Centralized Execution, Decentralized Control: Why We Go Slow in Defense Acquisition

by

John M. Mehrman
Lieutenant Colonel, United States Air Force

B.S. Mechanical Engineering, Rensselaer Polytechnic Institute, 1999
M.S. Aeronautical Engineering, Air Force Institute of Technology, 2006
Master of Military Operational Art and Science, Air University, 2011

SUBMITTED TO THE SYSTEM DESIGN AND MANAGEMENT PROGRAM IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE IN ENGINEERING AND MANAGEMENT

AT THE

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

FEBRUARY 2018

© 2018 John M. Mehrman. All rights reserved

The author hereby grants to MIT permission to reproduce and to distribute publicly paper and electronic copies of this thesis document in whole or in part in any medium now known or hereafter created.

Signature redacted

Signature of Author

Signature redacted

John M. Mehrman
System Design and Management Program
19 January 2018

Signature redacted

Certified by

Signature redacted

Bryan R. Moser, Ph.D.
MIT System Design and Management, Academic Director and Senior Lecturer
University of Tokyo, Associate Professor
Thesis Supervisor

Signature redacted

Accepted by

Signature redacted

Joan S. Rubin
Executive Director, System Design and Management Program
This Page Intentionally Left Blank
Disclaimer
The views expressed in this document are those of the author and do not reflect the official position or policies of the United States Air Force, Department of Defense, or Government
Centralized Execution, Decentralized Control: Why We Go Slow in Defense Acquisition

By

John M. Mehrman
Lieutenant Colonel, United States Air Force

Submitted to the System Design and Management Program on 19 January 2018 in partial fulfillment of the requirements for the degree of Master of Science in Engineering and Management

Abstract

The slow pace to field new defense weapon systems is allowing potential adversaries to catch up to the technological advantage the U.S. has maintained since World War II. Despite hundreds of studies, and a near constant state of “acquisition reform”, the problem continues.

This research analyzed the defense acquisition process as a socio-technical system, focusing on the source selection process as subset of the Defense Acquisition System (DAS) for modeling purposes to investigate the value of the separation of contracting and program management authorities. Network graphs showed how Conway’s law predicted the effect of the separation of authorities on the topographic structure of the source selection process and a high network distance between the separate authorities. An agent-based model was built that showed a 26% cost (112 days) in terms of schedule because of the separation of authorities. The benefit of the separation was investigated by scoring the comments received by the Multi-Functional Independent Review Team (MIRT) for five different source selections and found that less than 1% of comments had a likely impact on the decision and less than 4% had a likely or highly likely impact on protestability.

The results showed that while there is a small benefit to the separation of authorities currently implemented in the source selection process, the cost is very high. Enough data and evidence were generated to recommend taking steps to better structurally combine the two authorities and better integrate source selection expertise into the process.

Thesis Supervisor: Bryan R. Moser
Title: Academic Director and Senior Lecturer, MIT System Design and Management
Acknowledgements

First, I want to thank the Air Force, for giving me yet another opportunity to grow and learn. The opportunity to spend a year at MIT to recharge, reflect, and prepare academically for the next stage of my career has been invaluable.

I want to acknowledge my colleagues and friends in the Air Force acquisition community that provided immensely valuable thoughts, data, and most importantly, their valuable time, supporting this project. Lieutenant General Arnold Bunch from SAF/AQ, John Weyrick, Kelly Shackelford, and Chris Hampton in the F-16 program office, Jason Cedek and Barry Foster in the AFLCMC ACE office, David Hall, Nick Braun, Gail Krentz, and Captain Joey Baza in AFLCMC/PK, James Clift from the AFLOA, and Lieutenant Colonel Chad Searle from the AFNWC.

The entire faculty, staff, teaching assistants, and fellows of the System Design and Management program have been enormously supportive. Not only did they welcome my ideas, but they also shared their fascinating insights and stories that helped me navigate the challenging curriculum and better understand this complex world we live in. I especially want to thank Joan Rubin and Bill Foley who enthusiastically supported me when I inquired about continuing from the certificate program to pursue the full master’s degree.

I also wanted to thank Bryan Moser for welcoming me to his Global Technical Leaders research group and advising me during the thesis. The amount of time and patience he gave to guide me through the long research process was remarkable. His passion for seeking a better understanding of the management of complex systems and sharing with others is truly inspiring.

Lastly, I wanted to thank my wife and son for their endless support, encouragement, and the extra moves. Being a military family isn’t the easiest, but we have been able to share many amazing opportunities because of it. Your love and support is all I need in life.
Table of Contents

Abstract ........................................................................................................................................5
Acknowledgements ....................................................................................................................7
Table of Contents ...................................................................................................................9
List of Figures ..........................................................................................................................11
List of Tables ............................................................................................................................12
Introduction .............................................................................................................................13
  Motivation .............................................................................................................................13
  Defense Acquisition ..............................................................................................................14
  The Army “Null” Program ....................................................................................................17
  Problem Statement ...............................................................................................................18
Background and Related Research .........................................................................................23
  DAS Background ................................................................................................................23
  Acquisition Reform .............................................................................................................28
  Hypothesis ..........................................................................................................................31
  Model Selection ..................................................................................................................34
  Defining Value .....................................................................................................................37
  Determining Cost ................................................................................................................40
  Determining Benefit ............................................................................................................46
Analysis .....................................................................................................................................53
  System Definition ...............................................................................................................53
    Stakeholders ......................................................................................................................56
    Source Selection Process .................................................................................................62
  Orient ......................................................................................................................................67
    Stakeholder Value Network ...............................................................................................68
    Network Graph ..................................................................................................................71
  Cost .......................................................................................................................................73
    TeamPort Model ................................................................................................................74
    TeamPort Baseline Model Forecast .....................................................................................81
    Source Selection Design Walk and Cost Results ...............................................................85
  Benefit .....................................................................................................................................91
    Air Force Protest Analysis .................................................................................................92
    Process Benefits ...............................................................................................................93
Conclusions .............................................................................................................................99
  Summary of Cost ..................................................................................................................100
### Recommendations and Future Research

#### Recommendations

- Take More Risk in the Source Selection Process .................................................. 109
- Expand the ACE ........................................................................................................ 112
- Use ABMs and Project Design for Schedule Development ...................................... 113

#### Future Research

- Understanding Benefit ............................................................................................... 114
- Examination of Protests .......................................................................................... 114
- Coordination Distance – Separation of Authorities .................................................. 115

### Glossary

#### Bibliography
List of Figures

Figure 1. DoD Decision Support Systems (Defense Acquisition University 2017) .......................................................... 15
Figure 2. DoD Decision Process in 5 Dimensions (Defense Acquisition University 2017)............................................. 16
Figure 3. Integrated Defense Acquisition Life Cycle Management System (Shachtman 2010) ........................................... 17
Figure 4. John Boyd’s O-O-D-A Loop (Osinga 2005) ........................................................................................................ 20
Figure 5. Phases, Milestones and Decision Points of the DAS (AcqNotes n.d.) ................................................................. 24
Figure 6. Output Measures of the DAS (USD(AT&L) 2016) ......................................................................................... 24
Figure 7. DAS Program Tiered Chain of Command (Defense Acquisition University 2017) ............................................. 25
Figure 8. Major Defense Acquisition Reform Studies and Initiatives (McNew 2011) ........................................................ 29
Figure 9. Outcome Measures of the Source Selection System ................................................................................ 38
Figure 10. TeamPort ABM Software Symbology (Global Project Design 2016) ............................................................... 44
Figure 11. TeamPort ABM Software Architecture View (Global Project Design 2016) ....................................................... 46
Figure 12. Source Selection Value Diagram .................................................................................................................. 47
Figure 13. Example Comment from Air Force Source Selection CRM ........................................................................ 50
Figure 14. High Level Source Selection Process Diagram ........................................................................................... 54
Figure 15. AFLCMC Source Selection Standard Process - Key Decision Points (AFLCMC/AQ 2013) .................................. 64
Figure 16. AFLCMC Source Selection Standard Process (AFLCMC/AQ 2013) .............................................................. 66
Figure 17. Source Selection Stakeholder Value Network (SVN) .................................................................................. 70
Figure 18. Source Selection Process Network Graph - Yifun Hu Algorithm ................................................................. 72
Figure 19. Baseline TeamPort Model Stakeholder Organization ...................................................................................... 76
Figure 20. Baseline TeamPort Model Product Breakdown Structure ................................................................................ 77
Figure 21. Baseline TeamPort Model Activities and Phases (1 of 2) ........................................................................... 78
Figure 22. Baseline TeamPort Model Activities and Phases (2 of 2) ........................................................................... 78
Figure 23. Baseline TeamPort Source Selection Model Sketch ....................................................................................... 80
Figure 24. AFLCMC Source Selection Design Tradespace ............................................................................................. 87
Figure 25. Source Selection SVN Separation of Authorities Evolution ........................................................................ 90
Figure 26. Source Selection Network Graph Separation of Authorities Evolution ..................................................... 91
Figure 27. Air Force Competitive Action Protest Rate and Protest Effectiveness (AFLOA 2017) ......................................... 92
Figure 28. Sample CRM Scoring Sheet ......................................................................................................................... 94
Figure 29. Combined Comment Impact Pie Charts ......................................................................................................... 97
Figure 30. Value of the Separation of Authorities in Source Selections ........................................................................ 103
Figure 31. Risk Based Source Selection Process Matrix .............................................................................................. 110
List of Tables

Table 1. Source Selection CRM Scoring Scale ........................................................................................................... 50
Table 2. Baseline TeamPort Model Stakeholder Team Sizes .................................................................................. 75
Table 3. TeamPort Baseline Process Project Design - Activity, Work Effort, Contracts ........................................... 79
Table 4. TeamPort Baseline Process Project Forecast - Schedule, Work, Coord .................................................... 83
Table 5. TeamPort Baseline Process Total Work Forecast ..................................................................................... 84
Table 6. Source Selection Process Tradespace - Separation of Authorities ............................................................. 86
Table 7. Source Selection Comment Scoring Results .............................................................................................. 96
Introduction

The Congress has grown increasingly concerned that the U.S. military technological advantage is eroding as great power competitors modernize their militaries to counter our ability to project power. Part of this erosion is due to the defense acquisition system, which has grown too risk-adverse, takes too long, and costs too much to innovate, develop, and field new capabilities (McCain, 2017).

—Senator John McCain

Motivation

The U.S. defense acquisition system (DAS) is too slow. The U.S. military relies on a qualitative technical advantage to defend ourselves and our allies. This strategy has served the U.S. well since WWII. We have been able to secure the nations interests despite a decreasing number of military personnel, planes, ships, and tanks. However, the government process for acquiring new military technologies has become increasingly bloated with multiple sources of process overhead. It is not uncommon for major programs to take 10-15 years to field a new system. For perspective, shortly after Alan Sheppard’s first U.S. manned flight into space, President Kennedy announced his vision to land a man on the moon. It only took 9 more years to fulfill his vision. Other
nation states have closed the technological gap, especially as the information age has lessened the barriers to knowledge transfer. In short, our current acquisition system is threatening the ability of the U.S. to maintain its technological advantage and to ensure the nation’s defense.

Defense Acquisition

New systems are acquired in the Department of Defense (DoD) through the combination of three distinct processes as shown in Figure 1: The Joint Capabilities Integration and Development System (JCIDS), the Planning, Programming, Budgeting, and Execution (PPBE) process, and the Defense Acquisition System (DAS). Together, they are referred to as the “DoD Decision Process” or for acquisition simply the Big “A”. JCIDS defines the operational requirements for the system based upon inputs from the commands that use the systems. PPBE is the process by which the annual defense budget is planned and executed, covering the next 5 years of activities although only one year is authorized and appropriated by congress annually. The DAS is the process the defense acquisition community uses to develop, produce and field a system, usually through the contracting of private companies. The DAS is also referred to as the Little “a” to denote that the full acquisition process requires the other two DoD decision processes to field a capability.
All three processes need to operate in unison to field a desired capability. Imbalance between requirements, funding and acquisition strategy for a weapon system lead to program failure, and keeping the three aligned can be difficult. The five dimensions of the DoD Decision Support System can be seen in Figure 2 which illustrates the complexity involved in aligning the various regulations that define the processes and the numerous stakeholders involved. While cumbersome, this decision system has fielded some remarkable capabilities that have kept the U.S. at the forefront of military power in the world. The current Big A dates largely back to the 1960s when Robert McNamara was Secretary of Defense and sought to better organize how the DoD conducted business, making it more like a corporation. In fact, yet another name is “the corporate process”.

*Figure 1. DoD Decision Support Systems (Defense Acquisition University, 2017)*
The DAS alone is an enormously complex process. The Defense Acquisition University (DAU), where all acquisition professionals in the DoD are trained for their position, publishes a wall chart that shows the process. It is unreadable in any form smaller than about 3 x 2 feet. That wall chart is shown in Figure 3 in a size much smaller, but you don’t need to be able to read it to see the complexity of the process. Looking at it from afar, it’s amazing that anything gets fielded. This version was found on the web in an article titled, “Pentagon’s Craziest PowerPoint Slide Revealed” (Shachtman, 2010). The DoD had to create DAU just to teach the unique complexity of the DAS process.
The Army "Null" Program

In 2011, facing pressure to reduce the schedule on a new ground vehicle, the Army Ground Combat Systems (GCS) office conducted a baseline program review to find efficiencies and reduce timelines for major defense acquisition programs. Their baseline program was 16.5 years from the development decision to full rate production for a single variant ground vehicle system with limited technology development. This was unbelievable and unacceptable to many in the DoD. By the time you field a system, the requirements you used to build it are 16.5 years old. A lot changes in a
decade and a half including the capability gap and threats that were trying to be addressed.

The Army GCS office went further and build a baseline schedule that removed all of the design, build and test activities from the schedule. This left only the DAS required documentation, reviews, and processes. They called it the “null program” and they came up with 10 years (Polsen, 2011). For a Major Defense Acquisition Program (MDAP), they showed that the fastest you can go through the DAS process, without actually producing anything, is 10 years. These are enormously complex systems, but the current DAS process matches the complexity of the weapon system with the complexity of the bureaucracy to support it.

Problem Statement

For all of its problems, the DAS has delivered some of the most complex and technologically advanced systems in the world. Systems that have changed the nature of defense and for some, society as a whole. Successful systems such as ICBMs, nuclear submarines, the global positioning system, space surveillance and communication, precision guided munitions, and unmanned aerial vehicles were delivered using the DAS. However, as more layers of bureaucracy and oversight have been added to the process over the years, the system has slowed to glacial speed. As an example, the F-35 Joint Strike Fighter program awarded a system design and development contract to Lockheed Martin October of 2001 and achieved first flight in December of 2006 (Joint Strike Fighter Program Office, n.d.). It has been over 16 years
since contract award, and the system has still not reached initial operational capability with the U.S. Air Force.

