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HACKING THE DEFENSE INNOVATION ECOSYSTEM ENTERPRISE: A COMPARATIVE ANALYSIS

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December 2018

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Secretary Mattis' 2018 National Defense Strategy acknowledges that the Department of Defense's (DoD's) asymmetric technological capabilities, which enable a decisive military advantage over U.S. adversaries, are steadily eroding. Implementing underutilized traditional and non-traditional acquisition authorities to navigate the innovation ecosystem may prove to be a fast, flexible solution to this technological innovation gap. We comparatively analyze the DoD's innovation ecosystem to understand the communities that make up the ecosystem and how they apply various acquisition authorities, techniques, or processes to accelerate future capabilities to the warfighter, and across the Defense Acquisition System.

Our research shows that traditional and non-traditional micro-ecosystems play pivotal roles in the transition of cutting-edge technology through government, industry, and academic collaboration. Aside from traditional authorities, we highlight several non-traditional acquisition authorities with potential for broader adoption across the enterprise. Finally, we discuss lessons learned in terms of "what," "where," "when," and "how" mid-level management decision makers can think and act entrepreneurially to positively disrupt status-quo bureaucracies that inhibit rapid innovation across the ecosystem.

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LIST OF ACRONYMS AND ABBREVIATIONS

§	section
AFRL	Air Force Research Laboratory
ANSER	Analytic Services Incorporated
ARL	Army Research Laboratory
ASD-R&E	Under Secretary of Defense for Research and Engineering
ATI	Advanced Technology International
BAA	broad agency announcement
BRICC	Basic Research Innovation and Collaboration Center
C4ISR	command, control, communications, and cyber, intelligence, surveillance, and reconnaissance
CIA	Central Intelligence Agency
CISC	Center for International Security and Cooperation
CEO	Chief Executive Officer
CMO	Contracts Management Office
CNAS	Center for a New American Security
CRADA	cooperative research and development agreement
CSO	commercial solutions opening
CTO	Comparative Technology Office
DARPA	Defense Advanced Research Projects Agency
DIU	Defense Innovation Unit
DIUx	Defense Innovation Unit Experimental
DLE	Defense Laboratory Enterprise
DoD	Department of Defense
EPA	educational partnership agreement
ETO	Army Emerging Technologies Office
FAR	federal acquisition regulation
FFRDC	Federally Funded Research and Development Center
FNC	Office of Future Naval Capabilities
GAO	Government Accountability Office
GOCO	government owned contractor operated

GPS	global positioning satellite
H4D	Hacking for Defense
H4Di	Hacking for Defense Incorporated
IP	intellectual property
ISIL	Islamic State of Iraq and the Levant
JCIDS	joint capability integration development system
JCTD	Joint Capability Technology Demonstration Office
JRAC	Joint Rapid Acquisition Cell
MCWL	Marine Corps Warfighting Laboratories
NSTA	Military District 5 National Security Technology Accelerator
MDAP	major defense acquisition program
MIT	Massachusetts Institute of Technology
MVP	minimum viable product
n.d.	no date
NIAC	Naval Innovation Advisory Council
NIPA	naval innovation process adoption
NRL	Naval Research Laboratories
ONR	Office of Naval Research
OT	other transaction
OTA	other transaction authority
OUSD-AT&L	Office of the Under Secretary of Defense-Acquisition, Technology & Logistics
PIA	partnership intermediary agreement
PPB&E	planning, programming, budgeting & execution
R&D	research and development
RCO	Rapid Capabilities Office
REF	Army Rapid Equipping Force
RFP	request for prototype
RIF	Rapid Innovation Fund
RRTO	Rapid Reaction Technology Office
S&T	science and technology
SBA	Small Business Administration

SBIR	Small Business Innovation Research
SCO	Strategic Capabilities Office
SMART	science, mathematics, and research for transformation
STTR	Small Business Technology Transfer
TIA	technology investment agreement
TISO	Technology Initiative Screening Office
TTO	Naval Technology Transfer Office
UARC	University Affiliated Research Center
U.S.C.	United States code
VCI	Venture Capital Initiative
VT-ARC	Virginia Tech Applied Research Corporation
WBI	Wright Brothers Institute

I. INTRODUCTION

Since 2014 the Department of Defense (DoD) has been acutely aware of its position in the race for technological superiority over its adversaries. A substantial emphasis has been placed upon the eroding technological advantage and the need for delivering innovative capabilities to the warfighter. In 2014, then Secretary of Defense, Chuck Hagel, published The Defense Innovation Initiative. He charged all secretaries and directors throughout the DoD to "actively pursue innovative ways to sustain and advance our military superiority into the 21st century and improve business operations throughout the department" (Hagel, 2014, p. 1):

