordability remains a major focus in the DoD acquisition world and will no doubt get even more attention as the sequestration outcomes unfold. It is a central tenet of the DoD’s Better Buying Power initiatives, which continue to evolve as the DoD finds which of them work and which do not. This suggests that research with a focus on affordability will be of great interest to the DoD leadership in the year to come. Whether you’re a practitioner or scholar, we invite you to participate in that research.

We gratefully acknowledge the ongoing support and leadership of our sponsors, whose foresight and vision have assured the continuing success of the ARP:



- Office of the Under Secretary of Defense (Acquisition, Technology, & Logistics)
- Director, Acquisition Career Management, ASN (RD&A)
- Program Executive Officer, SHIPS
- Commander, Naval Sea Systems Command
- Program Executive Officer, Integrated Warfare Systems
- Army Contracting Command, U.S. Army Materiel Command
- Office of the Assistant Secretary of the Air Force (Acquisition)
- Office of the Assistant Secretary of the Army (Acquisition, Logistics, & Technology)
- Deputy Director, Acquisition Career Management, U.S. Army
- Office of Procurement and Assistance Management Headquarters, Department of Energy
- Director, Defense Security Cooperation Agency
- Deputy Assistant Secretary of the Navy, Research, Development, Test, & Evaluation
- Program Executive Officer, Tactical Aircraft
- Director, Office of Small Business Programs, Department of the Navy
- Director, Office of Acquisition Resources and Analysis (ARA)
- Deputy Assistant Secretary of the Navy, Acquisition & Procurement
- Director of Open Architecture, DASN (RDT&E)
- Program Executive Officer, Littoral Combat Ships

James B. Greene Jr.
Rear Admiral, U.S. Navy (Ret.)

Keith F. Snider, PhD
Associate Professor



System of Systems Management

Acquisition Management for System of Systems: Affordability Through Effective Portfolio Management

Navindran Davendralingam and Daniel DeLaurentis
Purdue University

Identifying Governance Best Practices in Systems-of-Systems Acquisition

David J. Berteau, Guy Ben-Ari, Joshua Archer, and Sneha Raghavan
Center for Strategic and International Studies

The Making of a DoD Acquisition Lead System Integrator (LSI)

Paul Montgomery, Ron Carlson, and John Quartuccio
Naval Postgraduate School

Innovating Naval Business Using a War Game

Nickolas Guertin and Brian Womble, *United States Navy*
Paul Bruhns, *ManTech International Corporation*

Computer-Aided Process and Tools for Mobile Software Acquisition

Christopher Bonine, Man-Tak Shing, and Thomas W. Otani
Naval Postgraduate School



Identifying Governance Best Practices in Systems-of-Systems Acquisition¹

David J. Berteau—Berteau is senior vice president and director of the CSIS International Security Program, covering national security strategy, policy, programs, and resources as well as defense management, contracting, and acquisition. His group also assesses national security economics and industry. Berteau is an adjunct professor at Georgetown University and at the Lyndon B. Johnson School of Public Affairs, a director of the Procurement Round Table, and a fellow of the National Academy of Public Administration and the Robert S. Strauss Center at the University of Texas. Prior to joining CSIS, he was director of national defense and homeland security for Clark & Weinstock, director of Syracuse University's National Security Studies Program, and senior vice president at Science Applications International Corporation (SAIC). He served at senior levels in the U.S. Defense Department under four defense secretaries, including four years as principal deputy assistant secretary of defense for production and logistics. Berteau graduated with a BA from Tulane University in 1971 and received his master's degree in 1981 from the LBJ School of Public Affairs at the University of Texas. [dberteau@csis.org]

Guy Ben-Ari—Ben-Ari served as a deputy director and senior fellow with the Defense-Industrial Initiatives Group at CSIS. His work focused on the links among innovation, industry, military capabilities, and defense policy. Prior to joining CSIS, he was a research associate at George Washington University's Center for International Science and Technology Policy. From 2000 to 2002, he managed collaborative research and development programs for Gilat Satellite Networks Ltd., an Israeli high-technology SATCOM company. From 1995 to 2000, he was a technology analyst for the Israeli government. He also consulted for the European Commission and the World Bank on innovation policy and project evaluation.

Joshua Archer—Archer is an intern with the Defense-Industrial Initiatives Group at CSIS, where his research interests include defense industrial supply chain and international joint development programs, particularly between the U.S. and Japan. Before joining CSIS, Archer performed supply side research in the defense and aerospace industry as a strategy consultant between 2010 and 2013. In 2009, Archer was a researcher with the James Martin Center for Nonproliferation Studies, where he contributed to the Taiwan military capabilities profile of the Nuclear Threat Initiative database. He holds an MA in international policy studies from the Monterey Institute of International Studies.

Sneha Raghavan—Raghavan is a research assistant with the Defense-Industrial Initiatives Group at CSIS. Her work covers Asian and European defense trends, as well as analysis of federal contracting. Prior to joining CSIS, she served as a senior research assistant with AidData, a development finance database at the College of William and Mary. She holds a BA with honors in international relations from the College of William and Mary, where she conducted her thesis on the effects of U.S. foreign aid in nuclear proliferation outcomes of recipient countries.