John Boyd, an Air Force fighter pilot and strategist, developed a framework of the decision-making process that can be applied from the individual to the national level called the “OODA” loop, shown in Figure 4. He studied systems theory amongst a wide and eclectic mix of disciplines and drew his OODA loop like a controls diagram with inputs, output and feedbacks. His model generally follows the scientific method, and starts with observing, where you are gathering data from the environment. Next comes orientating, where analysis and synthesis of the observation is combined with your previous experiences, knowledge and biases. Lastly a decision is made based upon a hypothesis and turned into action or a test. Feedback loops connect the model elements to form a continuous process. When applied to warfare, Boyd hypothesized that to win you, “should operate at a faster tempo or rhythm,” than your adversary’s OODA loop (Osinga, 2005).
Viewing the DAS through the perspective of John Boyd, our adversaries are now able to operate and react to our DAS OODA loop faster than we can get through it. The technological advantage we built through the Cold War, culminating in our complete dominance in the first Gulf War, has eroded as we have been mired in Afghanistan and Iraq as part of the Global War on Terrorism. The forces of globalization and the worldwide web have increased the speed of knowledge and technology dispersion, and are further enabling our adversaries to catch up to our technological advantage quickly. Comparing Chinese 5th Generation fighter development to the F-35, the Chinese J-20 fighter achieved first flight in January 2011 yet was just declared operational in October of 2017 (Gady, 2017). That is almost double the speed of fielding the F-35.
Our adversaries are able to react more quickly than we can and if we don’t change how we field new weapons, they will soon overtake our technological advantage. This leads to the problem statement of this research:

System Problem Statement

To improve Air Force acquisition timelines while maintaining a technological advantage,

By analyzing the DAS as a system and investigating its dynamics,

Using systems analysis tools and methodologies
Background and Related Research

Organizations which design systems...are constrained to produce designs which are copies of the communication structure of these organizations. (Conway, 1968)

-Melvin E. Conway

DAS Background

As discussed previously, the DAS is an enormously complex bureaucracy of people, regulations and processes. The U.S. spends around $500B a year on defense with about $100B going to the USAF. The 2017 President’s Budget request for the DoD included $71.7B for Research, Development, Test and Evaluation and another $112.0B for Procurement for the year. Acquisition is big business. The DAS is organized around milestone decision points (A, B, and C) where the program is fully evaluated by a designated Milestone Decision Authority (MDA) to determine if it should proceed to the next phase. A diagram of the DAS phases and milestones is shown in Figure 5.
A system diagram of the DAS is shown in Figure 6. The outputs of the DAS are programs whose properties include cost, schedule, and performance. Value to the department is measured by the balance of those properties (USD(AT&L), 2016). That is a broad definition of value and will require further clarification to be useful for analysis.

The DAS system is described by policies, regulations and guidance captured in DoDD 5000.01 The Defense Acquisition System (USD(AT&L), 2007) and DoDI 5000.02 Operation of the Defense Acquisition System (USD(AT&L), 2017). The DAS uses a tiered approach to oversight, with higher cost programs receiving more oversight. Each
program is assigned an Acquisition Category (ACAT) level that is based upon the total estimated RDT&E and Procurement funding needed to field the system. ACAT I programs are the largest and are also referred to as Major Defense Acquisition Programs (MDAP) or Major Automated Information Systems (MAIS) for information systems (Defense Acquisition University, 2017). In the 2017 PB, MDAP/MAIS programs accounted for 40% ($72.7B) of all RDT&E and Procurement funding for the DoD (USD(AT&L), 2016).

![Figure 7. DAS Program Tiered Chain of Command (Defense Acquisition University, 2017)](attachment:image)

The levels of oversight and authorities that correspond to each ACAT level can be found in Figure 7. The general line of authority for a program runs from the Program
Manager (PM) to the Program Executive Officer (PEO) who generally has a portfolio of programs in a certain area such as the AF PEO for Fighters and Bombers. PEOs report to the Service/Component Acquisition Executive (SAE/CAE) who is an Assistant Secretary in the Air Force. The SAE/CAE reports to the Defense Acquisition Executive (DAE) who is responsible for all acquisitions in the DoD and is the Undersecretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)).

The DAS manages risk through oversight, under the premise that the larger the program, the higher the consequence of a mistake or failure. The ACAT level determines who the Milestone Decision Authority (MDA). An MDA is assigned for each program and has the statutory authority to decide when a program is ready to move to the next phase of the DAS. They document decisions and guidance to Program Managers through Acquisition Decision Memorandums (ADMs). The larger the program or ACAT, the higher up the acquisition chain of command the MDA will be and the more layers of oversight will be applied.

However, adding more complexity to the DAS, there is another authority chain that has not yet been discussed. As shown back in Figure 2, contracting authorities in the DAS are separate from program management. The other two DoD decision systems do not have this separation of authorities. Almost all defense acquisition programs require contracts to execute. The general acquisition model of the U.S. is that private companies develop and build end-items for the government. Contracts are agreed upon between the government and these companies to deliver goods and/or services. In FY15, the DoD contracted for $132.6B of supplies and equipment and $146.5B of services (USD(AT&L), 2016). Not all of these contracts are in support of the
acquisition system, but point to the magnitude of transactions that the contracting management chain is responsible for each year. Regulations for contracting are captured in the Federal Acquisition Regulations (FAR). Supplements for the DoD (DFARS) and Air Force (AFFARS) include additional guidance specific to the agency (Federal Acquisition Regulations, n.d.).

FAR subpart 1.6 outlines the authorities and responsibilities of a contracting officer. Only contracting officers have the authority to enter into, administer or terminate a contract. Contracting authorities are delegated from the head of a government agency (Secretary), often through multiple levels, to the contracting officer through the SF 1402 Certificate of Appointment, otherwise known as a Warrant. The Warrant appoints the contracting officer and provides specific limits on their authority. They can then bind the government, within the limits documented in laws, regulations, and their SF 1402, to pay for the product or service per the terms of the contract. Contracting officers are responsible for ensuring performance of all necessary actions for effective contracting, ensuring compliance with the terms of the contract, and safeguarding the interests of the U.S. in its contractual relationships. In addition, contracting officers are responsible for ensuring that contractors receive impartial, fair, and equitable treatment (Federal Acquisition Regulations, n.d.). Because of the separation of authorities in the DAS, a successful relationship between a program manager and contracting officer is crucial for program success.
Acquisition Reform

Defense acquisition is often criticized for its cost, schedule, and performance shortfalls. The DAS has been in a near constant state of reform since the Office of the Secretary of Defense was created in 1947, with over 150 significant “studies” conducted on acquisition reform since WWII (Reeves, 1996). A 1970 study found that there were 79 different offices issuing acquisition policy leading to 30,000 pages of regulations. During the Cold War build-up in the early 1980s, major weapon system cost growth was especially bad, and the pace of reform increased (Schwartz, 2013). Many of today’s acquisition reform initiatives date back to the Packard Commission Report, which arguably led to the most impactful changes to the DAS (McNew, 2011). A summary of the major studies and initiatives is shown in Figure 8.
There are many excellent reviews of the various acquisition reform initiatives. Instead of reviewing the details of the initiatives here, several previous reviews are included in the bibliography. There are some general trends within the studies that are worth mentioning related to this research. The first, is that the studies often oscillate between recommendations. The preference for cost or fixed price contracts for development has switched about every ten years (Cancian, 1995). The various
initiatives have also oscillated between centralized control of acquisition under OSD and
decentralized control with OSD in more of an oversight role (Reeves, 1996). The
oscillations show that the system is overcorrecting to undesired system output. In
control theory terms, the gain is too high for the time constant of the system leading to
overshoot and instability. The second general trend is the opposite, that often the same
recommendations are made throughout the years (McNew, 2011). This indicates that
the underlying cause is never really acted upon. One consistent recommendation is the
consolidation and reduction of the bureaucracy and regulations that govern acquisition.
While a few initiatives have actually succeeded in reducing regulations, such as the
Federal Acquisition Streamlining Act (FASA) of 1994 which resulted in the creation of
the Federal Acquisition Regulations (FAR) (Schwartz, 2013), they continue to still be
viewed as too many and yet continue to grow. The latest acquisition reform initiative,
the Section 809 panel, has been specifically tasked with reviewing acquisition
regulations and recommending for elimination those not necessary to meet the overall
objectives of the system (Advisory Panel on Streamlining and Codifying Acquisition
Regulations, 2017).

Despite the numerous reform efforts, development contracts have experienced a
median cost growth of 32% since 1993 (Schwartz, 2013). Everyone from congress to
the Service Chiefs still complain that the system is broken – too slow, too expensive,
and too complex (Hebert A., 2017). In fact, several have argued that rather than
improving the system, acquisition reform efforts have made the DAS less effective and
efficient. (Schwartz, 2013) "In an attempt to not repeat past failures, additional staff,
processes, steps, and tasks have been imposed. While well intended, collectively these modifications are counterproductive” (U.S. Army, 2010).

The last general trend of these initiatives is that they have led to minimal effective and lasting changes to the DAS. These panels are generally conceived by asking a collection of subject matter experts (SMEs) related to the acquisition of complex systems to convene a panel and recommend changes. This usually includes former senior acquisition executives, high ranking operational military commanders, business executives and maybe someone from academia to sit on panel and hypothesize on what the problems could be by looking at the current architecture of the system and the high-level output data. Very few of the recommendations are based on a scientific approach that involves generating a hypothesis and then testing based on a theory of and underlying mechanism with empirical data. Instead, the panels make a bunch of recommendations, some are implemented fully or partially, and then the results at the highest-level outputs are measure several years later. The DAS is still not functioning as desired and it’s extraordinarily difficult to trace the effectiveness of any single recommendation to the overall output of the system. Then, commission another acquisition reform effort and the continuous process of acquisition reform begins anew.

Hypothesis

This research aimed at going deeper by looking at the dynamics of the DAS and how the multitude of parts interact to develop and produce a system. Given the
complexity of the DAS, this was a lofty goal. To start, a hypothesis needed to be developed to test against. The Air Force recently commissioned the Air Force Science Board for yet another study of the DAS titled “Owning the Technical Baseline for Acquisition Programs in the U.S. Air Force.” The group was tasked to make recommendations so they USAF could better “own the technical baseline for its acquisition programs.” The general feeling was that USAF acquisition program offices had lost the capability to provide close technical oversight of contractors building the next generation of weapon systems. One of the recommendations was to clarify the roles and authorities of the program manager (PM) and contracting officer (CO). The view was that the current mix of authorities and accountabilities, “are causing a dysfunctional, as opposed to creative, tension, which is negatively impacting government acquisition team effectiveness.” Expanding, the team concluded that the bifurcation of the PM and CO communities has resulted in two chains of authority managing a program (Air Force Studies Board, 2016).

This was an interesting perspective and hypothesis, but no data was presented to justify the position. Clearly this recommendation required a deeper look into the mechanisms of interaction among teams in a system to really understand the tradespace. Thus, the following research hypothesis was developed:
Hypothesis

The current extent of the separation of contracting and program management authorities in the Defense Acquisition System has a net negative value to the Air Force.
Research Methodology

More than ambition, more than ability, it is rules that limit contribution; rules are the lowest common denominator of human behavior. They are a substitute for rational thought. (Rickover, 1954)

- Admiral Hyman Rickover

Model Selection

One definition of a complex systems is that it, “has many elements or entities that are highly interrelated, interconnected, or interwoven” (Crawley, Cameron, & Selva, 2016). The DAS also meets the definition of a Complex Adaptive System (CAS). Holland described CAS as “systems that have large numbers of components, often called agents, that interact and adapt or learn” (Holland, 2006). The DAS has 1000s of stakeholders, defined here at the meso-level comprising of a group of individuals with a distinct mission and interests. These “agents” work together accomplishing the different activities required to execute the process. These activities require coordination among the agents to complete the activities and for each agent to make decisions about how to execute their activity.

However, one of the challenges of applying systems analysis methodologies to the DAS is the enormous size and complexity of the system. Testing the hypothesis previously presented for the entire DAS would be extraordinarily challenging. There are hundreds of interactions and variables that interact non-linearly with an equal number of
emergent behaviors. Even the yearly reports by the USD(AT&L) about the performance of the DAS, which is at least an attempt to more scientifically study the DAS, collects data at the macro-level and tries to draw conclusions about the effectiveness of policy changes by noting the trending of cost, schedule and performance measurements (USD(AT&L), 2016). Since multiple aspect of the DAS are changed between any given year, determining the positive or negative contribution of each change to the overall system data is nearly impossible.

Thus, for this research the source selection process was selected for the application of modelling and systems methodologies to better capture the effects of the separation of authorities on the system. The source selection process is a sub-process of the DAS and is used to select a contractor to provide goods and/or services to the DoD. The source selection process happens at least once for a defense acquisition program, usually right before the Milestone B decision point prior to the Engineering and Manufacturing Development (EMD) phase.

More specifically, this research analyzed a best-value competitive source selection. The federal government has a preference of utilizing competition in contracting actions. One of the central tenets of the USD(AT&L) Better Buying Power (BBP) initiatives is to “promote effective competition.” In a memorandum to the workforce describing actions to improve DoD competition from 2014, the USD(AT&L) Frank Kendall described competition, “as the most valuable means we have to motivate industry to deliver effective and efficient solutions” …and, “when we create and maintain a competitive
environment, we are able to spur innovation, improve quality and performance, and lower costs for the supplies and services we acquire” (Kendall, 2014).

The source selection process has a lot of qualities that make it a good substitute for the entire DAS to test different hypothesis about how the DAS functions. First, the source selection process is done almost entirely in serial fashion with the rest of the DAS processes. During source selection, almost the entire program office will be focused on completing the process. Therefore, the effect of multiple processes consuming overlapping resources, and agents having to choose which parallel process demand they need to satisfy at a given moment, is greatly reduced. Second, the source selection process is long, averaging between 1 to 3 years. Like the DAS, emergent behaviors that have longer time-constants before they reveal themselves may also be found in the source selection process. Also, even finding insights that only apply to the source selection process can translate to improvements in efficiency that have a large effect on the overall DAS timelines.

Additionally, the source selection process has several unique attributes that make it a good sub-process specifically for testing the hypothesis. First, the source selection process has elements clearly as a result of the separation of authorities. Second, the source selection process is vary controlled. Once the Request for Proposal (RFP) is released and contractors begin working on their proposals, the government source selection team is largely isolated from the externalities present in the rest of the DAS. They are not allowed to discuss how the source selection process is progressing outside of the key stakeholders. This “cone-of-silence” isolates the source selection
team from many of the political and bureaucratic pressures that can be challenging to model and isolate from other variables in the rest of the DAS.

Defining Value

Now that a source selection process has been chosen to analyze effects for extrapolation to the larger DAS, value has to be defined in relation to the source selection process. In general, value is, “the delivery of benefit at cost” (Crawley, Cameron, & Selva, 2016). Or, in equation form:

Value = Benefit – Cost (1)

If the benefit is greater than the cost than you have a positive value. Conversely, if the benefit is less than the cost you have a negative value. The challenge with value as a measurement is that the units of benefit and cost are often not the same, making the overall value determination subjective at best. The DoD in particular has this problem because while cost of acquisition programs has the unit of dollars, the benefit of that money as a contribution to the defense of the nation has no units. A commercial airline, on the other hand, has a good idea of how much revenue an airplane can generate. Revenue is their benefit and the units are the same as their cost. Therefore, they can easily determine the value of purchase a new airplane.
Defining value for a source selection starts with analyzing system. As described in the 2011 DoD Source Selection Procedures, the goal of the process is to, "deliver quality, timely products and services to the Warfighter and the Nation at the best value for the taxpayer" (USD(AT&L), 2011). Figure 9 below is a system level view of the source selection system outcomes in the same format as the DAS diagram in Figure 6. The output of the source selection process is a decision on which contractor proposal provides the best-value when evaluated against the Air Force's requirements. The product of that output is a documented decision and contract with the selected bidder. The source selection process output has several properties: the quality of the decision, the fairness of the decision process, and the schedule required to execute the process.