> We are entering an era where American dominance in key warfighting domains is eroding, and we must find new and creative ways to sustain, and in some areas expand, our advantages even as we deal with more limited resources. This will require a focus on new capabilities and becoming more efficient in their development and fielding…the demand for innovation must be Department-wide and come from the top…We must take the initiative to ensure that we do not lose the military-technological superiority that we have long taken for granted…America's continued strategic dominance will rely on innovation and adaptability across the defense enterprise. (Hagel, 2014, p. 1-2)

Further emphasis is substantiated by Dr. Frank Kendall in his response to The Defense Innovation Initiative with the need to evolve the acquisition process and adapt to the new environment. In 2015, then Under Secretary of Defense, Acquisitions, Technology and Logistics, Dr. Kendall, charged all secretaries and directors of defense agencies with emphasis on pioneering technical supremacy through innovation in his implementation directive for Better Buying Power 3.0 Initiatives:

> New in Better Buying Power 3.0 is a stronger emphasis on innovation, technical excellence, and the quality of our products. The technological superiority of the United States is now being challenged by potential adversaries in ways not seen since the Cold War. Efficiency and productivity are always important, but the military capability that we provide to our warfighters is paramount. Our operational effectiveness is based on the quality of our people and the quality of our products. The former is not in doubt; the latter depends on our efforts and on those of the industrial base. We will continue our work to improve productivity and

> efficiency, but we must also turn our attention increasingly to our ability to innovate, achieve technical excellence, and field dominant military capabilities. (Kendall, 2015, p. 1)

Additionally, Secretary James Mattis amplifies the need to prioritize the speed at which we acquire capability and continuous adaptation of technologies to deliver that technical advantage. In order to do so, acquisition professionals must find innovative ways within the current bureaucracy to think outside the box and execute more efficiently. Secretary Mattis emphasizes this in his 10-page unclassified synopsis of the National Defense Strategy providing strategic guidance to the Department of Defense:

> Success no longer goes to the country that develops a new fighting technology first, but rather to the one that better integrates it and adapts its way of fighting… Our response will be to prioritize speed of delivery, continuous adaptation, and frequent modular upgrades. We must not accept cumbersome approval chains, wasteful applications of resources in uncompetitive space, or overly risk-averse thinking that impedes change. (Mattis, 2018, p. 12)

To accomplish what Secretaries Hagel (2014), Mattis (2018) and Dr. Kendall (2015) seek to accomplish the DoD needs to put more priority on modernizing, "developing, and proliferating disruptive capabilities across the spectrum of conflict" (Hagel, 2014 p. 1) in today's fiscally constrained environment. This objective demands a more innovative and agile defense acquisition enterprise unlike anything we have experienced in the past. DoD organizations do a fantastic job at responding to innovation policy initiatives individually. But collaboratively, the DoD lacks effective implementation of resources in the existing defense acquisition construct, thus resulting in duplication of effort and inefficient utilization of the tools across its innovation ecosystem.

The ability to navigate the DoD's innovation ecosystem through the implementation of traditional and non-traditional acquisition authorities may prove to be a fast, flexible, and collaborative solution to the DoD's technological innovation gap. The purpose of this research is to analyze the current state of the DoD innovation ecosystem to understand what communities make up the ecosystem and how they apply various acquisition authorities, techniques or processes to accelerate next generation technology to the warfighter. A comparative analysis will be conducted of the various communities that

make up the DoD's innovation ecosystem as well as to determine which acquisition authorities, techniques or processes contribute to innovations in the acquisition process.

This chapter introduces the emphasis on and need for the identification of the innovation ecosystem within the DoD and various acquisition authorities, techniques or processes used to accelerate next generation technology to the warfighter. A brief background will discuss the urge for adopting innovation within our acquisition processes. Additionally, this chapter provides an overview of the purpose, research objectives and questions, research scope and limitations, methodology and organization for how we plan to identify the DoD's innovation ecosystem through this report.

A. BACKGROUND

"The United States has the full extent of industry and commercial partners needed to create an advantage in aggregate but, instead of capitalizing on these assets, the DoD disincentivizes new entrants to the defense market and the pursuit of capabilities that transcend stated requirements" (Fitzgerald, Sander, & Parziale, 2016, p. 37). The disincentive is the cumbersome and highly regulated traditional acquisition system utilizing Federal Acquisition Regulation authorities. This system is phenomenally suited for its intended purpose. Fitzgerald et al. assert that,

> in order to invest in technology that generates advantages, the DoD must be able to identify what it needs, but the requirements process is optimized for the development of large-scale, long-term, military unique systems and the department cannot continue to rely solely on highly formalized requirements, enshrined through capability-based analyses and the Joint Capability Integration and Development System (JCIDS) process. (2016, p. 24)

Successful implementation of The Defense Innovation Initiative is predicated on the DoD's ability to partner with traditional and non-traditional partners across the defense innovation ecosystem. The DoD has some adapting to do. In 2017, the GAO conducted a study of 12 non-traditional companies that do not typically do business with the DoD. Among the reasons for not doing business with the DoD, the acquisition process was the principal complaint. The complexity of the process, long procurement lead-times, and

intellectual property concerns were highlighted as aversions to partnering with the DoD. The GAO's report details steps the DoD is taking to alleviate these barriers.