Abstract

Acquisition governance currently confronts two problems: the growing size and complexity of systems-of-systems capabilities and the limited effectiveness of existing governance models

¹ This report was prepared for submission to the Naval Postgraduate School on the occasion of its 10th Annual Acquisition Research Symposium. All inquiries about this report should be directed to

David Berteau
Center for Strategic and International Studies
1800 K Street NW
Washington, DC
T: (202) 775-3136
E: DBerteau@csis.org



to ensure the on-cost and on-schedule delivery of those capabilities. The Center for Strategic and International Studies (CSIS) is engaging in research on systems-of-systems acquisition governance best practices that could help the defense acquisition community overcome some of these problems. This report provides an update on the progress of that effort. It reviews the evolution of acquisition governance models throughout the history of U.S. defense acquisition, characterizes the ways in which those models fall short of meeting the challenges of complex systems-of-systems acquisition, and offers preliminary observations on best practices to overcome those challenges based on the results of CSIS research to date. That research to date includes two new case studies. The research is continuing beyond this interim report. The final report will reflect additional work and incorporate more case studies.

Introduction

In this age of diverse and evolving security threats, the defense community is acquiring weapons, platforms, and systems with greater complexity. Here, the term *complexity* is used to describe systems-of-systems (SoS) involving multiple, interrelated elements that interact unpredictably. As defense products and capabilities become more complex, they are stressing the structure necessary for the acquisition of defense SoS. As a result, the acquisition community has encountered operational challenges in maintaining a sufficient engineering and acquisition workforce and process, as well as outcome challenges in acquiring capabilities on cost and on schedule.

SoS acquisition poses considerable challenges that the current Department of Defense (DoD) acquisition governance structure was not necessarily designed to address. Increasingly, defense capabilities must support the needs of multiple users and must operate as horizontally integrated systems incorporating multiple individual platforms and programs. The high degree of interoperability and collaboration required for these SoS capabilities necessitates not only advanced systems engineering capabilities but also advanced governance. Because the technical capabilities needed to achieve national defense missions have grown beyond the existing models of governance used to acquire them, the DoD faces challenges in developing, procuring, and deploying next-generation weapons and platforms. Furthermore, cost growth in its portfolio of accounts demonstrates that the DoD is encountering challenges managing cost and schedule risks associated with advanced and integrated capabilities.

The research of the Center for Strategic and International Studies (CSIS) on SoS acquisition governance best practices aims to help the defense acquisition community address some of the challenges of complexity and improve its governance processes for such acquisitions. The specific research covered in this interim report is supported by a grant from the Fleet Logistics Center of the Naval Supply Systems Command, under the auspices of the Acquisition Research Program of the Naval Postgraduate School. The research under this project will conclude with a final report to be submitted in September 2013.

This report focuses on the practical application of the CSIS eight-attribute governance framework in comparative governance model analysis. Specifically, it observes how the attribute profile of two case studies—Future Combat Systems (FCS) and Maritime Domain Awareness (MDA)—has influenced the processes and outcomes of those programs. It outlines the challenges of complexity in SoS acquisition and the historical origins of those challenges. It discusses the eight-attribute framework for the evaluation of individual acquisition programs and applies that framework to the first two example case studies. Finally, it discusses themes indicated by the case study comparison. In the end, this



analysis suggests that getting governance right is critical to addressing the barriers to effective SoS acquisition.

Complexity and Acquisition Governance

The growing complexity of defense systems is not a new challenge to the defense acquisition community. Technology developments in defense have often outpaced the evolution of federal and defense procurement processes, and policies for acquisition governance have had to keep pace. As Berteau, Ben-Ari, and Zlatnik (2009) noted in a report by CSIS, “Current approaches [to acquisition] were developed years ago in an environment where the government was technically astute and worked closely with one vertically integrated contractor per program” (p. 2). Today, acquisition programs regularly involve large networks of contractors that integrate increasingly complex technologies into SoS, but the government has not maintained the kind of strong technical workforce necessary for it to stay on top of these emerging technologies. This gap makes it more difficult for requirement setters to independently forecast development schedules and component compatibility.

By examining the applications of weapon system acquisition models over time, this analysis provides a basis for the CSIS acquisition governance framework in this report and the application of that framework to the case studies presented as follows. The analysis outlines two areas of foundational knowledge. First, how have preferred models for acquisition governance evolved over time? Second, how does growing complexity challenge the contemporary models for acquisition governance?

Evolution of Acquisition Governance Models—Historical Context

The DoD has exercised different approaches to acquisition over time, favoring various divisions of responsibility between industry suppliers and government customers. Harvey Sapolsky (2009) outlined these models in a paper published by CSIS, titled *Models for Governing Large Systems Projects*. Sapolsky’s discussion suggests that the government has preferred to push more of the functional responsibilities of acquisition away from itself and toward industry contractors over time. This is in part a product of the flow of human capital toward the private sector and the erosion of the government’s internal engineering expertise relative to industry. While the elements of the Sapolsky (2009) model have different levels of analytic validation, the overall trends of skill and task migration from government to industry are well-documented and difficult to dispute.

