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The Key Elements and Drivers of the Defense Acquisition System

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Abstract

A systemic diagram (systemigram) was developed to provide a systems view of the key elements and drivers of the complex defense acquisition system in the United States. An iterative process was used to develop the systemigram, after assessing the basic relationships among key actors and organizations within the system. The diagram provides a high-level overview of the Department of Defense ecosystem as it relates to acquisition, addressing the lack of available high-level visual representations of the overall acquisition system elements and their basic interactions within the literature. Using this diagram, individuals unfamiliar with the defense acquisition system can become better acquainted with it, while those familiar with defense acquisition are provided with a useful artifact to stimulate shared understanding, spark conversations about how to improve acquisition outcomes, and focus on the key inputs, processes, and ultimate goal of military capability.

Keywords: systemigram, acquisition innovation, acquisition overview

Introduction

Natural language (i.e., prose) descriptions of complex systems, such as the defense acquisition system, can be more effectively conveyed visually through the use of systemic diagrams (systemigrams; Mehler et al., 2010). Systemigrams can represent an entire

document's worth of information on a single page, which can be more easily and quickly consumed by an audience. The audience can then use the systemigram as a means to converge on a shared mental model of the system and to elicit insight through conversations about the diagram (Mehler et al., 2010). Systemigrams tell a story about the given system and are presented as a series of scenes to communicate the message of the diagram itself, as well as the message of the system (Blair et al., 2007). Each scene is comprised of a subnet of the diagram (Blair et al., 2007), displaying or adding only a small number of nodes (noun phrases) and arcs (verb phrases) at a time. The main purpose or takeaway of the system is represented as a sentence along the diagonal of the diagram and is called the mainstay (Sauser, 2019). The last node of the mainstay is the overall goal or objective of the system (Sauser, 2019).

A systemigram was chosen to provide a systems view of the Department of Defense (DoD) ecosystem as it relates to defense acquisition. The systemigram developed for this paper will be referred to as the Defense Acquisition Systemigram. The high-level Defense Acquisition Systemigram is especially useful for an audience of individuals just becoming acquainted with defense acquisition, such as professors beginning involvement in defense acquisition research or new members of Congress. The Defense Acquisition Systemigram may also have applications for those familiar with defense acquisition in providing context, recentering them on the ultimate goal of defense acquisition, and providing a means to have conversations about acquisition innovation.

Related Work

The Defense Acquisition Systemigram detailed in this paper is unique in its presentation of the defense acquisition process at a high level. Though at least two other systemigrams regarding defense acquisition exist, they are either constructed for a different audience, including finer details, or focus on the conditions that lead to the success or failure of acquisition projects, instead of the functions of acquisition. Outside of systemigrams, it is difficult to locate another visual depiction of the overall defense acquisition system. The Defense Acquisition Systemigram helps to fill a gap in the literature concerning high-level, visual depictions of the defense acquisition system.

Figure 1 displays the first of the two systemigrams about defense acquisition in the literature. The systemigram in Figure 1 aims to visualize the "structure, function, and process of the defense acquisition system and the extended acquisition enterprise" (Cilli et al., 2016). Figure 1 was developed as an interpretation of the, at the time, latest revision to the defense acquisition system and displays one pathway through the process. While useful, Figure 1 has been created for a different audience than the Defense Acquisition Systemigram as it includes more detail and utilizes terms related to the steps in the processes involved, rather than references to stakeholders, communities, and their relationships that provide key elements needed to acquire and field military capabilities.

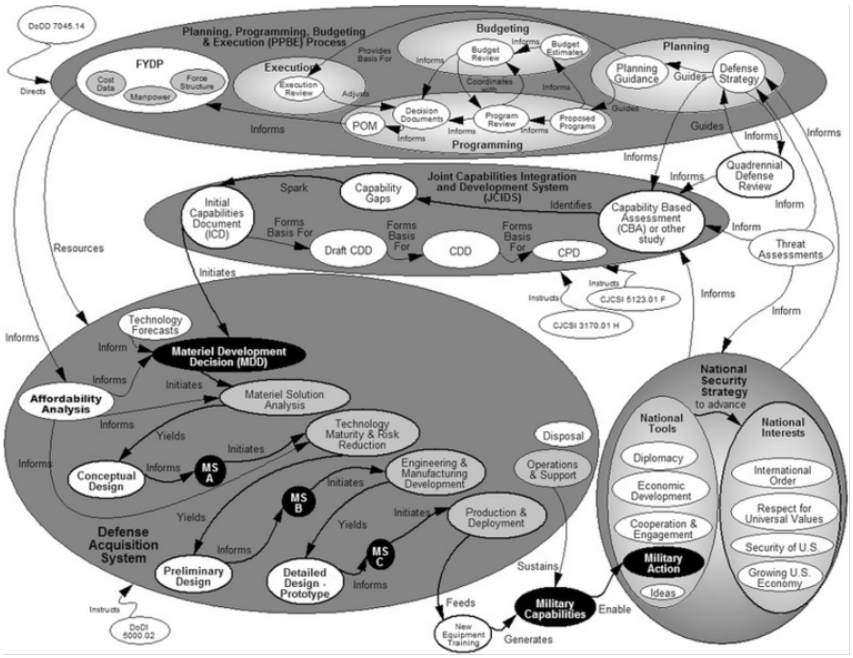

Figure 1. Systemigram from Cilli et al. (2016)

The second systemigram previously created about the defense acquisition system is reproduced in Figure 2. The focus of this systemigram is the conditions leading to a successful or unsuccessful acquisition project, which is fundamentally different from the Defense Acquisition Systemigram's concentration on the process as a whole. Figure 2 focuses on the actors of combat veterans, engineers, Congress, contractors, and program managers. The scenarios to be avoided are program delays or cancellation or increases in overall program cost or unit cost. It poses that the ultimate goal of the defense acquisition system is successful conflict outcome.