To address this problem, the 2016 National Defense Authorization Act enacted by Congress provided the DoD with expanded use of Other Transaction Authority (OTA) allowing the DoD to enter into flexible agreements apart from the traditional defense acquisition system. OT authority is an acquisition authority not subject to the traditional laws and regulations governed by the Federal Acquisition Regulation (FAR). Its utilized as a means to rapidly acquire innovative technological capabilities in a matter of months versus years through the traditional system. We discuss this authority in detail further in this report.

The DoD has established several organizations to take advantage of the research and development (R&D) opportunities in the commercial sector. The purpose of these organizations the DoD commonly refers to as Tech Accelerators, is to utilize OTAs to partner with non-traditional companies and provide greater capabilities in less time to the warfighter. The interpretation of a Tech Accelerator varies across the innovation ecosystem and is discussed further in this report. These are not the only organizations at the forefront of acquiring innovative technologies for the future of the force. They are a small facet of the innovation ecosystem but play an important role in catalyzing change in the way the DoD does business.

B. PURPOSE STATEMENT

"In today's knowledge-based global society, economic wealth, resources, information, and power are widely distributed, contributing to the emergence of new sources of disruptive innovation" (Harrison, Rao, & Mulloth, 2017, p. 1). Harrison et al. (2017, p. 1) claim that, "while the importance of technology to military competitiveness is a broadly accepted fact, the role that the Department of Defense plays in catalyzing the emergence of technology-based products with broad social and economic impact is less recognized." Their claim sets purpose for this MBA project. Our intent is to research and analyze the current state of the DoD innovation ecosystem to understand what communities make up the ecosystem and how they apply various acquisition authorities, techniques or

processes to accelerate next generation technology to the warfighter through traditional and non-traditional defense entities.

C. RESEARCH OBJECTIVES AND QUESTIONS

The primary objective of this research is to analyze the current state of the DoD innovation ecosystem to understand what traditional and non-traditional communities make up the ecosystem and how they apply various acquisition authorities, techniques or processes to accelerate next generation technology to the warfighter. We will do this by first examining the history of DoD's implementation of technological innovation efforts enterprise-wide and then presenting a comparative analysis of acquisition authorities, techniques or processes that various communities utilize to deliver next generation technology to the warfighter. To accomplish the primary objective, the question we will attempt to answer is, *"What communities make up the DoD's innovation ecosystem and what acquisition authorities, techniques or processes do they leverage to accelerate next generation technology to the warfighter?"*

We seek to bring greater awareness to the traditional and non-traditional acquisition authorities, techniques or processes implemented across the DoD's innovation ecosystem that has potential for greater application throughout the Defense Acquisition System. To accomplish this objective, the questions we will examine are:

- *What communities make up the DoD's innovation ecosystem?*
- *What traditional or non-traditional acquisition authorities are used to acquire innovative technologies?*
- *What technological innovation basis does each community or organization leverage?*
- *Are there any specialized acquisition techniques or processes that could be applied across the ecosystem?*
- *What lessons learned are shared across the ecosystem?*

D. RESEARCH SCOPE AND LIMITATIONS

This project comparatively analyzes the current state of the DoD innovation ecosystem to understand what communities make up the ecosystem and how they apply various acquisition authorities, techniques or processes to accelerate next generation technology to the warfighter through traditional and non-traditional defense entities. Additionally, we seek to gain a broader awareness surrounding the acquisition community's use of the various authorities mentioned in this report. We rely on qualitative feedback from various organizations within the innovation ecosystem to understand the application of these traditional and non-traditional authorities. While the organizations and their responses may be of limited sample size, we believe them to represent general consensus across the ecosystem.

We understand the GAO and defense acquisition community as a whole acknowledge broad acquisition discrepancies through the traditional procurement processes of the Joint Capabilities Integration and Development System (JCIDS); Planning, Programming, Budgeting & Execution (PPB&E); and defense acquisition system. We do not discuss these in our report nor analyze the current system in this research; rather, we assume a foundational knowledge and awareness of these processes. We do, however, analyze the various communities to include traditional and non-traditional entities across the DoD's innovation ecosystem pushing the bounds of innovation with respect to their application of traditional and non-traditional acquisition methods.