The original model for weapons acquisition dates back to the earliest days of the U.S. defense infrastructure. At that time, the U.S. Navy could specify the warship it needed along with the design, construction, and outfitting of the ship. The Navy managed and performed production operations and generated technical requirements at all levels of the acquisition chain. Sapolsky (2009) titled this acquisition approach the “Arsenal Model,” under which the government forms its own industrial base. It relies on scientists and engineers within the federal government’s defense workforce. It is still employed to an extent today through the DoD’s network of arsenals and maintenance depots around the country.

An acquisition approach known as the “Contract Model” involves greater industry participation in technical execution than the Arsenal Model. This model became dominant with the beginning of the Cold War. Increasingly, the government relied on the expertise and responsiveness of contractors to meet its needs for larger and more technically demanding weapon systems. Over time, the government maintained a workforce in contracting and acquisition program governance but began to outsource more technical execution to industry.



As weapons became more complex and management of these systems needed improvement, the acquisition community developed a preference for greater industry involvement under the Weapon System Manager Model of acquisition. This model employs large contractors responsible for the administration and coordination of a network of contractors working on subtasks integral to the overall acquisition effort. Passing responsibility to the weapon system managers has the advantage of involving large and responsive contractors that assist the integration of more complex systems that originate from a larger network of stakeholders.

As the DoD began to manage less of the implementation and program management capabilities, it also started to lose its ability to provide technical direction for its acquisition efforts. This was accelerated by the end of the Cold War, when technical direction almost exclusively became the purview of industry. At this time, DoD leadership preserved combat capabilities while seeking savings within the technical functions of the services. This fourth model, known as the Outsourcing Model, grew more prevalent due to greater preference for private-sector program implementation over government implementation.

The flow of more tasks and responsibility toward industry contributed to the growth of what Sapolsky (2009) called the “Lead System Integrator (LSI) Model” more commonly used today. Because the LSI Model has been adopted to describe a specific type of contracting, this paper refers to Sapolsky’s LSI Model as the “System Integration (SI) Model.” In the SI Model, capabilities requirements are still controlled by military officers, but technical expertise is contracted to SIs to advance the capabilities of the planned weapon systems.

As the adaptation of Sapolsky’s (2009) governance models in Table 1 indicates, the evolution of acquisition governance models over time—from preference toward the Arsenal Model in the earliest days of U.S. defense acquisition to greater use of the SI Model in large weapon systems acquisition today—is characterized by the gradual removal of responsibility from the government buyer. In theory, moving all of the functions formerly performed by the government to industry contractors lessens the personnel burden associated with the maintenance of a large in-house acquisition workforce. Furthermore, reliance upon industry to designate technologies that meet warfighter demands should allow government buyers to internalize Moore’s Law and procure and deploy advanced capabilities in a shorter amount of time. However, this evolution has fallen short of expectations in practice and may instead be contributing to cost and schedule overruns and compromising the government’s ability to manage large-scale acquisition efforts.



Table 1. Evolution of Acquisition Governance Models
(Sapolsky, 2009)

Model → Task ↓	ARSENAL	CONTRACT	WEAPON SYSTEM MANAGER	OUTSOURCING TO PRIVATE ARSENAL	SYSTEM INTEGRATOR
PROGRAM REQUIREMENTS	Government	Government	Government	Government	Government/ Industry
TECHNICAL DIRECTION	Government	Government	Government	Industry	Industry
PROGRAM MANAGEMENT	Government	Government	Industry	Industry	Industry
TECHNICAL EXECUTION	Government	Industry	Industry	Industry	Industry
EXTERNAL ENVIRONMENT	Infrequent wars Little commercial application of military tech	Some commercial application of military tech Private sector pays better, can be more responsive	Weapons become more complicated /complex Coordination of sub-systems becomes important Large companies can leverage political support more effectively	Government begins to lose in-house tech capabilities Outsourcing becomes increasingly acceptable	Loss of in-house government tech capabilities leads to inability to define what's possible

Note. The table has been adapted by CSIS and also appears in G. Ben-Ari and P. Chao's *Organizing for a Complex World: Developing Tomorrow's Defense and Net-Centric Systems* (p. 26).

The changing distribution of responsibilities between the industry supplier and the government customer, reflected in the Sapolsky (2009) model, serves to frame acquisition governance challenges in SoS acquisition. In addition, there are two distinct models for the direction of acquisition governance. In the traditional approach to acquisition governance, the capabilities comprising a SoS are governed downward from the program level. In an enterprise-wide governance approach, governance flows upward from the capabilities level. Because the “enterprise approach” is an emerging model that is currently evolving to meet the demands of SoS complexity, its application is not evident in early-stage acquisition governance models. Instead, traditional, top-down approaches to acquisition governance have been most prevalent throughout the evolution of governance models, from the Arsenal Model at the dawn of U.S. armed services to the SI Model today.

Complexity—The Problem Defined

The DoD's preferences for acquisition governance models have changed over time, reflecting the flow of human capital, technical knowledge, and production assets away from the government. In the process, the growth in weapon system complexity has outgrown existing models. Warfighters are increasingly reliant on capabilities developed as part of a broader SoS capability. These complex SoS are noteworthy for their size, scope, and inherent complexity. In this context, *complexity* is used to mean that systems consist of multiple elements that are typically developed and managed by more than one organization. This management dispersion adds to the complexity of unpredictable interactions inherent in



complex SoS. Furthermore, these system elements are often part of more than one set of capabilities; that is, a given system may be part of several SoS. This poses significant management and governance challenges. However, the payoff of successful delivery is the ability to achieve capabilities far greater than those delivered through individual programs or systems.