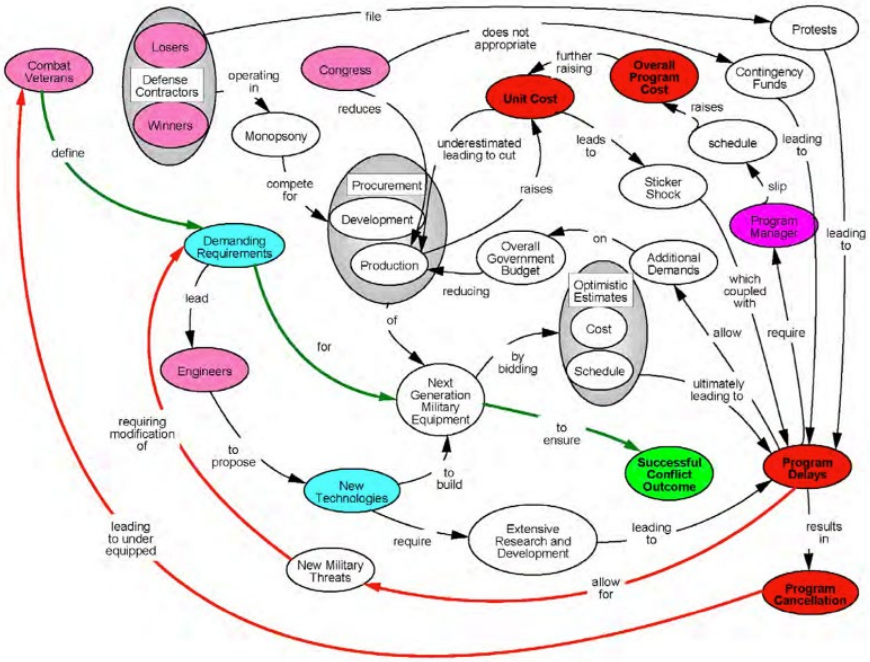

Figure 2. Systemigram from Wade & Batra (2019)

Process

Before beginning the Defense Acquisition Systemigram, a list was generated of actors involved in the system and the functions that they perform. Then, research was conducted on these actors, which are departments and organizations within and relating to the DoD. A hierarchy of these departments and organizations was developed to understand the basic relationships existing among actors and functions. An iterative process followed the creation of an initial draft of the systemigram. Drafts were presented to a subject-matter expert for feedback (P. S. Anton, personal communication, April–October 2021) and later improved. The aim of iterating was to arrive at the most accurate, useful, and visually understandable diagram form of the narrative. Important to this project was correctly stating the mainstay for the system and deciding on the level of detail for the systemigram, including key inputs, sources, and feedback loops.

Defense Acquisition Systemigram

Overview

The final Defense Acquisition Systemigram presents a high-level overview of the defense acquisition system, including how the Acquisition Community interfaces with other functions and organizations outside of itself. The diagram in its entirety is shown in Figure 3 and will be constructed, scene by scene, in the following sections.

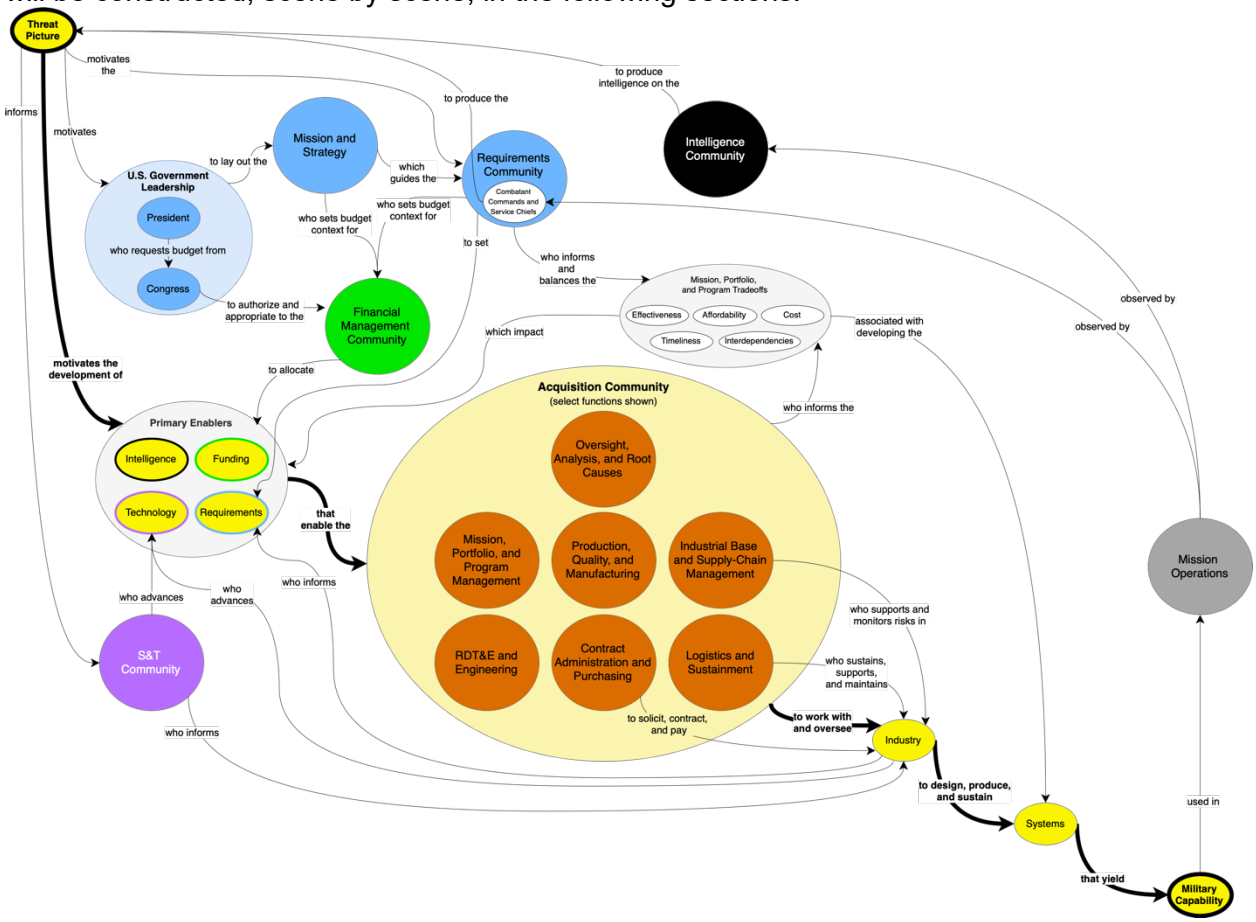

Figure 3. Defense Acquisition Systemigram

Scene 1: Mainstay

The first scene, shown in Figure 4, presents the mainstay of the systemigram, which describes the purpose or main takeaway of the system. The mainstay for this system is that the threat motivates the development of a series of primary enablers (requirements, funding, technology, and intelligence) that enable the Acquisition Community to work with and oversee industry to design, produce, and sustain systems that yield military capability. Military capability, as the last node in the mainstay, is the ultimate goal of the system. Stating this as the ultimate goal was drawn from DoD Directive 5000.01, which states that the acquisition system is designed to deliver "improvements to mission capability" (Under Secretary of Defense for Acquisition and Sustainment [USD(A&S)], 2020a) through the products and services it acquires.