![Diagram of Source Selection Process]

*Figure 9. Outcome Measures of the Source Selection System*

The source selection process serves two primary functions. The first function supports the more obvious purpose of the process which is to select a contractor to deliver goods and/or services to the Air Force. Broadly, this function supports a decision and the desire is to make the best decision by selecting the best source from the pool of bidding contractors. In most source selections, the Source Selection
Authority (SSA) determines which combination of performance, cost, and schedule offered by the competing contractors provides the best-value to the government. In other words, the lowest cost doesn’t always win. For the source selection process, the property of the first function is quality, as in the quality of the decision.

The second function is to ensure the fairness of the process so all bidders have an equal opportunity to bid and be selected. As stated in the FAR, the source selection process is, “designed to foster and impartial and comprehensive evaluation of offerors’ proposals” (Federal Acquisition Regulations, n.d.). According to the Government Accountability Office (GAO), “the laws and regulations that govern contracting with the federal government are designed to ensure that federal procurements are conducted fairly” (GAO, 2009). For government procurements, if a bidder feels the process has been unfair, they can file a protest to the GAO or the agency that issued the RFP. If the protest is sustained, corrective actions must be accomplished. This can include everything from a relatively quick re-evaluation of a proposal and updated decision to starting the source selection over with a new RFP and bids.

The fairness function is unique to government procurement. When a private company decides on a source, they don’t need to be fair. They can make the decision any way they want and only need to justify themselves to upper management or shareholders. A losing bidder has no recourse to protest the fairness of the decision. This is certainly a big factor in why commercial source selections are significantly faster than the government. The government source selection process needs to include activities and expend resources to ensure the fairness function is satisfied.
Determining Cost

Once value was defined and the source selection process outputs, properties, and functions were analyzed, the value equation was broken into its two elements for analysis. Cost was simpler to define and analyze for the source selection process, so analysis started there. Monetary cost for the source selection process is minimal, especially when compared with the size of the contracts that accompany large defense programs. Variations to the process would have a barely measurable monetary savings to the government. As stated in the motivation, it is the pace of the entire acquisition process that is allowing our adversaries to catch up to our technological advantage. Having a source selection process that can take well over a year has a large schedule cost on the DAS. Therefore, from a value perspective, cost was defined as the schedule to complete the process, aligning with the schedule output property of Figure 9.

The next step was to find a way to determine how the separation of authorities could affect schedule. Going back to the quote that started the Background and Related Research chapter, organizations often design complex systems in a way that mirrors their organizational structure, or lines of communication (Conway, 1968). This is often referred to as Conway’s Law and the same idea can be expanded to organizations that create processes. Conway’s theory can help explain why innovation tends to happen more in startup companies. The design of a small company’s system is not constrained by the stove-pipes of communication that characterize larger, more established companies. Once an organizational structure is in place, all problems are
viewed through the lens of that organizational structure. The evidence can be seen by observing how established companies struggle to adapt to changing markets and technologies. Those that have longevity are often the ones that can adapt the organization to keep innovating.

With Conway’s law in mind, the source selection process was analyzed from the standpoint of additional process scope or topology that could be related directly back to the separation of authorities. Using a concept discussed by Moser and Wood applied to complex socio-technical systems, Project Design was used to reverse engineer out costs (schedule) associated with the separation of authorities (Moser & Wood, 2015). The premise being that the source selection process was designed by an organizational structure that had a clear separation of program management and contracting authorities. Then, the following question was asked: If the organizational construct no longer constrained the process design, would the project architecture (source selection) be designed in a different way that reduces schedule? When looking for data on different constructs of source selections, not enough of varying structure with data could be found to investigate separation of authority effects. Some examples were found were process steps were rearranged or eliminated. They weren’t enough to draw conclusions and you still had the problem that source selection schedules are also dependent on many other factors outside of just the process. Therefore, comparing two different source selection schedules is not always apples-to-apples.

Project Design relies on three elements: 1) representation through sociotechnical system models, 2) analytics through behavior based simulation models, and 3)
workshops where the project team can engage in a cooperative project architecture process where they can test different approaches, learn more about the trade space, and converge to an optimized solution (Moser & Wood, 2015). This process can help to alleviate the organizational effects of Conway’s law on the project because the team in experimenting, learning and witnessing the tradespace themselves.

The workshop is done at the beginning of the project to build the design. In this case, the source selection process had already been designed, but using the same methodology, the process model was changed from the baseline source selection process to find different architectures and the schedule differences captured. The delta in schedule could then be associated as the cost of the element that was changed in the process. In that sense, topological changes to the process effecting the interaction of the stakeholders were explored, as well as steps in the process that could be considered duplicative or overlapping in function where scope could be reduced. This Project Design methodology has the advantage of being controlled, where non-changing elements can be held constant so measured difference can be related. The disadvantage is that it is based upon a model of the system instead of direct measurement. Therefore, results are based upon the assumptions and limitations of the model.

An Agent-Based Model (ABM) was used to represent and analyze the source selection process as a system. ABMs are a meso-level class of individual, organizational and societal (IOS) modeling and simulation techniques. Meso-level models, “represent interactions and influences among individuals in groups and cover both individual and group phenomena and their interactions”. The meso-level is in
contrast to macro-level models that represent interactions at the large group or society level and micro-level models that represent interactions at the purely individual level. ABMs are useful for the study of complex systems when: “(1) the systems are composed of multiple interacting entities and (2) the systems exhibit emergent properties…” (Committee on Organizational Modeling from Individuals to Societies, National Research Council, 2008). Both are the case in the source selection process.

ABMs are well suited for application to organizational processes. Stakeholders can be modeled as individuals or teams of individuals that interact as part of a process such as source selections. Rules are developed in the model that apply logic and algorithms to those interactions to include stochastic variation so the inherent uncertainty of any social interaction can be captured. Generally, when projects or process schedules are forecasted, the work effort for each task is estimated and then combined in a logical order of progression. By finding the critical path through the tasks, and knowing how many people are working on the activity at any given time, the schedule can be estimated. However, Brooks pointed out that this only holds true when tasks can be portioned among many workers with no communication among them. He went on to note that when communication is required among the sub-tasks, the effort of communication must be included in the amount of work required to complete the task (Brooks Jr., 1995). With an ABM, not only can the work effort be modeled for each task, but also the coordination (Brooks’ communication) between different agents in the process can be captured and estimated. Coordination between agents is modeled as a factor affecting work and schedule (Moser & Wood, 2015).
In response to the same observation as this research, that despite the number of studies and acquisition reform efforts, only marginal improvements have been witnessed over the years, Schwen et. al. premised that ABMs would be an effective tool to, "identify significant causal factors that contribute to the performance of the procurement system." They noted that ABMs are, "particularly well suited for developing and testing theory about the complex behavior of the meta-organization..." such as the DoD (Schwenn, Colombi, Wu, Oyamma, & Johnson, 2015).

TeamPort was the ABM software selected for this research because it has a simple user interface combined with a powerful advanced mathematics engine for detailed insights into project dynamics. TeamPort facilitates the Project Design process by including both the system model and simulation elements. The simple graphical interface allows for rapid architecture changes and simulation runs making the Project Design process very rapid. Figure 10 shows the symbology used in the TeamPort user interface.

![Figure 10. TeamPort ABM Software Symbology (Global Project Design, 2016)](image)

A project or process model starts by describing the project architecture. First, the teams are identified and connected through an organizational structure. Teams can be
sized from 1 to 100s of people. Second, the products that the team develops as part of the project or process are defined. Products can be defined at multiple levels in a Product Breakdown Structure (PBS) for easier analysis. Next, activities are defined for each product and linked together in a work breakdown structures (WBS) flow. The work effort required to complete each activity is a primary input and is measured in man-hours. In this case, work effort does not include coordination or communication time. Dependencies between activities can also be defined. Teams are then assigned roles (called contracts) for each activity linking products, activities, and teams together. Lastly, activities can be organized in phases for aggregate analysis. Figure 11 shows the architecture window of the TeamPort software and how the teams (agents), activities, products and phases are linked together. The black dashed lines indicate dependencies between activities. The detail panel on the right is where the different model parameters for each element can be entered (Global Project Design, 2016).
Once the project architecture is defined, a Monte Carlo simulation can be run that produces a detailed forecast report about the project dynamics. Output includes project and team level work, coordination, and wait times. It also includes detailed data that can be viewed from the team, activity, or product perspective.

Determining Benefit

Going back to Figure 9 and examining the properties of the outputs of the source selection process, quality and fairness are left. Increasing both quality and fairness have a benefit to the source selection process. Not making a quality decision on the best contractor to build and deliver a system will have long lasting negative ramifications.
on the Air Force. In addition, the fact that it is a government procurement, means that
the process must be fair. If a contractor perceives the process has been unfair to them,
they have an opportunity to protest. The protest process at the very least takes time
and resources to adjudicate, and in a worst case can lead to a complete overturn of the
decision causing the entire source selection process to be repeated. Figure 12 below is
an update to Figure 9 that includes a mapping of the source selection process output
properties to the cost and benefit elements of the value equation.

![Source Selection Value Diagram](image)

Figure 12. Source Selection Value Diagram

Quality and fairness are not outputs that can be easily captured in an agent-
based model. The best source for quality and fairness measurements are from the
system directly. Investigating the outputs of the source selection process, it is also
challenging to measure the quality of the decision. While measuring whether a program
was successful in meeting its objectives (cost, schedule, and performance), there are a
multitude of other execution externalities that effect a program, tracing program failure
back to a poor source selection decision is problematic. In addition, you only get to pick
one path so maybe the source selection decision was the best of many bad choices, and the program would have failed anyway. You can’t test the other paths.

You can test the output of the source selection process for fairness in the form of a protest. The number of protests is not the best measurement because that is a perceived unfairness and the offeror that protests only knows what they proposed. They have no knowledge of the details of other offerors proposals. However, protests that were upheld can be measured. Most source selection protests go through the Government Accountability Office (GAO). The GAO publishes a descriptive guide that covers how a bidder can file a protest against a solicitation. 4 C.F.R § 21.2 sets for the requirements for filing a protest. A bidder has until the initial evaluations are due to submit a protest alleging improprieties in the RFP. If they want to protest the decision or how they were evaluated, they have until 10 days after the debriefing of the source selection is received. Once a protest is received, the GAO forwards it to the agency responsible for the source selection for initial evaluation. In the Air Force, the protest goes to the Air Force Legal Operations Agency (AFLOA). After receipt, the agency has 30 days to send a written report back to the GAO. This can be in the form of corrective actions the agency proposes in response to the protest, or documentation supporting and agency claim that the process was conducted fairly. In the latest case, the GAO will issue a decision within 100 days of the protest filing (GAO, 2009). For this research, AFLOA was contacted and protest data was requested for the last 10 years of Air Force source selections.

But this only helps investigate the output of the current source selection process. It does not measure how the separation of authority's effects whether a protest will be
sustained and the process deemed unfair. To get more insight into the effect of the separation of authorities, the inner workings of past source selections was analyzed. It was noted, and will become more apparent in the system definition and orient sections, that execution of contracting authorities through the contract clearance process primarily involved reviewing the evaluation teams work. This requires an interaction between the SSEB/PCO and both the MIRT and CCA.

The interaction between the MIRT and SSEB/PCO is documented in the form of a comment resolution matrix (CRM). The interaction involves the SSEB/PCO submitting all of the relevant source selection documentation prior to a key decision point to the MIRT for a review. The MIRT documents its comments in the CRM. The comments include the reviewer names, document section/paragraph/line number, a rating of the comment (critical, substantive, or administrative), and the comment itself with justification. The SSEB/PCO then reviews each comment and documents the resolution (accept, partially accept, or reject). Once again, justification for the resolution is documented in the CRM. In some cases, the CRM resolution is returned to the MIRT to get concurrence on the resolution and justification. An example comment in a CRM from an Air Force source selection is shown in Figure 13.
To measure the benefit of this MIRT and SSEB interaction, the CRMs from five different AFLCMC source selections were collected. The source selections were all conducted in the last 12-18 months. The source selections were chosen for review by the AFLCMC/PKC staff that is responsible for running the MIRT teams. Each comment was then scored using a 0 to 5 scale representing the likelihood that the comment effected either the quality of the decision or the fairness of the process. The 0 to 5 scale definition can be seen in Table 1 below.

Table 1. Source Selection CRM Scoring Scale

<table>
<thead>
<tr>
<th>Score</th>
<th>Likelihood</th>
<th>Probability of Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Near Certainty</td>
<td>&gt; 80% to &lt; 99%</td>
</tr>
<tr>
<td>4</td>
<td>Highly Likely</td>
<td>&gt; 60% to &lt; 80%</td>
</tr>
<tr>
<td>3</td>
<td>Likely</td>
<td>&gt; 40% to &lt; 60%</td>
</tr>
<tr>
<td>2</td>
<td>Low Likelihood</td>
<td>&gt; 20% to &lt; 40%</td>
</tr>
<tr>
<td>1</td>
<td>Not Likely</td>
<td>&gt; 1% to &lt; 20%</td>
</tr>
<tr>
<td>0</td>
<td>No Likelihood</td>
<td>&lt; 1%</td>
</tr>
</tbody>
</table>
Both the author and an AFLCMC source selection subject matter expert (SME) scored each comment in the five CRMs. The scores were then aggregated for analysis. To protect the sensitivity of the source selections and any company proprietary information, the CRMs are not included in this report. Only the aggregate results will be shown. By scoring each property separately, the benefit of the interaction can also be measured separately for the effect on quality and fairness of the source selection process.
Analysis

From the highest level, and in response to an excess of reform-driven oversight the Air Force has undergone a bifurcation of the contracting community and program management community. Two chains of authority and decision making, which may be in conflict, have arisen and have replaced an effective working relationship between contracting personnel and PMs (Air Force Studies Board, 2016)

- Air Force Studies Board

System Definition

Following Boyd’s OODA loop, the first step is to observe and define the system. The highest-level description of the source selection process was included in the previous research methodology chapter, but a much more detailed analysis of the system was conducted to support this research. The source selection process is first described in the Federal Acquisition Regulations (FAR) with each level of agency, service, and command adding supplemental regulations, policies and guidance. This means that there are subtle differences between how differing commands in the DoD execute the process. For this research, the Air Force Life Cycle Management Center (AFLCMC) source selection process was used. AFLCMC has a published standard procedure for source selections that was used as the baseline for modelling and
analysis efforts. The 27 Aug 2013 version of the standard process was used for the modelling effort (AFLMC/AQ, 2013).

Figure 10 shows the source selection process at the next lower level of abstraction from Figure 9. The inputs to the source selection process start with funding from the PPBE process, requirements from the JCIDS process, and market research culminating in an approved acquisition strategy (AS). The AS describes the overarching strategy for acquiring, fielding and sustaining the needed product or service.