The divergence of current governance models from the service's complex SoS capabilities requirements is apparent in the pervasive acquisition challenges that the DoD faces. As capabilities become more complex, they demand a DoD systems engineering workforce that may exceed what the government customer can offer. Additionally, the DoD faces operational requirements from the demand for systems operability in multiple roles, missions, and environments. These challenges can result in structural difficulties for SoS capabilities that may not exist in traditional acquisition approaches. For instance, knowledge sharing—a straightforward task in traditional acquisition—faces new challenges in complex SoS acquisition efforts. Knowledge ownership and incentives for sharing become less clear, adding to the host of governance process shortfalls. Compounding these challenges in technology, operational requirements, and structure, the DoD organizations needed to develop and deploy the SoS capabilities are bigger and more difficult to manage and maintain than traditional acquisition organizations, particularly under the SI Model.

The growing divide between acquisition governance models and acquisition in practice is also clear in SoS acquisition outcomes. The government customers' ability to deliver complex SoS capabilities on cost in particular is declining. According to the Government Accountability Office (GAO; 2013), more than 86 Major Defense Acquisition Programs (MDAPs) in fiscal year 2012 showed approximately \$400 billion in aggregated cost overruns since their first full-year estimates, representing a 4% (\$90 billion) growth in development costs and a 5% (\$290 billion) growth in costs of procurement. As dramatic as this cost growth is, this latest annual report from the GAO is actually anomalous when compared against even greater cost growth in the 2012 GAO report. In that iteration, 96 MDAPs existing in that year had grown an aggregated \$447 billion in excess of their original estimated costs (GAO, 2012). Given the expected impact of sequestration, the 2012 GAO report is likely to more accurately represent the trend in cost growth. That trend is particularly evident when compared with the 2007 GAO report, which cited 64 MDAPs in the DoD's accounts that had grown at an average annual rate of 4.9%. This produced a total annual cost growth of \$165 billion by those programs in that year (GAO, 2007, p. 8). This indicates that cost overruns grew 170.9% in the years between 2006 and 2011.

The government is also encountering challenges in keeping its major weapons programs on schedule. In its latest report, the GAO (2013) found that MDAPs experienced an average delay of 27 months in reaching initial operational capability. This figure exceeds the 2012 estimate of 23 months in average delay (GAO, 2012, pp. 6–7). Combined with the upward trend in cost growth over time, this track record indicates that existing governance and management tools no longer suffice for today's complex weapon systems.

As cost and schedule overrun trends illustrate, delivering SoS depends on getting governance right. However, the traditional service-centric approach to acquisition governance is not sufficiently flexible to meet the needs of SoS. Specifically, flexibility is limited in two ways.

First, the current process of generating requirements does not allow for the integration of changes in user needs. Because complex SoSs are inherently dynamic, non-linear, and risk-intensive, acquisition leadership's ability to react to changes in user needs is critical to the successful delivery of SoS capabilities. Structured but flexible oversight



procedures improve alignment between DoD requirements and fielded systems by establishing clear systems-level metrics and measuring progress toward declared goals. Systems must also be able to respond to changes in external factors in order to ensure that the SoS capability is as relevant when it reaches the production and deployment phase as it was in pre-acquisition phases. These factors could include macro-level changes in the security environment and technological advances as well as micro-level changes in organizational politics and acquisition effort leadership.

Second, successful acquisition delivery requires the “power of the purse” to direct solutions and approaches. In order to direct efforts toward certain capabilities, program leadership must be able to dedicate resources such as real contracting dollars, as well as human capital and allocations for other overhead costs, to certain system efforts. However, budgetary power is limited when individual services and defense agencies are the highest level of governance, due to the relatively more limited ability of those stakeholders to guarantee funds for the system or to be able to shift and reapportion them at the system level. The process by which funds are secured also limits flexibility; the DoD’s 20-month-plus budget cycle that precedes actual appropriation may lead the DoD to acquire technologies that are bleeding-edge when a budget is begun but that may become outdated by the time the budget is enacted.

Given the limited effectiveness of traditional service-centric governance approaches, it is useful to look at new, enterprise-wide governance models for the acquisition and delivery of complex SoS capabilities. Numerous platforms and systems comprise SoS, and the interactions of these components are highly unpredictable. Coordination of these internal constituent systems is necessary to achieve the desired SoS capability, which otherwise would be out of reach for any single component alone. An enterprise-wide approach to governance would facilitate oversight and accountability of the systems’ individual components to achieve that coordination. The following case study was selected to reflect both the traditional and enterprise approaches.

Acquisition Governance Case Studies

CSIS is analyzing selected SoS case studies in order to understand the merits and demerits of existing governance models for SoS acquisition. Once complete, and adding to the following two case studies, the case studies will contribute to a theoretical framework for the development of a new acquisition governance model.