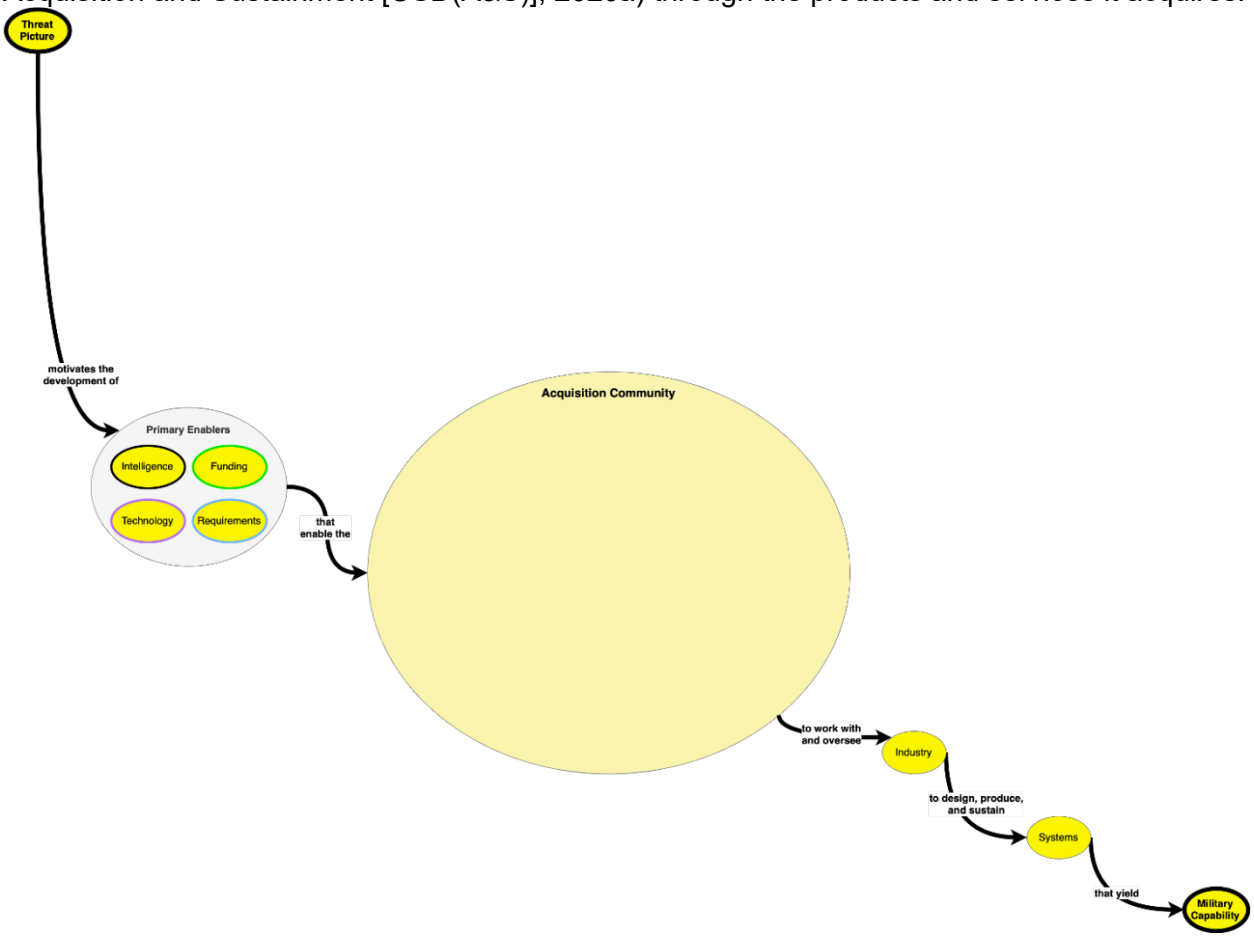

Figure 4. Scene 1: Mainstay

Scene 2: Feedback Loop

The second scene, Figure 5, depicts the feedback loop that exists within the defense acquisition system. The military capability generated by defense acquisition is used in Mission Operations. These operations are then observed by the Intelligence Community and Combatant Commands and Service Chiefs to produce the threat picture.