![Diagram of High Level Source Selection Process Diagram]

*Figure 14. High Level Source Selection Process Diagram*

If a competitive source selection is directed in the AS, the source selection process begins. From the AS, a source selection plan (SSP) and request for proposal (RFP) are generated. The SSP describes how the source selection itself will be executed, including identifying the source selection members, the evaluation factors, how the team will communicate internally and with the contractors, how the source selection will be documented, and a schedule of events (USD(AT&L), 2011). The RFP 54
documents the governments requirements for the contract, how to build and deliver the proposal, and how each proposal will be evaluated. “A well-written RFP is absolutely critical to the success of the source selection” (USD(AT&L), 2011). Often, draft RFPs are sent to industry to get feedback on the contents, missing or confusing requirements, and allow them to get an early start on proposal preparation for better quality initial proposals. RFPs themselves are large and complex documents. The first draft RFP of the new Army handgun was over 350 pages, not counting an additional 23 attachments (Advisory Panel on Streamlining and Codifying Acquisition Regulations, 2017).

AFLCMC also has a standard process for the development of the AS and RFP. The goal of the process is to complete the AS and RFP in 330 days, and it often takes longer (AFLCMC/AQ, 2016).

Once the RFP is released, potential bidders will have a set amount of time to responds with a proposal, usually 30-90 days, and then the evaluation process begins concluding with a decision on the winning source(s) and a contract(s). Based upon the terms of the contract, the product and/or services are delivered to the government. For the AFLCMC baseline process, the schedule goal from RFP release to contract is 335 days assuming that 4 offerors submit proposals for 1 contract award (AFLCMC/AQ, 2013). For this research, source selection value was investigated in the source selection model scope area of Figure 14, and did not capture the effect of the separation of authorities on development of the SSP or RFP. This was to align with the AFLCMC source selection standard process and metrics described later.
Stakeholders

Before diving deeper into the process, a review of the key stakeholders in the process is warranted. The source selection process has a number of stakeholders, some involved directly in the execution of a particular source selection, and others that have significant inputs to or outputs from the process.

Warfighters

Each service has Major Commands (MAJCOMs) that have an organize, train, and equip function for a particular warfighting domain. They work with the Combatant Commanders (COCOMs) to identify military capability gaps. If a gap requires the development and procurement of a new system, the MAJCOM kicks-off the acquisition process by working through the JCIDS process to identify the need and develop the operational requirements of the system. A program manager is then designated and they use those requirements to develop an acquisition strategy for the system. Once the requirements are validated the MAJCOM competes for funding resources in the PPBE process. The warfighter continues to work with the program manager to develop the lower level requirements for the source selection. Thus, they highly influence two of the major inputs into the source selection process. They may have an advisory role during source selection, but generally have little involvement once the RFP is released. They also receive the final product or service contracted service and determine if it is operationally suitable and effective. Warfighters primarily value the cost, schedule and performance of the system.
**Congress/Taxpayers**

For this research, Congress and taxpayers were combined into one stakeholder. Taxpayers elect officials to represent them in Congress and the interaction between them doesn’t greatly affect the results of any single source selection. First, Congress legislates the acquisition laws that source selections must comply with. Second, they authorize systems for procurement and appropriate money for their development, purchase and sustainment. They value both fairness and the quality of the source selection decision. Every source selection has winners and losers and the losers include constituents of multiple representatives and senators. It is not uncommon for congress to speak about the fairness of a source selection that a business in their district or state did not win. Fortunately, congress has little involvement executing the actual process so political influence is minimized.

**Contractors**

Contractors are independent businesses that compete with each other for contracts to build and deliver DoD systems. They respond to Requests for Proposals (RFPs) from the government in hopes of winning the contract and making a profit for their business. They provide jobs for the taxpayers that work for the contractor or their sub-contractors. If selected, they will deliver the system per contractual requirements to the warfighter. A lot of unpaid work goes into preparing the proposal for a source selection and they only get paid if they win. They primarily value the fairness of the
source selection if they lose, and have the ability to protest a decision if they do and believe that it might have been unfair.

**Source Selection Evaluation Board (SSEB)**

The SSEB is responsible for the evaluation of each submitted proposal when compared to the requirements in the RFP and the documentation of the evaluation. It is a multi-functional team with representatives from program management, engineering, configuration control, finance, and sometimes a warfighter representative. Note that the SSEB does not include the contracting officer, even though they participate heavily in the evaluation process. The size of the evaluation board depends on the size and complexity of the source selection and can range from 10 to 100+ personnel. The SSEB is often organized into teams that correspond to the source selection evaluation criteria (i.e. Technical Tea, Cost/Price Team, and Past Performance Team). The SSEB has a chairperson who is responsible for the overall management of the board. In many cases, the SSEB Chairperson is also the system program manager (USD(AT&L), 2016). The SSEB primarily focuses on the quality of the decision, but also on ensuring the fairness of the process through compliance.

**Source Selection Authority (SSA)**

The SSA is the person designated to make the source selection decision by determining the offeror whose proposal complies with the Request for Proposal (RFP) and provides the best value to the government. The level of position for the SSA depends on the complexity and dollar value of the acquisition, and can be as high as 58
the USD(AT&L). The SSA is also responsible for conduct of the source selection and compliance with all laws and regulations. They appoint the SSEB and SSAC members.

The SSA can be the PCO for contracts less than $100M, but for most system acquisition contracts the SSA is designated from the program management chain of authority (USD(AT&L), 2016). The SSA primarily focuses on the quality of the decision, but also on ensuring the fairness of the process through compliance.

Source Selection Advisory Council (SSAC)

An SSAC is established by the SSA to provide expertise and support during the source selection process. An SSAC is required for acquisitions with a total value greater than $100M. The SSAC provides a written comparative analysis of the proposals and makes a selection recommendation to the SSA. They also review the evaluation results of the SSEB to ensure that the process follows the criteria in the RFP and the ratings are consistently applied between the proposals. For source selections with an SSAC, the SSEB is advised not to compare proposals, and to only provide evaluations of each proposal independently to the SSAC and SSA. They are a multi-functional team with representatives from program management, engineering, finance and contracting. SSAC members are chosen based upon significant expertise in their functional area as well as source selection experience. They typically have a higher government grade than the members of the SSEB (USD(AT&L), 2016). The SSAC primarily focuses on the quality of the decision, but also on ensuring the fairness of the process through compliance.
Contract Clearance Authority (CCA)

The CCA is also referred to as the Clearance Approval Authority (CAA). The CCA is in the contracting chain-of-command and approves the Procuring Contracting Officer (PCO) to move forward with contracting actions. The CCA must be at least one level above the PCO but can go higher depending on the complexity and size of the contracting action. They are responsible for an independent review and assessment of contract actions associated with the source selection, ensuring that contracting actions are fair and reasonable, and consistent with laws, regulations, and policies (Air Force Federal Acquisition Regulations Supplement (AFFARS)). The CCA primarily focuses on ensuring the fairness of the process through compliance.

Procuring Contracting Officer (PCO)

PCO’s have the authority to “enter into, administer, or terminate contracts,” on behalf of the U.S. Government. They are in the contracting chain-of-authority. A PCO is appointed in writing via a SF-1402, Certificate of Appointment (Federal Acquisition Regulations, n.d.). This document is also called a Warrant and only warranted individuals can obligate the government to make future payments in exchange for goods or services. In a source selection, the PCO serves as the “primary business advisor,” managing all business aspects to ensure the “evaluation is conducted in accordance with the evaluation criteria specified in the solicitation.” While considered separate from the SSEB team, they also are involved daily in the proposal evaluation process. All communication with contractors during the source selection must go through the PCO.
They are also responsible for maintaining all required documentation of the source selection (USD(AT&L), 2016). They finalize the source selection by signing the winning contract. The PCO primarily focuses on ensuring the fairness of the process through compliance.

**Multi-functional Independent Review Team (MIRT)**

The MIRT falls under the contracting chain-of-authority. The MIRT is an independent review team comprised of functional representation from program management, engineering, legal, contracting, finance, and small business. The membership of the MIRT is approved by the CCA. The MIRT provides an assessment to the CCA regarding, “the state of the source selection/procurement.” All comments by the MIRT must be adjudicated by the CCA prior to contract clearance (Air Force Federal Acquisition Regulations Supplement (AFFARS)). The MIRT primarily focuses on ensuring the fairness of the process through compliance.

**Legal Counsel**

Legal counsel is required for all source selections. They review all source selection documentation for legal sufficiency and provides general legal advice to the SSA, PCO, SSEB, and CCA. They are also members of the MIRT and SSAC (USD(AT&L), 2016). Legal counsel primarily focuses on ensuring the fairness of the process through compliance.
Acquisition Center of Excellence (ACE)

The ACE is multi-functional team of experienced program office personnel that focus solely on helping program offices prepare acquisition strategies, RFPs, and conducting source selections. The ACE model has been implemented at Air Force procurement centers. During the source selection process, the ACE often provides secure spaces for the SSEB to conduct the evaluation process outside of their normal office. In addition, the maintain an electronic source selection workflow tool called EZ source and provide training on the tool and executing the source selection in general for the entire SSEB team. They also advise the team on writing the evaluations and will review the team’s documentation while they are drafting. Lastly, the ACE documents any lessons learned from each source selection and provide continuity to the variety of source selection teams (AFLCMC/AQ, 2017). They primarily focus on ensuring the fairness of the process through compliance.

Source Selection Process

At the next lower level of abstraction, the details of the AFLCMC source selection evaluation process are show in Figure 15. After the release of the RFP and the receipt of the proposals, the SSEB starts the evaluation process and produces an Initial Evaluation Briefing. At this point, the SSA can make a determination that one proposal provides best value and there is, "no reasonable expectation that the offer(s) and their expected value to the Government would be improved through discussions" (USD(AT&L), 2016). In that case, called award without discussions, the submitting contractors are debriefed on the source selection results and a contract is awarded to
the selected source. For major acquisition programs this is rare. DFARS 215.306 says, “for acquisitions with an estimated value of $100M or more, contracting officers should conduct discussions” (OUSD(AT&L), 2017). The DoD Source Selection Procedures goes even further and says, “Award without discussions on complex, large procurements is discouraged and seldom in the Government’s best interest” (USD(AT&L), 2016). However, awarding without discussions can save almost half of the source selection schedule as seen in Figure 15.

In most cases, discussions are held with the purpose of, “maximizing the Government’s ability to obtain best value…” (USD(AT&L), 2016). During discussions, each bidding contractor will receive a set of Evaluation Notices (EN) from the PCO that highlight a proposal deficiency or weakness, or an aspect of the proposal that could be enhanced to improve the potential for award. A best practice is for the PCO to require the offerors to submit written responses to each EN with proposed changes to their proposal prior to the Final Proposal Request (FPR). This is to ensure the that the contractors understand the ENs and the SSEB evaluators understand the response (USD(AT&L), 2016).
After discussions are complete, the PCO, with concurrence of the SSA, can release the Final Request for Proposal (FPR). The contractors submit their final proposed offer to the government and the SSEB completes a final evaluation. The results of the evaluation are documented and presented to the SSAC for a review of the accuracy, consistency and supportability of the evaluations. Then the SSAC completes a comparative analysis of the proposals for a recommendation to the SSA. The evaluations and comparative analysis are given to the SSA at the Final Evaluation Briefing (FEB) for a final source determination by the SSA. The SSA documents the rationale for the decision in the Source Selection Decision Document (SSDD). Then the bidders are notified of the decision and offered the opportunity for a debrief. A debrief will include the evaluation of the specific offeror and well as the high-level evaluation ratings of the other offerors. The PCO has to be careful not to release any proprietary information about another offerors proposal. Lastly, the contract is awarded to the winning offeror (USD(AT&L), 2016).
What has been discussed to this point, only includes the steps taken to make the
decision. Figure 16 below includes the additional steps in the AFLCMC course
selection process to ensure the fairness of the process and decision. These include
reviews by legal counsel, the MIRT, and contract clearance by the CCA (AFLCMC/AQ,
2013). If the estimated value of the contract is greater than $1B, in addition to the
MIRT, an OSD Defense Procurement and Acquisition Policy office led Peer Review
must also be conducted (Assad, 2008). These reviews happen before every key
decision point in Figure 15.
Contract clearance (sometime referred to as business clearance) is required by the AFFARS subpart 5301.90 for competitive acquisitions and noncompetitive contract actions. The level required for contract clearance is dependent on the size of the action. The Deputy Assistant Secretary of the Air Force for Contracting is the CCA for non-competitive contract actions greater than $500M and for competitive acquisitions greater than $1B. The objective of contract clearance is to ensure that: 1) Contract actions effectively implement approved acquisition strategies, 2) Contract actions result in fair and reasonable business arrangements, 3) Contract actions are consistent with
laws, regulations, and policies, and 4) an independent review and assessment of the proposed action is accomplished. Specifically, the AFFARS 5301.9001(e) says, “The Source Selection Authority (SSA) must not be the clearance approval authority” (SAF/AQC, 2017).

As stated above, the goal of AFLCMC is to, “complete a high quality source selection in less that 335 days.” They consider the lead times identified in the workflow as the maximum amount of time it should take to complete the source selection, and also note that the SSA may direct a more aggressive schedule based upon mission requirements (AFLCMC/AQ, 2013). However, they don’t identify any steps that can be relieved or any ways to speed up the process.

Orient

Continuing with Boyd’s OODA loop, the next step is to orient yourself. First, the history of Air Force source selection process was reviewed for context. The current Air Force source selection process is the result of a series of high profile source selection protests that resulted in the overturn of the award decisions in the 2005-2008 timeframe of several large programs. This includes the CSAR-X helicopter, KC-X tanker, and LAS Afghan Foreign Military Sales aircraft programs. The Air Force conducted a study of the Air Force acquisition system (another in addition to the major studies shown in Figure 8) and produced the Acquisition Improvement Plan. Initiative #4 of the plan was to improve Air Force major systems source selections. The actions taken as part of this
initiative included: 1) modifying Air Force source selection procedures to strengthen governance of the process, 2) require the use of Multi-functional Independent Review Teams (MIRTs) in the Air Force business clearance process by employing additional internal Air Force reviews during all phases of the source selection process, and 3) appoint a team of the most qualified Air Force source selection experts to provide on-call augmentation/consultation to source selections teams across the Air Force (SAF/AQ, 2009).

In initiative #5 of the same plan, the Air Force pointed out that the reporting chain of command of contracting officers, through the program manager, “diminished the functional mentoring and support that once provided our contracting officers with the sense of authority that allows necessary independent decision-making.” The plan directed the realignment of the rating and reporting chain of contracting officers (SAF/AQ, 2009). All of the actions from those two initiatives were implemented and largely stay true today.

**Stakeholder Value Network**

The separation of authorities is fundamentally about relationships between stakeholders if the process. The next step in orienting with the source selection system was to conduct a Stakeholder Value Network (SVN) analysis. A SVN is, “a multirelational network consisting of a focal organization, the focal organization’s stakeholders, and the tangible and intangible value exchanges between the focal organization and its stakeholders, as well as between the stakeholders themselves” (Feng & Crawley, 2008). SVN can be used as both a qualitative and quantitative tool.
for analyzing the direct and indirect relationship between stakeholders (Eppinger & Browning, 2012). Understanding the relationships can be a key insight into the behavior of complex socio-technical systems.