To date, the CSIS project team has conducted preliminary analysis of seven SoS case studies. Two relevant case studies are included in this interim report. The remaining case studies will be added to the final report. The FCS program case presents an example of a so-called traditional governance approach, in which governance of all systems is centralized at the program level and a program of record is established by the customer to procure the end-user capability. The MDA effort provides an example of an enterprise-wide approach to governance, in which families of capabilities are procured under the umbrella of larger programs with the MDA end-user capability in mind. Together, the two cases permit the introduction of a CSIS framework for the identification and application of acquisition governance attributes. Next, this interim report discusses the FCS and MDA case studies to offer a high-level picture of program performance. Finally, the framework is used to compare the FCS and MDA governance attributes and observe their relationship to program performance.

Applying the CSIS Acquisition Governance Framework in Case Study Analysis

Through previous work on acquisition models for the Office of the Secretary of Defense (OSD), CSIS has developed a framework for analyzing acquisition program



governance. The framework of eight attributes is presented for public release for the first time in Figure 1.

This framework is based on the CSIS process of research on SoS governance models, interviews with programmatic stakeholders and industry leaders, and findings revision through input from SoS experts. The framework attributes represent concerns, questions, and issues that must be addressed for an organization to be able to deliver SoS capabilities effectively. The significance of these attributes varies depending on the SoS being analyzed, but all eight attributes add important value to the final analysis.

GOVERNANCE ATTRIBUTE	DESCRIPTION
LEVEL OF ORGANIZATIONAL FOCUS	The level at which SoS governance occurs within the organization. This is not the same as systems/capabilities focus or technical focus, both of which are outside the scope of the CSIS SoS governance analysis.
INTEGRATION OF FUNCTIONAL END-USER NEEDS	The mechanism(s) and frequency with which the functional needs of end-users are built into the system-of-systems, and at which points in the process of delivering the system-of-systems this incorporation occurs.
DECISION-MAKING AUTHORITY	The formal mechanism by which delivery of systems-of-systems is governed, including how budget is allocated, standards are set, tradeoffs are managed, and inconsistencies are adjudicated.
ENFORCEMENT	The mechanisms and level of management oversight by which the objectives of the SoS capability to be delivered are ensured, including measurements and program metrics.
WORKFORCE	The examination of SoS workforce structures, unity of mission, and capability development and enhancement through use of contracted support.
INCENTIVE STRUCTURE	The alignment between enterprise goals and the incentive and reward structures of the components that implement them.
KNOWLEDGE OWNERSHIP / ACCESS TO KNOWLEDGE	The accessibility of information regarding the operating environment, technical standards, and other elements that comprise the system-of-systems.
RISK ASSESSMENT / RISK MANAGEMENT	Risk assessments and management strategies tailored to mission accomplishment and the flexibility and resilience required for delivering systems-of-systems in the face of unforeseen developments.

Figure 1. Eight Attributes of Acquisition Governance

This framework enables side-by-side comparison of programs like FCS and MDA. As demonstrated in the following case study comparison, the comprehensive acquisition governance framework allows dissection of an acquisition effort in order to examine the eight governance attributes independent of one another and to determine how the attributes correlate with quantitative performance metrics (e.g., gaps between test results and planned goals, schedule delays in months, cost overruns in billions of dollars, etc.). As part of this analysis, CSIS will be able to identify which attributes correspond more closely with poor acquisition governance. The analysis will also clarify and improve the eight-attribute framework outlining best practices in SoS acquisition governance.

Figure 2 compares the FCS and MDA cases to illustrate how this methodology can be applied in practice. The comparison offers a notional qualitative analysis of program characteristics for each of the eight attributes. Program characteristics are presented without



direct comparison to one another and independent of the outcomes and performance of the programs themselves. Instead, this first-level comparison serves to compose an initial profile of the programs for further analysis of best practices.

Future Combat Systems Case Study

The FCS program is one example of how traditional acquisition governance has fallen short of meeting the challenges of complexity. This program, officially initiated with a four-team competition in February 2000 and terminated nine years later in 2009, was to be the Army's major research, development, and acquisition program. It initially consisted of 18 manned and unmanned systems linked together via a network. As the largest acquisition program ever attempted by the Army, FCS was envisioned to transform the service by replacing current systems such as the M-1 Abrams tank and the M-2 Bradley infantry fighting vehicle as well as by adding new capabilities. The advanced technologies associated with the FCS program, in addition to the challenge of integrating subsystems, posed large problems for successful development and contributed to the program's high level of risk. The total cost for FCS ballooned to an estimated \$200 billion at the time of its cancellation (Corrin, 2012).

In May 2000, the Defense Advanced Research Projects Agency (DARPA) awarded four contracts to four industry teams to develop FCS designs. The Army awarded the LSI contract to a team led by Boeing and Science Applications International Corporation (SAIC) in March 2002 after nearly two years of design evaluation. The Boeing and SAIC team worked with more than 550 contractors and subcontractors in 41 states.