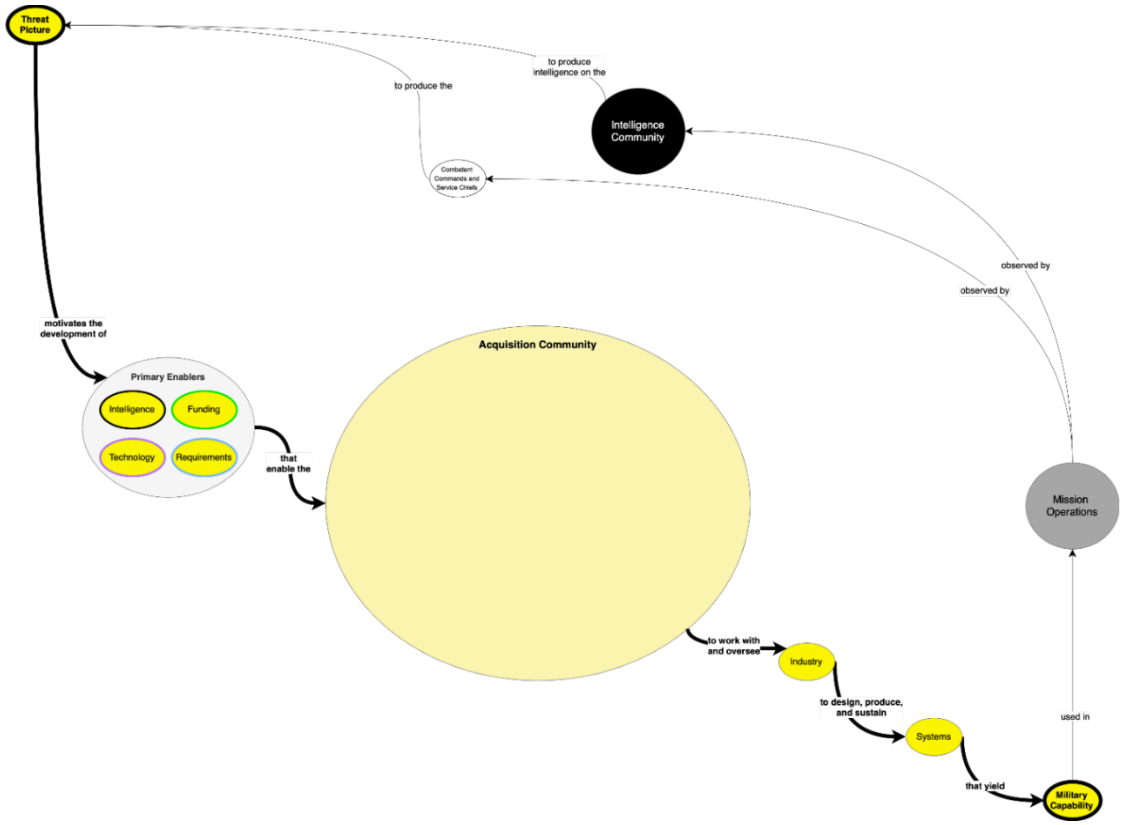

Figure 5. Scene 2: Feedback Loop

Scene 3: Tradeoffs

A key aspect to the overall goal of generating a military capability in a world of limited resources is to produce effective, timely, and affordable solutions (Office of Inspector General, 2020). Performance, schedule, and cost tradeoffs associated with the capability are made by the Service Chiefs and other stakeholders and informed by the Acquisition Community, as seen in Figure 6. These tradeoffs can impact the primary enablers, resulting in changes to requirements and funding adjustments. Note that the Combatant Commands and Service Chiefs, first shown in the second scene, are members of the Requirements Community, but they operate within a larger reporting and budgetary context not explicitly shown in the figure.

The tradeoffs node is labeled “Mission, Portfolio, and Program Tradeoffs” to reflect the increased effort to assess the combined effects of acquired programs as they interact to bring capabilities to the warfighter (Cronk, 2021; GAO, 2007). These assessments and tradeoffs consider how individual acquisition projects fit into larger sets of capabilities (i.e., portfolios) and how they interrelate to serve mission objectives. A mission- and portfolio-based perspective also addresses interdependencies (Cronk, 2021), included in the tradeoffs node of the systemigram, and synchronizes efforts across the entire portfolio, including technologies, capability areas, missions, and programs.

In addition, the tradeoffs node includes reference to both cost and affordability. Cost refers to the price of the system being acquired. Affordability is “the resources projected to be available in the DoD Component portfolio(s) or mission area(s) associated with the program under consideration” (USD[A&S], 2020b). In other words, affordability ensures that the system will be fully funded over its lifetime.

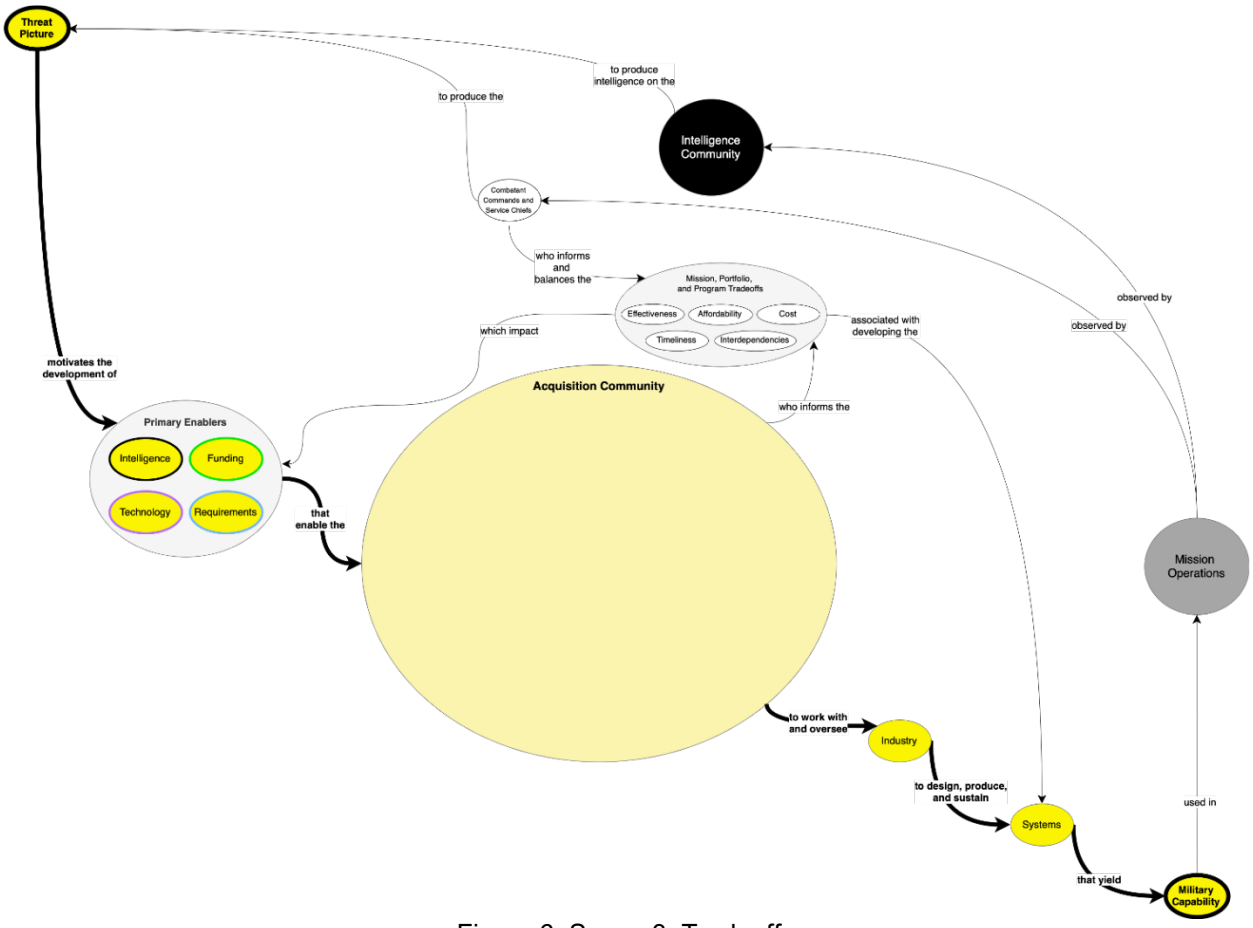

Figure 6. Scene 3: Tradeoffs

Primary Enablers

The primary enablers—requirements, funding, technology, and intelligence—are necessary for acquisition to take place. They can also interact with each other. For example, new technology and usage concepts can drive new requirements, or vice versa. Intelligence drives both requirements and informs acquisition. Funding constrains which needs are deemed important enough to become validated requirements. These interactions are not shown at the level of this diagram, but the presence of the primary enablers indicates their importance in the high-level process.