An SVN for the AFLCMC source selection process was generated and can be found in Figure 17. Each stakeholder was categorized by whether they were under the contracting, program management, or external chain-of-authority. The lines between the stakeholders represent their value exchanges in the source selection process. The arrow points to who is on the receiving side of the exchange. Each exchange was categorized by type: influence, information, money, or goods/services. A key for the categories is found in the upper right-hand corner of the figure. Lastly, a dashed box was drawn around the warfighters and congress/taxpayer stakeholders to highlight that they only have pre/post source selection process relationships.
Immediately apparent in the source selection SVN is the bifurcated relationships between the contracting and program management authority chains. The contracting chain (green boxes) has one loop of value exchange and the program management chain (blue boxes) has its own loop of value exchange. They exchange value in the process almost entirely separately with the legal counsel providing the only indirect connection above the core SSEB and PCO source selection stakeholders in an advisory fashion. It appears as if two separate teams are conducting a source selection independently and is a clear example of Conway’s law in affect.
Network Graph

Next, a network graph was generated from the SVN. Network graphs are powerful visualization tools to gain further insight into networked systems. The network graph was developed in a program called Gephi. Gephi is an open-source graph visualization platform that is especially useful for large and complex network visualization. It includes several different algorithms for organizing the visualization of the network. Nodes (stakeholders) and edges (relationships) are entered into the system which can then be characterized in a multitude of user defined ways (Gephi Consortium, n.d.).

Figure 18 shows a source selection stakeholder network graph produced by Gephi. The stakeholders are characterized by their chain-of-authority in the DAS. Orange is for acquisition (program management), green is for contracting, and purple is for chains-of-authority outside of the DAS. This network graph was generated using an algorithm called Yifun Hu, a force-directed methodology that models a “physical system of bodies, with forces acting between them. The algorithm finds a good placement of the bodies by minimizing the energy of the system.” It works by modeling a repulsive force between each stakeholder, pushing them apart. With no connections (edges), they would organize in a circle. It also models a spring force that acts at the connections between the nodes. The spring forces counteract the repulsive force and the Yifun Hu algorithm arrangements the nodes to have a minimum system energy (Hu, 2005). The resulting arrangement of nodes is then shown. If all of the nodes are not
connected, as is the case with the source selection network graph, the shape of the resulting drawing can provide insight into the network structure.

![Source Selection Process Network Graph - Yifun Hu Algorithm](image)

In the case of the source selection stakeholder graph, the shape is far from balanced, with the largest distance seen between the MIRT and the SSAC. The distance can be thought of as spring tension, where the relationship between the stakeholders puts them in a relatively large tension with each other. It is hypothesized that this "tension" is related to the long schedule of source selections. Tension in springs creates heat, which cause a loss of energy in the system and inefficiency. The same can be thought of with relationships. The separation of authorities has resulted in a topological arrangement of relationships in the source selection process that creates a large tension in the system. Tension adds time to the schedule by separating individuals/teams in a process that are part of the overall coordination stream.
This concept is related to the pairwise coordination distance affect researched by Moser, but at the network level. Moser defined coordination distance as, "a measure for two teams interacting in a project which is the proportion of their effective effort to satisfy their dependence compared to the nominal case." The nominal case was defined as when the interaction occurred between individuals with shared backgrounds, native language, and are face-to-face. Therefore, coordination distance becomes a multiplier to the work effort to satisfy the dependency for coordination that occurs when the sharing of ideas is more difficult. One example he uses if for teams that are geographically separated and need to travel or communicate through a teleconference (Moser B. R., 2012). Coordination distance accounts for the inefficiency of the interaction. In the source selection process, the coordination distance is a network level effect caused by the topographical separation of the relationships in the process. This is another source of inefficiency in the system that adds work to the total process activity.

Based upon the stakeholder graph visualization in Figure 18, the SSAC, MIRT and Legal (circled in red in the graph) were identified as areas to look at in regard to reducing tension in the system and the effect of the separation of authorities.

Cost

As discussed earlier, the AFLCMC source selection standard process was used as a baseline for this research. It should be noted that the 2013 process was used as
the baseline and that the standard process has been updated since the start of this research. An ABM was built in TeamPort that represented the baseline source selection process. To provide confidence in the model, data was collected from a recent actual source selection to include planned and actual schedule data for each step in the process, team sizes, number of bidders, and monetary size. The name of the source selection isn’t provided, but will be referred to as Example SS #1.

This source selection was also unique in that it included approved deviations from the standard process. This would help provide confidence that the TeamPort model was accurately capturing the dynamics of the specific process relationships. The baseline model was built with the same team sizes and number of bidders (2) as the example SS so direct comparisons could be made. Example SS #1 was also under the threshold monetary size for a Peer Review, so that step in the standard process was not modelled.

**TeamPort Model**

The first step in building a TeamPort model is to define the project teams and connect them through an organizational structure. The baseline stakeholder team sizes are shown in Table 2. To better model the dynamics of the source selection process, the SSEB was separated into two teams, the SSEB leads and the Source Selection Evaluation Team (SSET). The SSEB leads consisted of the SSEB chair, deputy chair and the evaluation factor chiefs. The SSET included the rest of the source selection evaluators. Most of the coordination with other teams is done through the
SSEB leads and separation allowed for a more accurate capture of coordination schedule.

Table 2. Baseline TeamPort Model Stakeholder Team Sizes

<table>
<thead>
<tr>
<th>Stakeholder (PM)</th>
<th>Size</th>
<th>Stakeholder (Contracting)</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSA</td>
<td>1</td>
<td>CCA</td>
<td>1</td>
</tr>
<tr>
<td>SSAC</td>
<td>9</td>
<td>MIRT</td>
<td>8</td>
</tr>
<tr>
<td>SSEB Leads</td>
<td>6</td>
<td>PCO</td>
<td>3</td>
</tr>
<tr>
<td>SSET</td>
<td>29</td>
<td>Contractor A</td>
<td>1</td>
</tr>
<tr>
<td>Legal</td>
<td>1</td>
<td>Contractor B</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2 is roughly aligned in two halves that represent the PM and contracting chains-of-authority. Legal counsel is highlighted in purple to represent that they have their own authority chain. Additionally, while the contractors that submit bids have a significant number of people working on their “capture” teams, they were modeled as 1 member. This was done because their portion of the process has a fixed schedule defined by the PCO. For example, they may have 60 days from RFP release to submit their initial proposal. The time allowed for each source selection is defined in the RFP. Since they have fixed times and we are interested in the government side of the process, representing the contractor as one person made it easier to separate out their work effort from the overall process.

The TeamPort baseline organizational breakdown structure (OBS) is shown in Figure 19. This does not fully match the separation of authorities of the system which
would have no connection between the SSA and CCA. TeamPort, however does not support two separate OBS, so the CCA was represented as subordinate to the SSA. From a TeamPort model perspective, the connection between SSA and CCA does not change the results of the model runs.

![Figure 19. Baseline TeamPort Model Stakeholder Organization](image)

The next step is to define the products that the team will be building as part of the project. The products can be organized in multiple level in a Product Breakdown structure (PBS). The PBS for the source selection process is shown in Figure 20. For a source selection, the final product is the contract to the winning bidder and the rest of the source selection documentation builds towards that final contract. The 1279 is a document that is part of the congressional notification process occurring just prior to contract award.
Next, the activities are defined for the system and linked together to show dependencies in a work breakdown structure (WBS). The baseline source selection process TeamPort WBS is shown in Figure 21 and Figure 22. The primary inputs to the activities are the predicted work effort in full-time equivalent (FTE) man-hours and complexity. The work effort for the source selection process activities can be found in Table 3. In TeamPort, complexity factors into the amount of upstream and downstream coordination by the primary team that will be required to explain the activity. The higher the complexity, the more coordination will be required (Global Project Design, 2017). Because most of the coordination in a source selection consists of reviewing documentation, the complexity for all of the activities were in the low to very low range.
Linking together the activities creates a dependency structure for the project. In the case of the source selection process, some activities are conducted in parallel such as proposal build, reviews, and EN generation, combining later in an evaluation briefing. The parallel paths can be witnessed in Figure 21 and Figure 22. While multiple types of dependencies can be defined in TeamPort, the source selection process has virtually no overlap of activities, and the dependencies were defined as Finish-to-Start. The phases
are added to help with data analysis as a way to aggregate results. Table 3 also includes a mapping of the AFLCMC standard process WBS numbers to the TeamPort model activity.

Table 3. TeamPort Baseline Process Project Design - Activity, Work Effort, Contracts

<table>
<thead>
<tr>
<th>Project Design</th>
<th>Work Effort (FTE hrs)</th>
<th>Project Design Contracts</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFLCMC WBS</td>
<td>Activity</td>
<td>SSAC</td>
</tr>
<tr>
<td>1.1.1</td>
<td>Build Proposal A</td>
<td></td>
</tr>
<tr>
<td>1.1.2</td>
<td>Complete Eval and Ens A</td>
<td>5200</td>
</tr>
<tr>
<td>1.1.3</td>
<td>EN A Legal Review</td>
<td>32</td>
</tr>
<tr>
<td>1.1.4/5</td>
<td>Clarification A</td>
<td>40</td>
</tr>
<tr>
<td>1.1.6</td>
<td>Finalize Initial Eval</td>
<td>2000</td>
</tr>
<tr>
<td>1.1.7</td>
<td>MIRT A</td>
<td>600</td>
</tr>
<tr>
<td>1.1.8</td>
<td>IEB Brief to SSAC</td>
<td>480</td>
</tr>
<tr>
<td>1.1.9</td>
<td>IEB Brief to SSA</td>
<td>400</td>
</tr>
<tr>
<td>1.2.2/3</td>
<td>Release Ens A</td>
<td>40</td>
</tr>
<tr>
<td>1.2.4/5</td>
<td>Discussions A</td>
<td>3000</td>
</tr>
<tr>
<td>1.2.5/6/7/8</td>
<td>Prepare FPR Brief</td>
<td>2000</td>
</tr>
<tr>
<td>1.2.9</td>
<td>MIRT B</td>
<td>600</td>
</tr>
<tr>
<td>1.2.10</td>
<td>FPR Legal Review</td>
<td>64</td>
</tr>
<tr>
<td>1.2.11</td>
<td>FPR Contract Clearance</td>
<td>200</td>
</tr>
<tr>
<td>1.2.12</td>
<td>FPR Brief to SSAC</td>
<td>480</td>
</tr>
<tr>
<td>1.2.13</td>
<td>Prepare Final Proposal A</td>
<td>480</td>
</tr>
<tr>
<td>1.3.1/2</td>
<td>Disposition Ens A</td>
<td>2400</td>
</tr>
<tr>
<td>1.3.3</td>
<td>MIRT C</td>
<td>600</td>
</tr>
<tr>
<td>1.3.4</td>
<td>Legal Review Final Eval</td>
<td>64</td>
</tr>
<tr>
<td>1.3.5</td>
<td>Contract Clearance</td>
<td>200</td>
</tr>
<tr>
<td>1.3.6</td>
<td>FEB to SSAC</td>
<td>480</td>
</tr>
<tr>
<td>1.3.7</td>
<td>Congressional Notification</td>
<td>480</td>
</tr>
<tr>
<td>1.4.1</td>
<td>Award Contract</td>
<td>40</td>
</tr>
</tbody>
</table>

The penultimate step is to link products to the activities. For the source selection process this only provided another way to review the forecast data. Last, the teams are linked to the activities in what TeamPort terms “contracts”. “P” designates primary and
the team, "ensures the activity completes and coordinates with others." "D" designates decision and the team, "handles the exceptions should a quality issue be uncovered." "Q" designates quality and the team, "reviews work in progress to discover errors." Lastly, "A" designates assist and the team, "lends its capacity to the primary team for direct work only." (Global Project Design, 2016). Table 3 also shows the contracts between each team and activity in the TeamPort source selection model.

Figure 23. Baseline TeamPort Source Selection Model Sketch

A sketch view of the final source selection baseline model is shown in Figure 23. All of the teams, phases, activities and products can be seen, as well as, their dependencies, primary contracts and linkages. It is at this point in the project design
process that the model can be simulated and a forecast generated for analysis and redesign.

**TeamPort Baseline Model Forecast**

Table 4 summarizes the schedule work and coordination forecasts for the activities in the baseline model. Only the schedule days are shown for the build proposal and prepare final proposal activities because the schedule of 60 and 15 days respectively was forced into the model. Once again, because contractor effort was not a concern of this research and team size was set to one, the work and coordination effort were also not included. Table 5 shows the totals from the design work effort inputted into project and the forecast work and coordination effort generated as output.

The first result to note is the forecast work is always higher than the design work effort input. This is because the ABM in TeamPort does not assume 100% efficiency in agents completing assigned work. The second, and most important note is that coordination effort accounts for about 10% of the total work effort. Coordination effort represents one of the main advantages of using an ABM such as TeamPort to model the process. The upstream and downstream effects of coordination are not captured well in traditional program schedule tools such as Gantt and PERT charts but certainly add to the total effort required to complete an activity (Moser & Wood, 2015). The effect of coordination is smaller than more traditional design projects because the complexity of the activities is lower, however, it definitely needs to be accounted for.
The baseline schedule forecast was 425 total days, which was significantly higher than the AFLCMC standard process goal of 335 days. As shown in Table 4, the schedule forecast is largely dependent on the design work effort inputted into the model parameters. No data could be found on the actual work effort associated with each of the activities in the model and this is the hardest part to estimate when developing a project model in TeamPort for a complex system.
### Table 4. TeamPort Baseline Process Project Forecast - Schedule, Work, Coord