The termination of FCS can be attributed to any of a number of problems. Three related to program flexibility are worth discussing here. First, the capabilities being developed under the program had fallen out of alignment with warfighter needs. The Army began developing the FCS concept in the 1990s, and the service had designed the system to meet requirements for rapid deployability, in-theater tactical maneuverability, and survivability. These requirements were not suited to the close-combat and urban terrain operations in which the Army was engaged post-9/11 (Pernin et al., 2012, pp. 54–57). Second, several evolutionary capabilities essential to program success were not developed at the projected pace. In its attempt to avoid capabilities obsolescence, the Army chose evolutionary capabilities to meet the core survivability requirements of the manned ground vehicle (MGV). The situational awareness and understanding (SA/SU) network, for example, was consistently behind its projected development schedule (Pernin et al., 2012, pp. 109–110, 264). Third, in part due to the slow pace of capabilities development and the high rate of expenditure, remaining resources were low compared with the level of progress achieved. Sources projected in 2009 that 60% of the project's funding would be exhausted by the Preliminary Design Review, leaving the remainder to cover the entire system development phase (GAO, 2012). In the end, FCS was terminated, and the Army continued the development of some select families of capabilities as individual systems (Malenic, 2009, 2010).

Maritime Domain Awareness Case Study

MDA provides a useful contrast with traditional acquisition governance. MDA is not a formal program like FCS and other traditional acquisition efforts. Instead, this enterprise approach to capabilities acquisition is an interagency, international strategy to deal with threats and challenges in maritime theaters. The MDA system aims to support and integrate government-wide efforts to collect, fuse, analyze, and disseminate data among defense, law enforcement, and border protection officials from the U.S. and allied countries, creating a cross-domain common operating view.



The MDA concept originated from a 1998 presidential initiative and was developed further in two presidential directives (NSPD-41 and HSPD-13) released on December 21, 2004. Since then, the established technology investment strategy and its supporting offices and business systems have undergone numerous changes. Currently, the National Maritime Intelligence-Integration Office (NMIO), under the direction of appointees from the Navy and Coast Guard, is the nominal lead for MDA's information exchange portal, the open architecture tool at the heart of the MDA mission.

Two stages or "spirals" of technology acquisition were planned to develop and integrate the infrastructure that MDA would need to achieve its mission objectives. While a number of policy directives have offered strategic direction, the participating agencies—primarily the U.S. Coast Guard and Navy, with some additional contributions from Customs and Border Protection—have mostly led their own initiatives. Each entity is free to develop its own definition of maritime domain awareness. These definitions may not fit together across the enterprise, even though they are generated from the bottom up. As one former MDA executive expressed in a conversation with CSIS, "To some, binoculars are a maritime domain awareness technology."

Analysis of budget requests from 2009 to the present day shows that to date, services have procured MDA assets mostly under the umbrella of larger program elements. Furthermore, with the exception of some research and development programs led by the Office of Naval Research (ONR), the services have procured primarily non-development items (NDI) and commercial off-the shelf (COTS) products. As a result of this approach to acquisition, investments in MDA are difficult to quantify, progress is difficult to monitor, and oversight is difficult to ensure.

Individually, the attributes described in Figure 2 underscore some merits and demerits of both traditional and enterprise-wide approaches to acquisition governance. The attributes also offer additional insight into acquisition governance best practices when viewed in comparison across the two case study programs. Thus, there are key attribute-specific takeaways offered by the case studies, both in isolation and compared to one another. These takeaways are discussed in Figure 2.



GOVERNANCE ATTRIBUTE	FUTURE COMBAT SYSTEMS	MARITIME DOMAIN AWARENESS
LEVEL OF ORGANIZATIONAL FOCUS	<ul style="list-style-type: none"> Focus on the final product, governance centralized at the program level 	<ul style="list-style-type: none"> Implementation at sub-program level Enterprise-level integration has been prescribed but not implemented
INTEGRATION OF FUNCTIONAL END-USER NEEDS	<ul style="list-style-type: none"> Top-down requirements-setting produced low integration of end-user needs into ongoing FCS development 	<ul style="list-style-type: none"> MDA infrastructure integrates end-user needs as they were described at program start Sub-program funding allows for folding of new needs into spirals of technologies
DECISION-MAKING AUTHORITY	<ul style="list-style-type: none"> Governance model was organized to segregate decision-making and push it downward 	<ul style="list-style-type: none"> Program executives choose whether and to what extent MDA should be incorporated in investment objectives
ENFORCEMENT	<ul style="list-style-type: none"> Other Transaction Authority contract format with minimal management oversight of contractors 	<ul style="list-style-type: none"> No substantial enforcement guiding MDA-relevant programs to desired end state Lacks funding and structure necessary for cross-service enforcement of MDA goals No investments in new workforce development, relying instead on existing acquisition workforce at individual program offices
WORKFORCE	<ul style="list-style-type: none"> Contractor program managers act in the role of acquisition leadership IPTs co-led by one appointee from the LSI and one appointee from the Army 	<ul style="list-style-type: none"> Program managers have no incentive to incorporate MDA objectives into requirements generation or procurement planning
INCENTIVE STRUCTURE	<ul style="list-style-type: none"> Performance incentives based on completion of program events (e.g. design reviews); Cost incentives based on projected life-cycle cost 	<ul style="list-style-type: none"> Informal knowledge sharing occurs through white papers and other forms of thought-leadership
KNOWLEDGE OWNERSHIP / ACCESS TO KNOWLEDGE	<ul style="list-style-type: none"> Significant stovepiping of knowledge; Sub-contractors hesitant to submit competitive information to LSI team 	<ul style="list-style-type: none"> Lack of meaningful leadership mechanisms with no identified tools for management of unforeseen circumstances
RISK ASSESSMENT / RISK MANAGEMENT	<ul style="list-style-type: none"> PMFCS and the LSI conducted independent assessments of program health periodically using an Earned Value Management System (EVMS) 	

Figure 2. Comparison of FCS and MDA Acquisition Governance Attributes

The cases illustrate that the impact of the level of organizational focus in acquisition governance is dependent on how much oversight is in place. In FCS, the concentration of organizational focus at the program level resulted in slow responsiveness to changing warfighter needs and factional protection of capabilities families, such as manned ground vehicles. Rigid oversight from the top constrained the program's progress.