Scene 4: Requirements

The fourth scene, shown in Figure 7, concerns the primary enabler of *requirements*. The threat picture motivates U.S. Government Leadership (i.e., the President and Congress, in their various roles, responsibilities, and authorities) to lay out the Mission and Strategy, which guides the Requirements Community to set the requirements. Though not explicitly shown in the diagram, the requirements flow through the Acquisition Community and then to industry as system and contractual requirements.

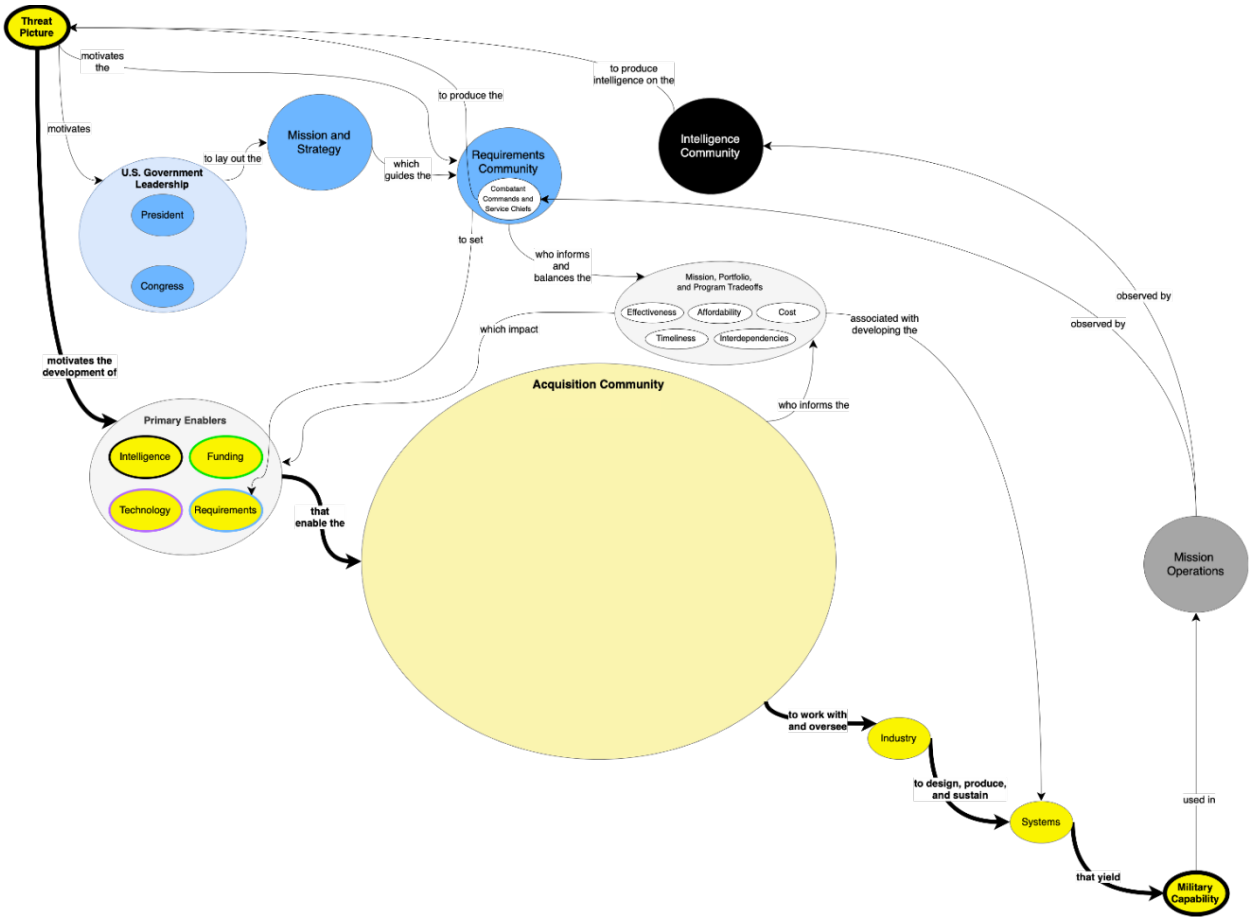

Figure 7. Scene 4: Requirements

Scene 5: Funding

The scene in Figure 8 adds the entities involved in the primary enabler of *funding*. The President requests a budget from Congress, who then authorizes and appropriates a version of the budget back through the Executive Branch hierarchy to the Financial Management Community to allocate funding (initially obligation authority but later as expenditures). The Mission and Strategy and Requirements Communities also set the context for a budget controlled by the Financial Management Community. Given the focus on the acquisition system, the details on how budgets are requested, set, and governed are not shown; that complicated system is out of scope of this paper and deserves its own systemigram (or set of systemigrams).