<table>
<thead>
<tr>
<th>AFCLMC WBS</th>
<th>Activity</th>
<th>Work Effort (FTE hrs)</th>
<th>Sched (Days)</th>
<th>Work (hrs)</th>
<th>Coord (hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1.1</td>
<td>Build Proposal A</td>
<td></td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1.2</td>
<td>Build Proposal B</td>
<td></td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1.2</td>
<td>Complete Eval and ENs A</td>
<td>5200</td>
<td>54</td>
<td>5,483.7</td>
<td>583.9</td>
</tr>
<tr>
<td>1.1.2</td>
<td>Complete Eval and ENs B</td>
<td>5200</td>
<td>51</td>
<td>5,479.1</td>
<td>560.7</td>
</tr>
<tr>
<td>1.1.3</td>
<td>EN A Legal Review</td>
<td>32</td>
<td>13</td>
<td>35.6</td>
<td>115.7</td>
</tr>
<tr>
<td>1.1.3</td>
<td>EN B Legal Review</td>
<td>32</td>
<td>12</td>
<td>36.1</td>
<td>120.8</td>
</tr>
<tr>
<td>1.1.4/5</td>
<td>Clarification A</td>
<td>40</td>
<td>14</td>
<td>45.7</td>
<td>20.3</td>
</tr>
<tr>
<td>1.1.4/5</td>
<td>Clarification B</td>
<td>40</td>
<td>15</td>
<td>46.2</td>
<td>20.1</td>
</tr>
<tr>
<td>1.1.6</td>
<td>Finalize Initial Evaluation</td>
<td>2000</td>
<td>11</td>
<td>2,186.2</td>
<td>339.7</td>
</tr>
<tr>
<td>1.1.7</td>
<td>MIRT 3</td>
<td>600</td>
<td>13</td>
<td>670.4</td>
<td>399.1</td>
</tr>
<tr>
<td>1.1.8</td>
<td>IEB Brief to SSAC</td>
<td>480</td>
<td>9</td>
<td>487.9</td>
<td>76.2</td>
</tr>
<tr>
<td>1.1.9</td>
<td>IEB Brief to SSA</td>
<td>400</td>
<td>9</td>
<td>430.3</td>
<td>69.1</td>
</tr>
<tr>
<td>1.2.2/3</td>
<td>Release ENs A</td>
<td>40</td>
<td>3</td>
<td>50.0</td>
<td>41.8</td>
</tr>
<tr>
<td>1.2.2/3</td>
<td>Release ENs B</td>
<td>40</td>
<td>2</td>
<td>48.6</td>
<td>30.1</td>
</tr>
<tr>
<td>1.2.4</td>
<td>Discussions A</td>
<td>3000</td>
<td>26</td>
<td>3,264.7</td>
<td>55.7</td>
</tr>
<tr>
<td>1.2.4</td>
<td>Discussions B</td>
<td>3000</td>
<td>25</td>
<td>3,277.9</td>
<td>37.5</td>
</tr>
<tr>
<td>1.2.5/6/7/8</td>
<td>Prepare FPR Brief</td>
<td>2000</td>
<td>11</td>
<td>2,193.9</td>
<td>224.5</td>
</tr>
<tr>
<td>1.2.9</td>
<td>MIRT 4</td>
<td>600</td>
<td>11</td>
<td>697.3</td>
<td>324.3</td>
</tr>
<tr>
<td>1.2.11</td>
<td>FPR Legal Review</td>
<td>64</td>
<td>13</td>
<td>65.4</td>
<td>47.1</td>
</tr>
<tr>
<td>1.2.12</td>
<td>FPR Contract Clearance</td>
<td>200</td>
<td>9</td>
<td>218.6</td>
<td>16.7</td>
</tr>
<tr>
<td>1.2.15</td>
<td>FPR Brief to SSAC</td>
<td>480</td>
<td>8</td>
<td>580.7</td>
<td>34.7</td>
</tr>
<tr>
<td>1.2.15</td>
<td>FPR Brief to SSA</td>
<td>480</td>
<td>9</td>
<td>529.5</td>
<td>21.5</td>
</tr>
<tr>
<td>1.2.16</td>
<td>Prepare Final Proposal A</td>
<td></td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2.16</td>
<td>Prepare Final Proposal B</td>
<td></td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3.1/2</td>
<td>Disposition ENs A</td>
<td>2400</td>
<td>22</td>
<td>2,627.8</td>
<td>136.1</td>
</tr>
<tr>
<td>1.3.1/2</td>
<td>Disposition ENs B</td>
<td>2400</td>
<td>21</td>
<td>2,606.6</td>
<td>168.5</td>
</tr>
<tr>
<td>1.3.2</td>
<td>Finalize Evaluation</td>
<td>2400</td>
<td>13</td>
<td>2,588.9</td>
<td>265.1</td>
</tr>
<tr>
<td>1.3.3</td>
<td>MIRT 5</td>
<td>600</td>
<td>11</td>
<td>686.9</td>
<td>243.8</td>
</tr>
<tr>
<td>1.3.5</td>
<td>Legal Review Final Evaluation</td>
<td>64</td>
<td>12</td>
<td>65.4</td>
<td>33.1</td>
</tr>
<tr>
<td>1.3.6</td>
<td>Contract Clearance</td>
<td>200</td>
<td>10</td>
<td>216.7</td>
<td>13.4</td>
</tr>
<tr>
<td>1.3.7</td>
<td>FEB to SSAC</td>
<td>480</td>
<td>8</td>
<td>567.4</td>
<td>33.6</td>
</tr>
<tr>
<td>1.3.8</td>
<td>FEB Brief to SSA</td>
<td>480</td>
<td>10</td>
<td>526.7</td>
<td>19.8</td>
</tr>
<tr>
<td>1.4.1</td>
<td>Congressional Notification</td>
<td></td>
<td>2</td>
<td>48.7</td>
<td>24.6</td>
</tr>
<tr>
<td>1.4.2</td>
<td>Award Contract</td>
<td>40</td>
<td>2</td>
<td>57.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>
Table 5. TeamPort Baseline Process Total Work Forecast

<table>
<thead>
<tr>
<th>Design Work Effort (FTE hrs)</th>
<th>Forecast Work (hrs)</th>
<th>Forecast Coord (hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>32992</td>
<td>35820</td>
<td>4078</td>
</tr>
</tbody>
</table>

To gain confidence in the model, several other factors were investigated and considered. The first was that AFLCMC source selection teams at the time were frequently experiencing schedules much longer than the 335-day goal. Each source selection is more different than the ABM can capture, but after personal experience building a more detailed source selection schedule for SS example #1 and discussing with our source selection teams, 435 days appeared to be more realistic than 335 if all process steps were required. The second factor that provided confidence in the baseline model was through a feature in TeamPort that allows you to simulate the model using a traditional critical path method (CPM) approach. The CPM simulation ignores coordination and other inefficiencies in the system and calculates schedule based upon activity dependencies, work effort and number of team members assigned. This traditional approach, which does not account for coordination time, yielded 357 days, which was much closer to the standard process goals.

Lastly, detailed schedule data was collected for SS example #1 to include deviations from the standard process that were approved and executed. The TeamPort
model was modified to match the process executed for SS example #1 being careful to keep everything else the same as the baseline. In this case, the TeamPort model forecast a 349-day schedule which was very close to the actual 372-day schedule of the source selection. In fact, the SSEB chair noted that they were held up from awarding for over a month waiting for another authority chain (Chief Information Officer) to approve non-source selection related documentation before they could move forward. This delay is not captured in the source selection process and brings the actual result closer to TeamPort forecast. This provided a large confidence boost to the baseline model, but was still probably not sufficient to claim that the model was “validated”.

**Source Selection Design Walk and Cost Results**

With confidence in the design of the baseline TeamPort model, further design changes were made to simulate changes to the process that reduce the separation of authorities. Adjustments to the MIRT and Legal were pursued first because of the system tension concerns highlighted in the network graph analysis. Ten cases were examined in a design walk style progression, starting with the baseline AFLCMC standard process. The cases and details about what modifications to the standard process were made are summarized in Table 6. Also captured in the table are the forecast schedule for that case, delta days saved from the baseline, percent of schedule savings, and the percent of schedule that can be associated with oversight activities. Oversight was defined as any activity conducted above the SSEB or PCO level. When cases were combined, such as concurrent legal review and combined MIRT/SSAC
team, the comments section notes which cases were combined. Figure 24 shows a graph of the cases in a tradespace of schedule and percent total oversight.

Table 6. Source Selection Process Tradespace - Separation of Authorities

<table>
<thead>
<tr>
<th>Case #</th>
<th>Case Name</th>
<th>Schedule (Days)</th>
<th>Delta from Baseline</th>
<th>% Sched Savings</th>
<th>% Total Oversight</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Baseline - AFLMC Standard Process</td>
<td>425</td>
<td>-1</td>
<td>0</td>
<td>33.4%</td>
<td>AFLMC Standard Process</td>
</tr>
<tr>
<td>2</td>
<td>No Discussion Award</td>
<td>254</td>
<td>-171</td>
<td>40%</td>
<td>33.5%</td>
<td>Standard Process - No Final Proposal From Vendors</td>
</tr>
<tr>
<td>3</td>
<td>SSAC/MIRT Combined Review</td>
<td>406</td>
<td>-19</td>
<td>4%</td>
<td>33.7%</td>
<td>Review with MIRT and SSAC at same time</td>
</tr>
<tr>
<td>4</td>
<td>Concurrent Legal Review</td>
<td>376</td>
<td>-49</td>
<td>12%</td>
<td>28.2%</td>
<td>Legal Counsel Embedded With SSEB</td>
</tr>
<tr>
<td>5</td>
<td>MIRT 4 Waiver</td>
<td>401</td>
<td>-24</td>
<td>6%</td>
<td>36.4%</td>
<td>No MIRT 4</td>
</tr>
<tr>
<td>6</td>
<td>SS Example #1 (Validation Case)</td>
<td>342</td>
<td>-76</td>
<td>16%</td>
<td>24.9%</td>
<td>Combined 3.4.5</td>
</tr>
<tr>
<td>7</td>
<td>Combine MIRT/SSAC Team</td>
<td>363</td>
<td>-62</td>
<td>15%</td>
<td>27.0%</td>
<td>One independent team</td>
</tr>
<tr>
<td>8</td>
<td>Combined SSACCA</td>
<td>402</td>
<td>-23</td>
<td>5%</td>
<td>26.1%</td>
<td>Or CCA is part of SSAC/MIRT Combined Team</td>
</tr>
<tr>
<td>9</td>
<td>Concurrent Legal and Combined MIRT/SSAC team</td>
<td>330</td>
<td>-85</td>
<td>22%</td>
<td>22.1%</td>
<td>4.7</td>
</tr>
<tr>
<td>10</td>
<td>Fully Combined Contracting and PM authorities</td>
<td>313</td>
<td>-112</td>
<td>26%</td>
<td>16.6%</td>
<td>6.9</td>
</tr>
</tbody>
</table>

Case #2 was the specialized procedure when the SSA decides that decision can be made after receipt of the initial proposals and there is no government advantage to continuing with discussions. As discussed earlier, the no discussion scenario is discouraged, but it can save over 40% of the source selection schedule. Case #3 still had separate MIRT and SSAC teams, but they conducted their reviews at the same time in the process. The schedule savings was minimal at 4%, but every day counts to the warfighter who wants a new system to fill a capability gap. The results weren't as large as expected because the SSEB leads had to divide time between two reviews causing inefficiencies that drove the work effort of both the MIRT and SSAC reviews higher than the baseline.
Case #4 integrated legal into the SSEB team. This saved 49 days or 12% of the schedule. Going back to the baseline process details in Table 4, the majority of time during the legal review is due to coordination. In the standard process, the SSEB and PCO develop a large amount of source selection documentation which then is sent to the legal counsel for review and comment. The work effort is low, but coordination effort is very high. By integrated legal into the SSEB, they review the documentation at the same time as the SSEB team, greatly reducing the amount of coordination effort required.
Case #5 was waiving one of the MIRT activities. This saved 24 days or 6% of the program schedule. At first this seemed like a mistake because the MIRT 4 schedule in the process baseline was only 11 days. However, this is a great example of the upstream and downstream effects of coordination that are often discounted in traditional schedule estimation techniques. This is also an example of emergent behavior that is characteristic of a complex system.

Case #6 was the SS example #1. It was a combination of cases 3, 4, and 5. It showed a savings of 76 days or 18%. Saving over two and one-half months of schedule is very significant for the warfighter. Despite the fact that it was a very competitive market for the system, the decision was not protested because the team executed so well. It also shows the effect of emergent behavior in the dynamics of the system in the negative way. If you add up the schedule savings from cases 3, 4, and 5 you get 92 days which is greater than the actual savings of combining them.

Case #7 went further than Case #3 and combined the SSAC and MIRT teams. This case really started to make changes to the process that reduced the separation of authorities and combined the MIRT and SSAC oversight roles into one body. That body would serve both the decision and quality function. Combining the teams saved 62 days or 15% of the schedule. A majority of the work effort involved for both involves reviewing the source selection document. The MIRT had a higher work effort than the SSAC, so the work effort for the MIRT was chosen for the combined team. Once again though, if you add up the schedule for the SSAC reviews in the baseline whose scope was dropped in the combination of the MIRT and SSAC you get only 25 days of
savings. Once again, the upstream and downstream effects of coordination have a large impact on the dynamics and emergent behavior of the process.

Case #8 looked at another way to collapse the separation of authorities by combining the SSA and CCA. This resulted in a schedule savings of 23 days or 5% of the schedule. Case #9 combined cases 4 and 7 with a concurrent legal and combined MIRT/SSAC team. The result was a savings of 95 days or 22%.

Case #10 represented the full collapse of the separation of authorities down to the PCO and SSEB level which were still kept separate. They function as a team and the PCO could be thought of as being part of the SSEB except for the separate chain of authority that has to be satisfied and the unique role of the PCO compared to the rest of the evaluators in the SSEB. For the TeamPort model, keeping the PCO and SSEB separated had no effect on the results. However, the separation of authorities in the source selection process has a cost of 112 days or 26%. This is a significant cost on not just the source selection process, but the entire DAS procurement process.

Another interesting result was found when the modifications to the process were also captured in the SVN and network graph visualizations described in the orient section. The updated SVNs are shown in Figure 25. Combined authorities are shown in a blue/green shaded box. The evolution of the SVN from case 1 to case 10 shows a collapsing of the program management and contracting loops. Moving legal counsel into the SSEB for concurrent review in case 4 highlighted the separate loops even more, although is still showed a significant reduction in source selection schedule. In
addition, the complexity of the stakeholder relationships decreases as the authorities are combined which translates directly to less demand for coordination in the process.

Lastly, the evolution of network graphs using the force-directed Yifun Hu algorithm is shown in Figure 26. Like the SVN, integrating legal counsel into the SSEB in case 4 did not decrease the network distance that was concerning in the baseline case. However, as authorities were combined in case 9 and even further in case 10, that network distance shrinks significantly.

![Network Graphs](image)

*Figure 25. Source Selection SVN Separation of Authorities Evolution*
Benefit

As discussed earlier, the source selection process output has two properties that can be measured in respect to benefit and that is the quality and fairness of the decision. This research focused on the fairness aspect, which is the driver of the separation of authorities. Fairness was measured by whether a source selection decision was protested by a bidder and sustained. The analysis of benefit started with data from the Air Force Legal Operations Agency (AFLOA) that captures protest rates and decisions for the entire Air Force. As discussed previously, all Air Force GAO filed protests are sent to AFLOA for an agency position before ruling.
Air Force Protest Analysis

Figure 27 shows Air Force protest data from fiscal year (FY) 2004 through FY 2017. The left graph shows the number of competitive contract actions (i.e. source selections) that the Air Force executes each year in red. The general trend has been that the number of competitive actions has decreased from about 160,000 to 100,000. The trend matches the total number of contract actions which includes non-competitive contract actions so the relative percentage has stayed the same. The protest rate is also shown on the left graph in blue, and has trended to rise as the number of contract actions has decreased. While the total number of competitive actions has declined since 2004, the number of protests filed each year has risen. The overall percentage though is still extremely low at less than 0.3%.

Figure 27. Air Force Competitive Action Protest Rate and Protest Effectiveness (AFLOA, 2017)
The protest effectiveness rate is shown in the right graph, and has also tended to rise since 2004 from about 35% to 45%. Protest effectiveness includes both protests where the Air Force decided to take corrective action on their own, and those where the Air Force responded that they had been fair, but the GAO disagreed and sustained the protest. What is most notable about the protest data is that despite the overhaul of the source selection process in 2009, the results have tended to be worse. The total number of protests filed is relatively small and isn’t concerning because just because a protest is filed, doesn’t mean that the process was unfair. However, the effectiveness of protests rising is concerning. The changes were initiated by several high-profile programs receiving sustained protests that resulted in the entire source selection being discarded. Presumably the changes were put in place to further ensure the fairness of the source selection process, however, the protest effectiveness increase indicates that they have been slightly less fair.

Process Benefits

The MIRT review was used as the process step most associated with the separation of authorities as indicated by the network graph to measure the benefit of such independent reviews. The schedule cost of the separate reviews was shown to be high in the previous section. As mentioned previously, five CRMs were provided from AFLCMC for use in the benefit analysis. The CRMs were all from MIRT 3 of the source selection process and included a total of 313 comments. MIRT 3 happens as part of the initial evaluation briefing phase and is viewed by AFLCMC contracting as the most
impactful of the five MIRT reviews. Each comment in the CRM was scored and a sample of the scoring spreadsheet is shown in Figure 28. Each scoring column excepted a score between 0-5 corresponding with the likelihood of impact.