In contrast with this organizational rigidity, the MDA case demonstrates that a more liberal organizational focus in an enterprise-wide governance approach also presents challenges. MDA capabilities acquisition efforts are divided among numerous programs, and the responsibilities for acquisition governance decisions are siloed within separate and occasionally unrelated programs. Progress on the MDA mission has been slow in part because of this dynamic. With greater oversight on the direction of capabilities development, it is possible that MDA assets could reach the theater more quickly and interact more easily.

Additionally, the case comparison suggests that setting requirements and adjusting them to the changing demands of the end user is difficult under top-down governance, whether the responsibility of governance falls to the government or industry. As discussed previously, industry began taking the requirements generation role from the government during the evolution of acquisition governance from the Weapon System Manager Model to the Arsenal Model. The reason for this natural progression was that the government no longer had the technical astuteness to manage more advanced technical requirements. However, the FCS industry LSI also failed to adjust requirements properly and was similarly hamstrung in its efforts to manage subsystem capabilities. Indeed, the size of the



subcontractor network and the diversity of the systems and capabilities being acquired exposed the insufficiencies of a traditional approach to governance.

The MDA effort, by comparison, has demonstrated more agility in its ability to adjust requirements to the end-user community's changing demands. By distributing responsibilities for generating requirements across a network of programs and subprograms, the MDA effort has enabled those closest to the end user to determine capabilities requirements. While guidance from the DoD Executive Agent for Maritime Awareness has provided a framework for the capabilities required in its spirals of technology, the participating offices are free to determine what specific systems fit into that framework. The flaw in this approach is that the definition of maritime domain awareness per se can differ among the offices. Furthermore, there are no mechanisms to ensure that tasks are delegated between government and industry stakeholders in a way that enables timely and cost-efficient delivery of systems and subsystems. A critical system could be delayed due to a unit-level acquisition effort being governed under the LSI Model, for example, with potentially damaging consequences for the broader SoS.

Thus, these differences in the two attributes for Level of Organizational Focus and Integration of Functional End-User Needs help to identify challenges in both the traditional and enterprise-wide approaches to acquisition governance. In contrast, similarities between FCS and MDA illustrate that some governance attributes transcend the dimension of task delegation between the government and industry stakeholder communities. Specifically, a comparison of the attributes for Enforcement, Incentive Structure, and Knowledge Ownership shows that there are critical oversight functions that both industry and government need to get right in order to facilitate complex SoS acquisition.

The FCS and MDA cases both illustrate that system delivery suffers when proper oversight enforcement mechanisms are not in place. Use of an Other Transaction Authority (OTA) contract in FCS created oversight challenges at the systems level, resulting in limited enforcement of cost and technical readiness standards. It is also reported that the LSI issued contracts with standards below those in its contract with the Army. The Army addressed these issues when it revised the contract to a Federal Acquisition Regulation (FAR) contract and established processes for greater Army involvement in capabilities selection and requirements.

Enforcement has been lacking at both the systems and SoS level within MDA. Because the MDA effort is a loose network of individual program offices guided by overarching objectives without prescriptive benchmarks, the DoD has encountered a good deal of difficulty in moving it forward and gauging its progress.

Effective incentives for capability delivery on schedule and on cost were also noticeably absent in both programs. In the case of FCS, performance incentives were based on the completion of program events such as design reviews, rather than on a meaningful metrics-based assessment of technical performance. The misalignment of technical requirements between the LSI team and the government compounded this problem, detracting from the effectiveness of incentives in encouraging on-schedule capability delivery. Cost incentives also were based on artificial benchmarks, assessing contractor cost-performance based on the projected life cycle cost of capabilities rather than on their actual cost track record.

The patchwork of incentives in MDA also appears to be ineffective. In contrast with the artificial incentives in FCS, MDA has few incentives at all on the SoS level. On the systems level, individual programs are responsible for the establishment of incentives for the



delivery of individual capabilities. A more explicit incentives infrastructure may be necessary to encourage greater commitment to the MDA objectives.

Finally, the FCS and MDA cases underscore the importance of knowledge ownership in delivering SoS capabilities. Significant stovepiping was apparent in the FCS case, where the use of an industry-led acquisition workforce raised concerns among subcontractors about the fairness of competition and the use of proprietary information. These concerns created barriers to transparent information sharing across and within programs. While stovepiping has not been prevalent in MDA, unstructured information-sharing processes, combined with a lack of uniform maritime domain awareness definitions, have hampered knowledge sharing among the MDA stakeholders.