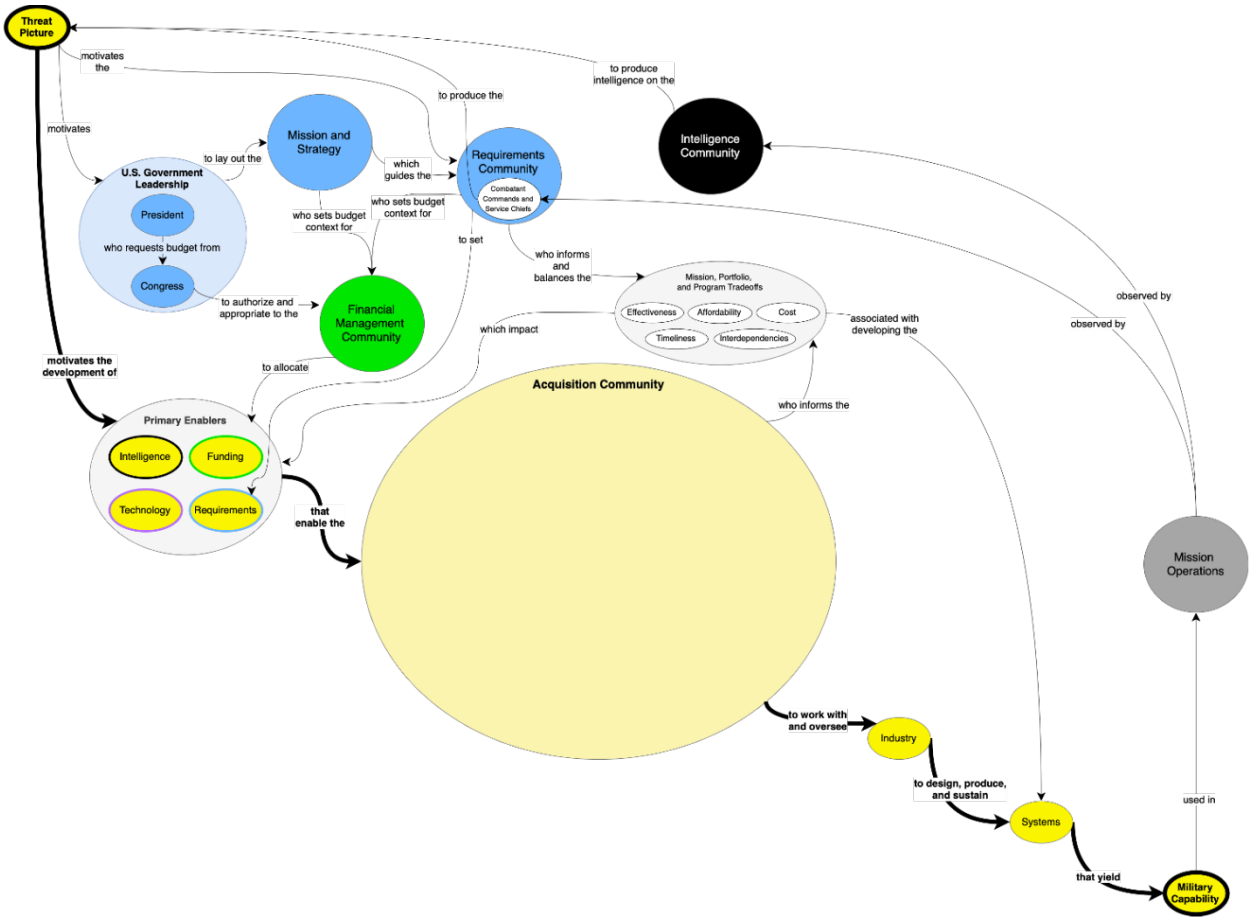

Figure 8. Scene 5: Funding

Scene 6: Technology

Scene 6, illustrated in Figure 9, regards the primary enabler of *technology*. The threat picture informs the Science and Technology (S&T) Community, which then informs industry of specific needs. Here, S&T refers to the applied research efforts within the defense acquisition system. Both S&T and industry advance the state of technology, and research and development of new technologies from industry are a main contributor to the requirements and acquisition processes.

In some cases, the requirements for a project or mission are unable to be fulfilled with technologies that are currently available, resulting in an advancement of the state of technology as a result of the defense acquisition process. In other scenarios, a technological advancement from industry or the research and development efforts within the Acquisition Community triggers the acquisition process. Regardless of whether technological advancement results from or activates the defense acquisition process, as a primary enabler it is required for the acquisition of new systems.