<table>
<thead>
<tr>
<th>CRM Chart</th>
<th>Type</th>
<th>Comment</th>
<th>Team Comment Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRM 72 A</td>
<td></td>
<td></td>
<td>A - changed chart 72 heading from &quot;Cost/Price/TP Structure&quot; to &quot;Cost/Price - TEP Structure&quot;</td>
</tr>
<tr>
<td>CRM 74 A</td>
<td></td>
<td></td>
<td>A - Added comment to bottom of chart. &quot;Initial Government Adjustments will change based on RN-resolutions&quot;</td>
</tr>
<tr>
<td>CRM 75 A</td>
<td></td>
<td></td>
<td>A - Clarified that the reliability cost was provided by the offeror in the TEP workbook. Reliability cost is based on the offeror's technical solution</td>
</tr>
</tbody>
</table>

Figure 28. Sample CRM Scoring Sheet

Two evaluators were used to score the CRMs. The first was the author who has over 18 years of experience in Air Force program management and engineering. He was involved in one mid-size source selection as an advisor. The second evaluator is from AFLCMC and has over 15 years of experience as an Air Force contracting officer. He has served as the PCO and an advisor to multiple source selections. While the sample size of evaluators was small, the fact that each chain of authority was represented added credibility to the scoring by reducing the effect of any confirmation bias of the author and by averaging any cultural bias associated with each evaluator’s respective chain of authority with regard to the benefit of the comments.

The results of the scoring are shown in Table 7. The scoring for each evaluator is shown as well as the combined results where the two were added together. Note that the combined scoring has double the number of comments (count) and scores for each
category because the results of each evaluator were added together. Scores for each of the five source selection examples are shown as well as an aggregated total. Scores for the impact of the comment on the decision is on the left of each example, and the impact on protestability is shown in the fairness column. The average was calculated by dividing the sum of the scores for each benefit column by the number of comments (count). Lastly, some comments were repeated, either the same comment from different reviewers or from the same reviewer but in different sections of the paperwork. The latter is an artifact of the CRM format where you are supposed to indicate which area of the documentation the comment is from. These repeats were discounted and not included in the final scores. It was also noted that if a comment had a probability of impacting the decision, it would also impact the protestability which must be at least of an equal scoring.
Between the two evaluators the scores did not vary widely, although evaluator #2 generally scored higher (higher probability of impact) than evaluator #1. Evaluator #2's average score has higher for four of the five SS examples. Also, while evaluator #1 didn't score any comments higher than likely, evaluator #2 had more rated likely and
several rated highly likely. Because of the subjectivity in assessing probability, the differences in scoring were considered relatively close and acceptable for analysis.

Figure 29. Combined Comment Impact Pie Charts

Figure 29 shows the total combined evaluator scores of all five CRMs by category. Note that the scores represent two evaluations for each comment for both decision and fairness so the total count is double the number of comments. The first result noted was that the large majority of comments had no likelihood or were not likely to impact either the decision or protestability (fairness) of the source selection. The comments were mostly administrative or misunderstandings by the reviewers. From the perspective of benefit, these comments added very little the either the decision or fairness of source selection. The second result to note was that the comments had more of a benefit to the fairness of the process. This makes sense because the MIRT is on the contracting side of authorities and is primarily focused on ensuring compliance.
with laws, regulations and policies in support of fairness. The contract clearance decision the MIRT supports looks for both compliance and fairness to the government and contractors.

However, there were comments that showed benefit for both quality decisions and fairness by reducing the likelihood of a protest. Whether the probability of impact was likely or highly likely, the comment certainly represented an area that you would like to catch before making a final decision and awarding a contract. Of the 313 total comments in the five source selection CRMs, about a dozen were scored at that level. One source selection had none, but the other four source selections had at least two. While a vast majority of comments had a very minimal benefit, the overall MIRT showed a benefit by catching comments that had a moderate probability of impacting the decision or the potential for a sustained protest.
Conclusions

A loser is someone – individual or group – who cannot build snowmobiles when facing uncertainty and unpredictable change; Whereas, a winner is someone – individual or group – who can build snowmobiles, and employ them in an appropriate fashion, when facing uncertainty and unpredictable change. (Boyd, 1987)

- John Boyd

Using an analogy to snowmobiles, John Boyd argued that building and employing defense systems faster than your enemy was essential for winning a war. He also implied that excepting uncertainty and risk was a main ingredient of a winning strategy. The separation of authorities has benefits, but this research sought to better understand if the current implementation of the separation of authorities between contracting and program management in the DAS was costing more than the benefit. Our country was founded under the idea of separation of authorities, with the framers of the constitution fearing too much authority in any one group. Our constitution divides the government into three distinct branches that exercise checks on each other’s power (Monk, 2003). As any U.S. citizen can attest, sometimes that means that the government moves slowly. It was not necessarily designed to go slow, but that is an
emergent behavior of the system as constructed. The framers of the constitution probably had some understanding of what the separation of powers meant as far as the speed of government, but gladly traded speed to avoid another monarchy. In the 230 years since the U.S. constitution was ratified, the benefits of the separation of authorities at the highest level of government have proved to be far greater than the cost. But when the separation of authorities filters down to lower levels of government, do the benefits still outweigh the cost, providing value to the system? For source selections, the separation of authorities is in place to ensure that errors are not made in the source selection. Has the process pushed too far in reducing errors that the schedule cost is too high? If you accepted more risk in source selections, could you reduce the schedule?

The DAS was too complex to model and gather enough empirical data to answer the hypothesis, therefore this research focused on a subset of the DAS, the source selection process. The source selection process was an ideal sub-process of the DAS to model because it has a relatively large schedule, is well defined, serial to the rest of the DAS processes, and had limited interaction from external stakeholder's due to the sensitivity of undue influence on the fairness of the process.

Summary of Cost

This research model estimated that the cost of the separation of program management and contracting authorities in the source selection process is relatively high, accounting for 26% of the schedule in the AFLCMC source selection standard
process. The schedule cost was entirely in duplicative oversight activities above the SSEB and PCO, who are the primary executors of the process. A lower schedule cost source selection process was accomplished by combining the MIRT and SSAC teams, as well as the SSA and CCA position, collapsing the parallel contracting and program management process loops noted in the SVN analysis. A schedule cost of 26% equates to 112 days or almost one-third of a year of schedule in the baseline process. Therefore, looking only at the schedule cost with no consideration of benefit, eliminating the separation of authorities above the PM and PCO could 112 days which represents a significant savings for source selection timelines and also significantly reduces overall DAS schedules, even though it is just one step in the process.

Summary of Benefit

The benefit of the separation of authorities between contacting and program management was more difficult to quantify and measure. The source selection process was analyzed based upon its two functions, to decide the best-value source for developing and producing a system, and to ensure the fairness of the process to all potential bidders. It was difficult to review overall program result data to decide if the wrong decisions were being made in source selections leading to failed programs. There are too many other factors that go into the success or failure of a program and only one alternative path is chosen to provide data. It still could have been the best choice despite a failed program.
However, with regard to the fairness function, protest data was reviewed as a measure of the fairness. The data showed that less than 1% of competitive contracting actions are protested, meaning that bidders largely believe the process is consistently fair to all parties. When protests are filed, they are successful in generating corrective action by the government about 40% of the time. The cost of the protest depends on the action taken. If the agency takes corrective action on its own, the protest may only cost a few weeks of schedule. The general time frame for a GAO decision is 100 days. If the GAO sustains the protests and the agency took no corrective action, the extreme case is that the source selection decision is discarded and the source selection process needs to be started again costing another year.

Next, the benefit of the implementation of the separation of authorities between contracting and program management was analyzed inside the source selection process itself. The interaction between the SSEB/PCO and the MIRT is documented in a CRM, and the comments from five different mid-size source selections were scored by two different evaluators. Each comment was evaluated for its probability of impacting either the decision or protestability of the source selection. The large majority of comments had no likelihood of impact while less than 1% were evaluated to have a likely impact on the decision and less than 4% were evaluated to have a likely or highly likely impact on protestability. However, it was noted that while the vast majority of comments had very little benefit to the source selection process, those few comments that would have a likely benefit of improving the decision or avoiding a protest certainly have a benefit to the process.
Value of the Separation of Authorities

For the source selection process, value is largely a tradeoff between the benefits of the process design and costs in terms of schedule. Figure 30 combines the results of the cost and benefit analysis onto one graph for interpreting the tradespace. The source selection schedule is the cost in the chart and benefit is gained by reducing the likelihood that an error escapes the process that impacts fairness or quality. The black triangle represents the baseline source selection process. The likelihood of an error in the source selection documentation that would impact the quality of the decision or perceived fairness of the process aligns with the relatively low percentage of source selections that are protested, but at a very high schedule cost of 425 days.

Figure 30. Value of the Separation of Authorities in Source Selections
The yellow circle and green square represent the measured impact on the probability that quality or fairness respectively will be impacted if the source selection authorities are collapsed. While the probability of impact goes up, the source selection schedule is reduced by a significant amount. Curves were drawn between the fully collapsed authorities case and the baseline case estimating how a tradespace of options to balance the benefit and cost would likely appear. A safe assumption is that the oversight function that the collapse represents would follow a diminishing marginal utility profile where each next increment of oversight schedule would have a diminishing impact on the probability of error escape. This would mean that process designs with small amounts of separation of authority would likely capture large errors at a minimal schedule cost compared to the baseline. As expected, the fairness property is more sensitive to the separation of authorities, likely because the fairness property and the avoidance of a protest is what the MIRT activity that was examined focuses on.

While not conclusive, this research shows supporting evidence for the hypothesis that the current implementation of the separation of program management and contracting authorities has a negative value, at least in the source selection process. There may also be alternative structures outside of those investigated under the separation of authorities that could provide near equivalent benefit without the high cost. One possibility is that a combined SSAC/MIRT activity would still find the most probable inconsistencies and errors that could lead to a bad decision or sustained protest at a much lower cost.
Additional Conclusions

As part of the cost analysis, the oversight schedule of each case in the project design walk was calculated. Oversight was defined as any activity that was above the SSEB/PCO level who are the primary executors of the process. The baseline model showed an oversight schedule cost of 33.4% which was remarkably high. This included the 75 days allocated to initial and final proposal development by the contractors. That means over 40% of the time the government spends evaluating the proposals and making the decision is oversight of the SSEB and PCO. Part of this time had to do with the separation of authorities as the oversight cost reduced to 16.6% when the separation of authorities was collapsed in case 10. Therefore, another conclusion of this research is that oversight can be costly. Analyzing the TeamPort ABM results, a large portion of the oversight cost is not the work itself, but the coordination required to effectively conduct the oversight role, both upstream and downstream of the activity. Simply placing legal counsel in with the SSEB greatly reduced that coordination time and saved 12% of the schedule. Oversight normally consists of more experienced experts in the functional areas that check the work when it’s done. It is far less costly for that expertise to be integrated with the team.

Another conclusion from the research is that an ABM approach to analysis can be useful in applying theory to the study of complex socio-technical systems like the DAS. Simply analyzing the source selection process with a Gantt chart, as is typically done in programs, would not have shown the upstream and downstream impacts of
coordination, and would underestimate the cost of review processes such as the MIRT. Schwenn et. al. noted that the lack of improvement in defense acquisition despite the continuous attempts at reform may be due to the lack of understanding and empirical research into how the system operates. They suggested modeling as a way to test hypothesis about how the system works before making changes and that ABMs would be useful tool to better understand and test the DAS (Schwenn, Colombi, Wu, Oyamma, & Johnson, 2015). This research showed promise for the use of ABMs at the intermediate (or meso) level of the DAS and provided encouragement that larger scale models could and should be built for research.

In addition, this research showed how network visualization techniques can be used to augment more complex models to gain an understand of complex socio-technical systems like the DAS. Both the SVN and force-directed network graph techniques were extremely useful in highlighting how the process shapes the relationships between stakeholders. The SVN highlighted the effect of Conway’s law on the organization of the process and the network graph highlighted which portions of the process to focus on to collapse the effect of the separation of authorities.

Lastly, we circle back to the title of this thesis, “Centralized Execution, Decentralized Control: We Why Go Slow in Defense Acquisition.” As described in USAF basic doctrine, the first tenet of Airpower is centralized control, decentralized execution. The tenet argues that airpower, “should be controlled by a single Airman who maintains the broad, strategic perspective necessary to balance and prioritize,” the use of force, however, also recognizing that decentralized execution allows the flexibility to take advantage of tactical opportunities and local circumstances (U.S. Air Force, 106
Lt Col Cliff Hinote argued that without decentralized execution, tactical level options are limited and leads to slower reactions and even paralysis (Hinote, 2009).

The source selection process has the opposite arrangement. Execution of the source selection process is largely centralized, with many constraints put on the system program offices where the members of the SSEB and PCO reside. There is little flexibility at the tactical level to adjust to meet the needs of the program (usually speed). In addition, control is decentralized with two separate chains of authority controlling how the source selection progress with the CCA and SSA both shaping and sharing the authority to approve of a decision or way forward. As the central tenet of Airpower argues, this leads to slow reactions.

The argument can be extended to the DAS as well. The system program office is still the center of execution, but control of the programs is split between many lines of authority. Inside the DAS itself, several approvals for a program are required from the Chief Information Officer (CIO) for any system that exchanges information. In the 21st century, that applies to nearly every program. Program resources are allocated by one chain of command, while program direction is executed by another. In the source selections used as examples for this research, AFLCMC has organize, train, and equip authority, while SAF/AQ has program execution authority. The PEO is where the two chains of command split and they work for both. Also, the DAS is only a portion of the big A. Requirements are generated through the CJCS chain of authority and the budget for each year is controlled largely by congress. If we truly want the DAS to execute
faster, a careful look about how we want to collapse the separation of authorities needs to be investigated.
Recommendations and Future Research

The risk adverse culture of Air Force acquisition is governed primarily by process compliance, the cost of which is estimated to account for nearly 25 percent of every dollar spent. The high level of oversight in place for military programs, and the weight of meeting the oversight requirements, constrain and hinder programs and program staff. (Air Force Studies Board, 2016)

- Air Force Studies Board

Recommendations

Take More Risk in the Source Selection Process

Leaders in DoD acquisition have recognized that the speed of the DAS is becoming a large national security concern. General John Hyten, head of U.S. Strategic Command noted, “We have to go faster, and we’re not, and it is frustrating the heck out of me” (Hebert A. J., 2017). As Andrew Hunter from the Center for Strategic and International Studies noted, “there is a near consensus that the acquisition system needs to be willing to take greater risk to develop and deploy new capabilities more rapidly” (Hunter, 2017). Ellen Lord, the current USD(AT&L) and former CEO of a major defense contractor, has recognized that the source selection process is a large portion of the total DAS schedule to field a new weapon system. She has set an interim goal of
280 days to complete a source selection, with an eventual goal of 180 days (Mehta, 2017).