Toward a New Acquisition Governance Model

The case study analysis presented previously offers several preliminary key findings for the CSIS effort to identify governance best practices in SoS acquisition. The cases begin to support three themes in the creation of a new governance model.

First, SoS acquisition governance benefits from having strong and structured management oversight procedures tied to documented results. Shared FCS and MDA shortcomings in Enforcement and Incentive Structure originated in insufficient or otherwise flawed oversight. The reported inadequacies of government oversight over the LSI exacerbated technical and programmatic flaws in FCS. In MDA, minimal oversight over a broad network of government customers has caused problems with both the establishment of requirements and the measurement of progress.

Second, existing approaches to acquisition are challenged by high barriers to knowledge sharing and a lack of clarity regarding the ownership of this knowledge. The use of an LSI contractor in FCS created disincentives to information sharing, both within the program and with the customer. Industry stakeholders perceived that information sharing between and among their peers would damage their competitiveness and compromise their proprietary information. While these structural impediments to knowledge sharing are not apparent in MDA, that program instead has minimal incentives to promote knowledge sharing. In other words, explicit barriers do not exist between and among MDA stakeholders, but there is insufficient payoff for knowledge sharing outside of lower level systems.

Third, a new model of acquisition governance may require more task sharing between government and industry than has been seen in prior models. Some problems with FCS are attributable to that program's use of an SI Model of acquisition governance. However, similar problems apparent in the MDA program show that designating other tasks to government—in the case of that program, the task of Program Management—is not sufficient to fix problems of management oversight. In fact, a comparison of MDA and FCS shows that replacing industry with government in non-Program Requirements tasks of the SI Model to create a new model seems to have created additional problems with the lead agency's ability to coordinate and enforce progress among other participating agencies.

Conclusion

As government demands to defeat threats to global security cause systems of capabilities to grow in size and complexity, the limited effectiveness of existing models of acquisition governance is becoming more apparent. The initial analysis reflected in this interim report underscores the importance of further research on best practices in acquisition governance with a view toward the creation of a new model. The example case studies presented here are a first step in an effort by CSIS to identify those best practices.



The case studies illustrate that getting governance right would involve a thorough analysis of how program outcomes are affected by a comprehensive set of governance attributes. Each of the eight attributes used here represents a different but vital element of any acquisition effort. Moving forward, the CSIS Complexity project team will perform an analysis similar to the one discussed previously across a total of seven SoS acquisition case studies to identify what practices in acquisition governance contribute to program success and what practices make successful capabilities development and acquisition more difficult to achieve. The preliminary cases presented here will also be refined based on the results of an ongoing primary research effort.

This interim report serves as a progress report on efforts by CSIS to identify best practices in SoS acquisition governance. This effort will incorporate additional case studies in the coming months and will conclude in September 2013 with a full report on best practices and a framework for new governance models. The report will be presented at the May 2014 Naval Postgraduate School Acquisition Research Symposium.

References

- Ben-Ari, G., & Chao, P. (Eds.). (2009). *Organizing for a complex world: Developing tomorrow's defense and net-centric systems*. Washington, DC: CSIS.
- Berteau, D. J., Ben-Ari, G., & Zlatnik, M. (2009). *Complex government technology development programs: Meeting the policy challenges*. Presented at 2009 Atlanta Conference on Science and Innovation Policy, Atlanta, GA, Georgia Institute of Technology.
- Corrin, A. (2012, May 29). Army to pay \$500M for Future Combat Systems termination. *Federal Computer Week*. Retrieved from <http://fcw.com/articles/2012/05/29/army-future-combat-systems-500-million-cancellation-fee.aspx>
- GAO. (2007, March). *Assessments of selected weapons programs: Report to congressional committees* (GAO-07-406SP). Retrieved from <http://www.gao.gov/assets/260/258416.pdf>
- GAO. (2012, March). *Assessments of selected weapons programs: Report to congressional committees* (GAO-12-400SP). Retrieved from <http://www.gao.gov/assets/590/589695.pdf>
- GAO. (2013, March). *Assessments of selected weapons programs: Report to congressional committees* (GAO-13-294SP). Retrieved from <http://www.gao.gov/assets/660/653379.pdf>
- Malenic, M. (2009, May 22). Army awaits approval to break FCS into three programs. *Defense Daily*.
- Malenic, M. (2010, January 15). Army chief expects new vehicle program to avoid FCS pitfalls. *Defense Daily*.
- Pernin, C., et al. (2012). *Lessons from the Army's Future Combat Systems program*. Santa Monica, CA: RAND.
- Sapolsky, H. (2009). Models for governing large systems projects. In G. Ben-Ari & P. Chao (Eds.), *Organizing for a complex world: Developing tomorrow's defense and net-centric systems*. Washington, DC: CSIS.

Acknowledgement

This paper is dedicated to the memory of Guy Ben-Ari (1973–2013). Throughout his career, Guy contributed pioneering thought to the field of innovation in the defense industry. He will be missed.





ACQUISITION RESEARCH PROGRAM
GRADUATE SCHOOL OF BUSINESS & PUBLIC POLICY
NAVAL POSTGRADUATE SCHOOL
555 DYER ROAD, INGERSOLL HALL
MONTEREY, CA 93943

www.acquisitionresearch.net