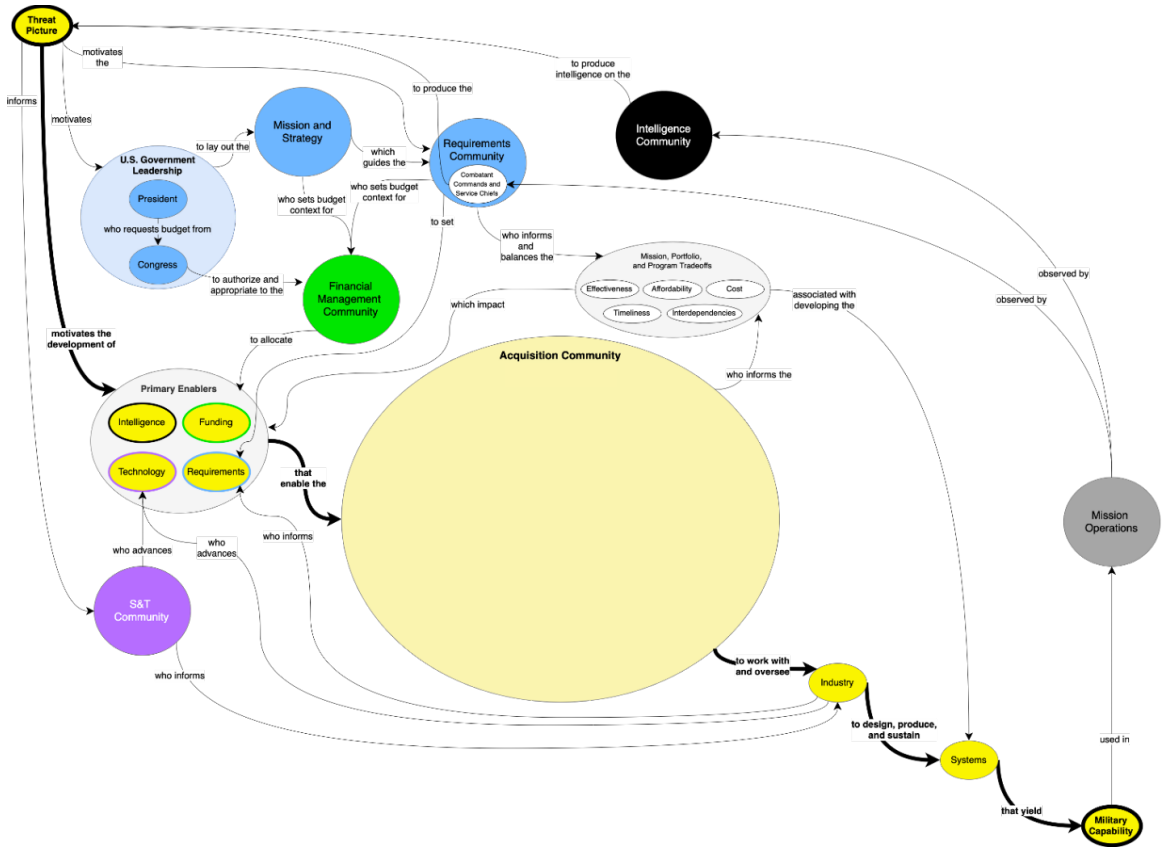

Figure 9. Scene 6: Technology

Scene 7: Acquisition Community

The final scene, Figure 10, fills in some elements of the Acquisition Community. Only select functions have been included as an example of those that exist within the extensive Acquisition Community. The Oversight, Analysis, and Root Causes function serves to examine the successes and deficiencies of the defense acquisition system and their causes. This function monitors the system to ensure that it functions properly and achieves its goal. The function was placed at the top of the Acquisition Community node to emphasize its role in overseeing the workings of the remainder of the community.

Additional functions within the Acquisition Community are Mission, Portfolio, and Program Management; Production, Quality, and Manufacturing; and Research, Development, Test, and Evaluation (RDT&E) and Engineering. Industrial Base and Supply-Chain Management supports and monitors risks in industry, as evidenced by the DoD Office of Industrial Policy's commitment to "providing detailed analyses and in-depth understanding of the increasingly global, commercial, and financially complex industrial supply chain" (Office of Industrial Policy, 2021). Contract Administration and Purchasing solicits, contracts, and pays industry. Logistics and Sustainment sustains, supports, and maintains the systems developed as a result of defense acquisition. Responsibility for sustaining these systems falls on both industry and a member of the Acquisition Community.

Interactions within the Acquisition Community have been intentionally excluded from this systemigram. This better achieves the intention of producing a high-level overview of the acquisition system and how the Acquisition Community interacts with functions and organizations outside of it.

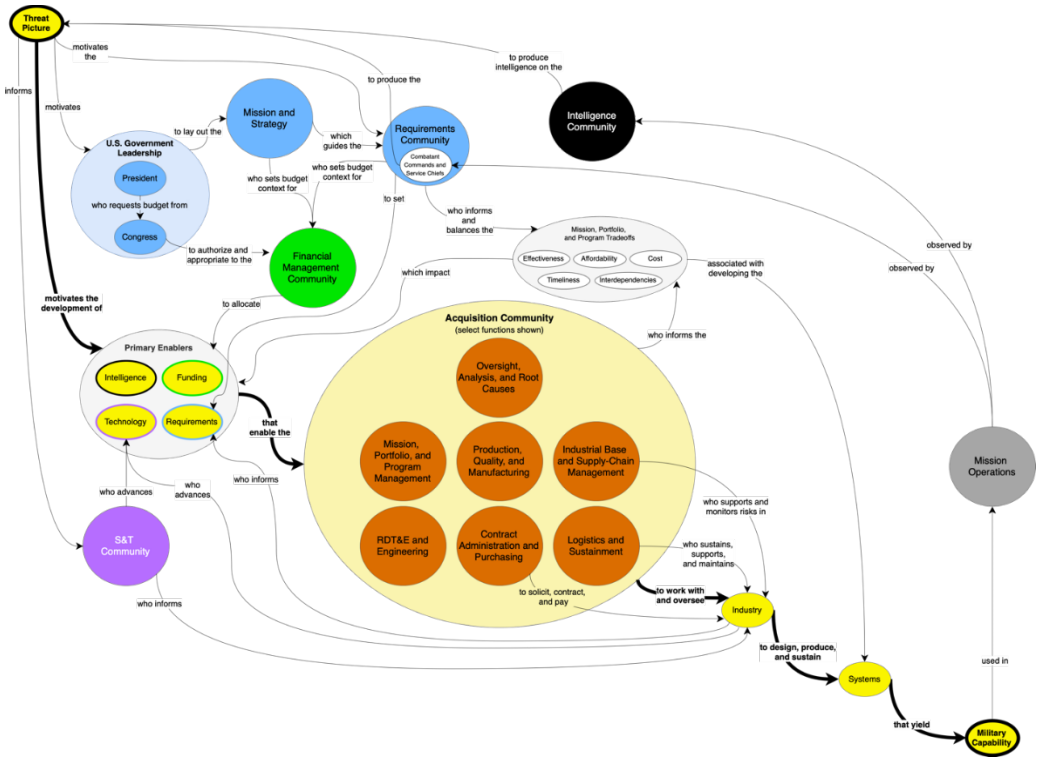

Figure 10. Scene 7: Acquisition Community

Verification and Validation

The verification and validation processes for the Defense Acquisition Systemigram consisted of ensuring that it meets the rules of systemigram creation and that it accurately depicts the defense acquisition system at a high level.

As a Systemigram

While creating the diagram, care was taken to ensure that it meets the rules of systemigram creation. First, the diagram has a mainstay, which reads from the top left to the bottom right (Sauser, 2019). Nodes consist of noun phrases and are not repeated, while arcs comprise verb phrases and do not cross any other arcs in the diagram (Sauser, 2019). Another requirement is that every node has at least one input and output, save for the beginning and ending nodes of the mainstay (Sauser, 2019). Nodes within a containment node (e.g., in this diagram, the primary enablers and nodes within the Acquisition Community) are also exempt from this rule, so long as the containment node has at least one input and output. The Defense Acquisition Systemigram meets this rule, as well. Finally, the imperative of beautification (Sauser, 2019) has been followed through the use of color and line thickness in the diagram. Color aids in understanding the flow of the diagram and visually grouping nodes that appear within the same scene. Line thickness differentiates arcs involved in the mainstay from those that are not. As the rules for creation have been met, the diagram is a legitimate systemigram.

As a High-Level Depiction of Defense Acquisition

To ensure that the diagram accurately depicts the defense acquisition system at a high level, it was shown to another expert within the field. The expert agreed that the diagram would be useful for individuals or universities to better understand the interactions within the defense acquisition system but also expressed concern with keeping it up to date as changes are made to DoD policy. The addition of the Oversight, Analysis, and Root Cause function resulted from this review, to show that the Acquisition Community monitors its process and progress. The goal

of the system was also amended to “military capability” from “military advantage” to reflect that the acquisition system still maintains purpose after one threat no longer exists.