Risk is characterized by the likelihood and consequence of an event (USD(AT&L), 2017). Applying a risk framework to the architecture of the source selection process, an argument can be made that the consequence of a sustained protest increases as the size of the program increases because of the relative size of the defense resource that is at risk. Figure 31 shows an example of how the DoD views risk and applies consequence criteria appropriate for source selection sizes. This is not a new concept for the DAS, as this is how the system currently is managed. The higher the value of a program, the higher the decision authority in the acquisition and contracting chains. The current source selection process has simplified procedures for contracts valued at less than $50M and contracts over $1B require an OSD level Peer review in addition to the MIRT.

![Figure 31: Risk Based Source Selection Process Matrix](image)

*Figure 31. Risk Based Source Selection Process Matrix*
The recommendation is that the source selection process continues to utilize a tiered approach to the execution of source selections, but that the tiering is changed to accept more risk in the process. Accepting more risk is contingent upon first understanding the risks you are taking. This research highlighted that the current source selection process operates as two separate sub-processes, one that executes program management authorities and one that exercises contracting authorities. The current MIRT construct has a marginal benefit, but at a very high cost. This research has provided some benefit data to give acquisition leadership a better understanding of how to apply the process tradespace to manage the balance between benefit and schedule cost through a risk perspective.

AFLCMC has already recognized the poor schedule performance of the process and is already heading down this path. They updated the standard source selection process in 2017 to include reducing the schedule goal to 308 days. (AFLCMC/AQ, 2017) They also changed the policy for MIRTs, allowing the use of existing review processes to satisfy the need for MIRTs 4 and 5 (Robinson, 2016). While not the complete collapse of separation as represented in case 10, this does show how AFLCMC is trying to find the right risk balance. AFLCMC collects and reports quarterly metrics on source selection schedules, but are achieving their goal of 308 days less than 60% of the time (AFLCMC/AZ, 2017). More works needs to be done.
Expand the ACE

This research also highlighted the cost of coordination for between the separate chain of authority and with external teams in general. The MIRT and SSAC add experience and expertise to the SSEB and PCO teams that are usually less experienced. However, applying that expertise in a review process that requires a lot of coordination is very inefficient. The effect could be seen by the large schedule decrease of integrating legal counsel into the SSEB team and internal processes.

The ACE is a resource that while shown as a stakeholder in the source selection process, was not modelled separately. They integrate with the SSEB and PCO and their mission is to, “provide expert advice and hands-on assistance to the acquisition workforce/leadership and instill credibility, excellence and innovation in the Air Force acquisition and sustainment process.” Their core capabilities include assistance in Acquisition Strategy development, RFP development, and Source Selection support. This includes specialized training for the execution of a source selection including a Red Flag style exercise prior to the start of evaluations (Cadek, 2017).

Because ACE personnel integrate directly into the source selection teams, they provide high value to the process. The ACE provides the benefit of access to experience and expertise like the MIRT, but at a very low schedule cost. It is highly recommended that the ACE concept be utilized more across the DoD. In addition, it is recommended that the current resourcing of existing ACE offices be reviewed with an eye towards expansion.
Use ABMs and Project Design for Schedule Development

Lastly, it is recommended that project management teams in the DoD migrate away from more traditional Gantt and Microsoft Project based scheduling techniques and towards Agent-Based Models. When teams, products, and activities are linked together in a model and simulated, the dynamics and emergent behavior of the socio-technical system are better captured and a more realistic schedule is obtained. The effect of coordination on upstream and downstream activities that was shown in this research is an example of work effort that often isn’t capture well with traditional tools. In addition, a project design walk style analysis of the interaction among the teams, products, and activities can quickly identify more optimal arrangements to meet program goals before the project even starts. The migration should happen over time so calibration data can be captured through trial programs and parameters refined for the unique nature of defense acquisition.
Future Research

Understanding Benefit

While the ABM in TeamPort allowed for testing of many different cases, the benefit analysis was limited to a small sample size of only MIRT 3 activities. To better support the risk based process implementation decisions recommended above, much more research and experimentation needs to be conducted on the benefits of the various reviews in the process. For competitive actions above $1B, a similar analysis should be conducted of the Peer reviews. In addition, experiments should be conducted with combined MIRT/SSAC teams to see if the likely to highly likely impact comments found would still be found in a less schedule costly arrangement. Research should also be conducted to find ways to better model and predict discovery of source selection issues so project design type techniques could be applied. System dynamic model have been applied in other error propagation studies and could be tried for this application.

Examination of Protests

A closer look at source selection protests needs to be further researched. The last major study that could be found was conducted by the RAND Corporation in 2012. Much of the data they used was from source selections conducted prior to the process overhaul that started in 2009 (Camm, et al., 2012). Recent high level data would suggest that protests are so rare we should not worry about them. The reality is that the high interest failures such as KC-X and CSAR-X can shake the faith in the entire
system. In both cases, over 130 issues were raised in the protest filed. For CSAR-X only one was sustained and in KC-X only 8 of those issued were sustained (Camm, et al., 2012). But only one is needed to throw out an entire source selection and cast enough doubt in the system that leaders reflexively require even more rigor be added to the process, slowing down source selections for everything else. More updated research should be conducted that explores when and how protests happen.

**Coordination Distance – Separation of Authorities**

One of the more interesting findings in this research was the visualization of network distance with a force-directed network graph and its correlation with increased process coordination and schedule. As discussed previously, Moser discussed coordination distance as a pairwise effect characterized by the efficiency of two teams satisfying a demand to coordinate when compared to other teams. A coordination distance of 0 requires no effort to satisfy the demand and information it transferred without any effort. A coordination distance of 1.0 is the nominal distance for sharing information between teams with, “shared work background, common native language, and co-location.” Then as the conditions for the interaction differ from the nominal 1.0 case, such as one party working in a 2nd language, the coordination distance grows above one and more effort is needed to satisfy the same demand for coordination (Moser B. R., 2012). Some research effort has been applied to better quantifying coordination distance in specific features, however this is an area with that should be further refined.
Building upon the pairwise coordination distance is the network distance that this research used as a tool. In a force-directed network graph, each stakeholder has a repulsive force that is evenly applied to all other stakeholders. Then a spring like force is applied connecting stakeholders when they have a relationship and the entire interconnected system so stakeholder location minimizes total system energy. With more quantification of pairwise coordination distance, those relationships based upon information exchanges (coordination) could be weighted. In the network graph technique used, the “spring” constant was the same for all relationships. A parting hypothesis from this research for future exploration is that multiplying the spring constant by the inverse of the pairwise coordination distance between the two teams could add more information to the visualized network distance shown in the network graph.
## Glossary

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABM</td>
<td>Agent-Based Model</td>
</tr>
<tr>
<td>ACAT</td>
<td>Acquisition Category</td>
</tr>
<tr>
<td>ACE</td>
<td>Acquisition Center of Excellence</td>
</tr>
<tr>
<td>ADM</td>
<td>Acquisition Decision Memorandum</td>
</tr>
<tr>
<td>AFFARS</td>
<td>Air Force Federal Acquisition Regulations Supplement</td>
</tr>
<tr>
<td>AFLCMC</td>
<td>Air Force Life Cycle Management Center</td>
</tr>
<tr>
<td>AFLOA</td>
<td>Air Force Legal Operations Agency</td>
</tr>
<tr>
<td>BBP</td>
<td>Better Buying Power</td>
</tr>
<tr>
<td>CAA</td>
<td>Clearance Approval Authority (alternative name for CCA below)</td>
</tr>
<tr>
<td>CAE</td>
<td>Component Acquisition Executive (alternative name for SAE)</td>
</tr>
<tr>
<td>CAS</td>
<td>Complex Adaptive System</td>
</tr>
<tr>
<td>CCA</td>
<td>Contract Clearance Authority (alternative name for CAA above)</td>
</tr>
<tr>
<td>CDD</td>
<td>Capability Development Document</td>
</tr>
<tr>
<td>CDR</td>
<td>Critical Design Review</td>
</tr>
<tr>
<td>CJCS</td>
<td>Chairman of the Joint Chiefs of Staff</td>
</tr>
<tr>
<td>CO</td>
<td>Contracting Officer</td>
</tr>
<tr>
<td>COCOM</td>
<td>Combatant Command</td>
</tr>
<tr>
<td>CPM</td>
<td>Critical Path Method</td>
</tr>
<tr>
<td>CRM</td>
<td>Comment Resolution Matrix</td>
</tr>
<tr>
<td>DAB</td>
<td>Defense Acquisition Board</td>
</tr>
<tr>
<td>DAE</td>
<td>Defense Acquisition Executive</td>
</tr>
<tr>
<td>DAS</td>
<td>Defense Acquisition System</td>
</tr>
<tr>
<td>DAU</td>
<td>Defense Acquisition University</td>
</tr>
<tr>
<td>DCMA</td>
<td>Defense Contract Management Agency</td>
</tr>
<tr>
<td>DEPSECDEF</td>
<td>Deputy Secretary of Defense</td>
</tr>
<tr>
<td>DFARS</td>
<td>Defense Federal Acquisition Regulations Supplement</td>
</tr>
<tr>
<td>DMAG</td>
<td>Deputy’s Management Advisory Group</td>
</tr>
<tr>
<td>DoD</td>
<td>Department of Defense</td>
</tr>
<tr>
<td>DoDD</td>
<td>Department of Defense Directive</td>
</tr>
<tr>
<td>DoDI</td>
<td>Department of Defense Instruction</td>
</tr>
<tr>
<td>DPAP</td>
<td>Defense Procurement and Acquisition Policy</td>
</tr>
<tr>
<td>Acronym</td>
<td>Full Form</td>
</tr>
<tr>
<td>---------</td>
<td>-----------</td>
</tr>
<tr>
<td>DPG</td>
<td>Defense Planning Guidance</td>
</tr>
<tr>
<td>EMD</td>
<td>Engineering and Manufacturing Development</td>
</tr>
<tr>
<td>EN</td>
<td>Evaluation Notice</td>
</tr>
<tr>
<td>FAR</td>
<td>Federal Acquisition Regulations</td>
</tr>
<tr>
<td>FASA</td>
<td>Federal Acquisition Streamlining Act</td>
</tr>
<tr>
<td>FEB</td>
<td>Final Evaluation Briefing</td>
</tr>
<tr>
<td>FOC</td>
<td>Full Operational Capability</td>
</tr>
<tr>
<td>FPR</td>
<td>Final Proposal Request</td>
</tr>
<tr>
<td>FRP</td>
<td>Full Rate Production</td>
</tr>
<tr>
<td>FTE</td>
<td>Full-Time Equivalent</td>
</tr>
<tr>
<td>FY</td>
<td>Fiscal Year (Starts 1 Oct for the U.S. Government)</td>
</tr>
<tr>
<td>FYDP</td>
<td>Future Years’ Defense Plan</td>
</tr>
<tr>
<td>GAO</td>
<td>Government Accountability Office</td>
</tr>
<tr>
<td>GCS</td>
<td>Ground Combat Systems</td>
</tr>
<tr>
<td>HCA</td>
<td>Head of Contracting Activity</td>
</tr>
<tr>
<td>IEB</td>
<td>Initial Evaluation Brief</td>
</tr>
<tr>
<td>IOC</td>
<td>Initial Operational Capability</td>
</tr>
<tr>
<td>IPT</td>
<td>Integrated Product Team</td>
</tr>
<tr>
<td>JCIDS</td>
<td>Joint Capabilities Integration and Development System</td>
</tr>
<tr>
<td>JROC</td>
<td>Joint Requirements Oversight Committee</td>
</tr>
<tr>
<td>LRIP</td>
<td>Low-Rate Initial Production</td>
</tr>
<tr>
<td>MAIS</td>
<td>Major Automated Information System</td>
</tr>
<tr>
<td>MAJCOM</td>
<td>Major Command</td>
</tr>
<tr>
<td>MDA</td>
<td>Milestone Decision Authority</td>
</tr>
<tr>
<td>MDAP</td>
<td>Major Defense Acquisition Program</td>
</tr>
<tr>
<td>MDD</td>
<td>Materiel Development Decision</td>
</tr>
<tr>
<td>MIRT</td>
<td>Multi-Functional Independent Review Team</td>
</tr>
<tr>
<td>OBS</td>
<td>Organizational Breakdown Structure</td>
</tr>
<tr>
<td>OMB</td>
<td>Office of Management and Budget</td>
</tr>
<tr>
<td>OSD</td>
<td>Office of the Secretary of Defense</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Form</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td>OT&amp;E</td>
<td>Operational Test and Evaluation</td>
</tr>
<tr>
<td>OUSD</td>
<td>Office of the Under Secretary of Defense</td>
</tr>
<tr>
<td>PBS</td>
<td>Product Breakdown Structure</td>
</tr>
<tr>
<td>PCO</td>
<td>Procuring Contracting Officer</td>
</tr>
<tr>
<td>PDR</td>
<td>Preliminary Design Review</td>
</tr>
<tr>
<td>PEO</td>
<td>Program Executive Officer</td>
</tr>
<tr>
<td>PM</td>
<td>Program Manager</td>
</tr>
<tr>
<td>PO</td>
<td>Program Office (sometimes referred to as System Program Office)</td>
</tr>
<tr>
<td>POM</td>
<td>Program Objective Memorandum</td>
</tr>
<tr>
<td>PPBE</td>
<td>Planning, Programming, Budgeting and Execution</td>
</tr>
<tr>
<td>PRR</td>
<td>Production Readiness Review</td>
</tr>
<tr>
<td>RDT&amp;E</td>
<td>Research, Development, Test and Evaluation</td>
</tr>
<tr>
<td>RFP</td>
<td>Request for Proposal</td>
</tr>
<tr>
<td>SAE</td>
<td>Service Acquisition Executive (alternative name for CAE)</td>
</tr>
<tr>
<td>SECDEF</td>
<td>Secretary of Defense</td>
</tr>
<tr>
<td>SF</td>
<td>Standard Form</td>
</tr>
<tr>
<td>SME</td>
<td>Subject Matter Expert</td>
</tr>
<tr>
<td>SPO</td>
<td>System Program Office</td>
</tr>
<tr>
<td>SSA</td>
<td>Source Selection Authority</td>
</tr>
<tr>
<td>SSAC</td>
<td>Source Selection Advisory Council</td>
</tr>
<tr>
<td>SSDD</td>
<td>Source Selection Decision Document</td>
</tr>
<tr>
<td>SSEB</td>
<td>Source Selection Evaluation Board (alternative name for SSET)</td>
</tr>
<tr>
<td>SSET</td>
<td>Source Selection Evaluation Team (alternative name for SSEB)</td>
</tr>
<tr>
<td>SSP</td>
<td>Source Selection Plan</td>
</tr>
<tr>
<td>SVN</td>
<td>Stakeholder Value Network</td>
</tr>
<tr>
<td>USAF</td>
<td>United States Air Force</td>
</tr>
<tr>
<td>USD(AT&amp;L)</td>
<td>Undersecretary of Defense for Acquisition, Technology, and Logistics</td>
</tr>
<tr>
<td>VCJCS</td>
<td>Vice Chairman of the Joint Chiefs of Staff</td>
</tr>
<tr>
<td>WBS</td>
<td>Work Breakdown Structure</td>
</tr>
<tr>
<td>WSARA</td>
<td>Weapon System Acquisition Reform Act</td>
</tr>
</tbody>
</table>
This Page Intentionally Left Blank
Bibliography


Evidence and Options - Executive Summary. Santa Monica, CA: RAND Corporation.