Relevance

The relevance of the Defense Acquisition Systemigram includes addressing a gap in the literature, use by individuals within and outside of the defense acquisition system, and the potential to inform systemic improvements for better acquisition outcomes.

Literature Gap

As addressed in the Related Work section, there is a gap in the literature regarding a high-level view of the overall defense acquisition system. This work helps to fill that gap by providing one such view in the form of a systemigram.

The diagram also distinguishes itself from other systemigrams about defense acquisition. The Defense Acquisition Systemigram reflects a functional flow of the system, which differs from the typical process-oriented perspective provided by the systemigram in Figure 1. The Defense Acquisition Systemigram and the diagram in Figure 2 are differentiated by their choices of the beginning node of the mainstay. Figure 2 states that combat veterans drive the defense acquisition system, but the Defense Acquisition Systemigram asserts that it is the threat picture. The systemigram in Figure 2 does not examine the role of intelligence, though it does include the other primary enablers of the Defense Acquisition Systemigram.

Use by Individuals Within and Outside of the System

This systemigram could be useful for both individuals within and outside of the defense acquisition system. While individuals within the system may already possess knowledge of its workings at this high level, the systemigram can stimulate shared understanding and provide useful context about how functions and departments buried within this large enterprise relate to others within the system. Another powerful potential use for the systemigram is to help individuals within the acquisition system refocus on the ultimate goal of achieving military capability, rather than just the immediate objectives of their embedded function and organization.

Similarly, the systemigram can be used by those outside of the defense acquisition system to learn more about how it works. This high-level overview could be useful for professors or students aiming to get involved with defense acquisition, or perhaps Defense Acquisition University students or new members of Congress.

Applications for Acquisition Innovation

This systemigram also has applications for improving defense acquisition. While changes would likely not take place at the level of fidelity shown in the Defense Acquisition Systemigram, it clarifies the key systemic elements and processes involved. For example, the systemigram reinforces that the threat is the reason for the Acquisition Community to exist because it is the beginning node of the mainstay. Also, requirements, funding, intelligence, and technology are necessary enablers of acquisition; impedances in those flows can have negative consequences for the effectiveness of defense acquisition, so simply improving the processes within the Acquisition Community may be insufficient for better outcomes. If not illuminating areas for innovation, at the very least, the diagram could generate discussion about its correctness, which is also useful to gain and codify knowledge about the system.

The Defense Acquisition Systemigram could serve as an “as is” depiction of the system in innovation efforts. Another systemigram, illustrating the “to be” version of the system, could be created and compared to the Defense Acquisition Systemigram. Innovation efforts could then focus on how to achieve the “to be” systemigram from the “as is” systemigram.

A final use of the systemigram is to ensure that changes focus on the ultimate goal of military capability. All decisions and innovation efforts should keep this goal in mind and clarify to stakeholders and employees the importance of their work in relation to this goal.

Future Work

Almost every arc and node in the Defense Acquisition Systemigram could be expanded into its own systemigram to explain the complexity of the relationships in the defense ecosystem. Future projects could work to create a family of systemigrams that more completely illustrate the system and show varying levels of detail. In particular, a systemigram is needed to represent the interactions within the Acquisition Community. These relationships were excluded from the Defense Acquisition Systemigram in order to maintain a high-level overview of the system. The flow of trained personnel throughout the system and the legal advising process were removed from earlier versions of the diagram for a similar reason.

Conclusion

The Defense Acquisition Systemigram represents the interactions between actors in the defense acquisition system at a high level, providing a systems view of the key elements and drivers of the complex system. The diagram addresses a lack of high-level visual representations of the overall system in the literature and also offers applications for individuals within and outside of the system, as well as acquisition innovation. The most profound implication of the Defense Acquisition Systemigram is the ability to recenter the defense acquisition effort on key enablers necessary for acquisition and in creating military capability, which is the ultimate goal of the system.

References

Blair, C. D., Boardman, J. T., & Sauser, B. J. (2007). Communicating strategic intent with systemigrams: Application to the network-enabled challenge. *Systems Engineering*, *10*(4), 309–322.

Cilli, M. V., Parnell, G. S., Cloutier, R., & Zigh, T. S. (2016). A systems engineering perspective on the revised defense acquisition system. *Systems Engineering*, *18*(6), 584–603.

Cronk, T. M. (2021, September 28). *DOD official says concept of integrated deterrence is call to action*. DoD News. https://www.defense.gov/News/News-Stories/Article/Article/2791589/dod-official-says-concept-of-integrated-deterrence-is-call-to-action/

GAO. (2007). *Best practices: An integrated portfolio management approach to weapon system investments could improve DOD's acquisition outcomes* (GAO-07-388). https://www.gao.gov/products/gao-07-388

Mehler, J., McGee, S., & Edson, R. (2010). Leveraging systemigrams for conceptual analysis of complex systems: Application to the U.S. national security system. *8th Conference on Systems Engineering Research*. http://anser.org/docs/asyst-doc/Leveraging-Systemigrams-and-Their-Application-to-the-US-National-Security.pdf

Office of Industrial Policy. (2021). *Home.* DoD. https://www.businessdefense.gov

Office of Inspector General. (2020). *Special report: Lessons learned for Department of Defense acquisition officials during acquisition reform.* DoD. https://media.defense.gov/2020/Aug/04/2002469834/-1/-1/1/DODIG-2020-109.PDF

Sauser, B. (2019, November 18). *Systems thinking workshop* [PowerPoint slides]. Systems Engineering Research Center. https://sercuarc.org/wp-content/uploads/2019/12/Systems-Thinking-Workshop_CombinedSlides.pdf

Under Secretary of Defense for Acquisition and Sustainment. (2020a). *The defense acquisition system* (DoD Directive 5000.01). DoD. https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodd/500001p.pdf?ver=2020-09-09-160307-310

Under Secretary of Defense for Acquisition and Sustainment. (2020b). *Operation of the adaptive acquisition framework* (DoD Instruction 5000.02). DoD. https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/500002p.pdf

Wade, J., & Batra, K. (2019). *Systems thinking workshop: SystemiTool 2.0* [PowerPoint slides]. Systems Engineering Research Center. https://sercuarc.org/wp-content/uploads/2019/12/Systems-Thinking-Workshop_CombinedSlides.pdf

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