Several factors inhibit the creative implementation of acquisition authorities, thus amalgamating and complicating the challenges faced in the current system. These factors include, but are not limited to, organizational culture, statutory and regulatory limitations, policy or procedural guidance, fiscal appropriations and funding authorities. We do not intend to provide solutions to the various challenges exposed through the current acquisition system, however we do intend to bring awareness to and emphasis on the potential for greater application of non-traditional innovation-based acquisition authorities, techniques or processes applied throughout the DoD's innovation ecosystem to the traditional defense acquisition system programs of record.

E. METHODOLOGY

This report is intended to explore the current state of the DoD innovation ecosystem to understand what communities make up the ecosystem and how they apply various acquisition authorities, techniques or processes to accelerate next generation technology to the warfighter. Our research analyzes the current literature on innovative acquisition practices across the DoD enterprise through review of relevant policy and case studies. Additionally, we use qualitative collection methods which involved telephone and in-person surveys with various traditional and non-traditional entities to help synthesize the value that each community delivers to the DoD innovation ecosystem enterprise.

F. ORGANIZATION OF REPORT

Chapter I presented the background, purpose statement, research objectives and questions, research scope and limitations, and methodology. In Chapter II, we present a review of a brief history of the literature surrounding the defense innovation ecosystem. We discuss the origins and importance of an ecosystem by defining what an innovation ecosystem is through the lenses of the DoD and Industry. We conclude Chapter II with a review of examples of traditional and non-traditional entities across the innovation ecosystem and the various acquisition authorities, techniques or processes leveraged providing purpose for our research. In Chapter III, we discuss our data collection methods, which involved telephone and in-person surveys with various traditional and non-traditional entities. Finally, in Chapter IV, we analyze the research findings. We identify the various communities that make up the DoD innovation ecosystem and analyze the various acquisition authorities, techniques or processes utilized to accelerate next generation technology to the warfighter. We also summarize leading acquisition practices the ecosystem refers to as "positive disruptioneering," a term coined by the Defense Advanced Research Projects Agency (DARPA), from a couple traditional and non-traditional entities before concluding with future areas worth researching.

G. SUMMARY

In summary, this chapter introduced the emphasis on and need for the identification of the traditional and non-traditional communities that make up the DoD's innovation ecosystem and how they acquire innovative technologies. A brief background discussed the urge for adopting innovation within our acquisition system and processes. Additionally, this chapter provided an overview of the purpose, research objectives and questions, research scope and limitations, methodology and organization for how we plan to identify the DoD's innovation ecosystem through this report. The next chapter will provide a review of the literature surrounding innovation ecosystems, and more precisely, how this is applied throughout the DoD.

II. LITERATURE REVIEW

There exists a need for the identification of the traditional and non-traditional communities that make up the DoD's innovation ecosystem and how they acquire innovative technologies. This chapter examines the various DoD entities operating within the innovation ecosystem that are attempting to bridge the gap between the DoD and the rapidly changing, tech-based commercial sector in Silicon Valley and beyond. In summarizing the National Defense Strategy, Secretary Mattis emphasized the need to prioritize investments in technological innovation, "specifically, cyber, advanced computing, big data analytics, artificial intelligence, autonomy, robotics, miniaturization, additive manufacturing, directed energy, and hypersonics are the very technologies that we need to fight and win wars of the future" (Cronk, 2018). The need for these advanced capabilities only magnifies the need for expanded defense-industry partnerships. The review will begin with a history of the DoD's efforts to capture commercial innovation to provide enhanced capabilities to the warfighter. We then analyze the development of the innovation ecosystem including some key players and Tech Accelerators implementing various acquisition authorities, techniques or processes who attract the business of non-traditional defense contractors.[1]

A. THE DEFENSE INNOVATION INITIATIVE: ORIGINS AND IMPORTANCE

Former Secretary of Defense Hagel suggests that "America's continued strategic dominance will rely on innovation and adaptability across our defense enterprise. This will build the foundation for American leadership well into the 21st century" (Hagel, 2014, p. 2). These closing words of the former Secretary of Defense's memorandum for the Defense Innovation Initiative have been echoed by the current Secretary of Defense James Mattis who said that the DoD Innovation Initiative is one of his top-level priorities. (Cronk, 2017).

[1] A non-traditional defense contractor is defined by the DoD's Guide for Prototype Projects as "an entity that is not currently performing and has not performed, for at least the one-year period preceding the solicitation of sources by DoD for the procurement or transaction, any contract or subcontract for DoD that is subject to full coverage under the cost accounting standards prescribed pursuant to 41 U.S.C. § 1502 and the regulations implementing such section" (DoD, 2017).

Since its signing, there has been increased emphasis on and need for the identification of the innovation ecosystem within the DoD and various acquisition authorities, techniques or processes used to accelerate next generation technology to the warfighter.

1. Innovation Defined

Dr. Hummel, a former program manager at DARPA, expands on the concept of innovation as an agile process of adopting new concepts and processes.

> The key is this magic buzzword, "innovation." It means doing things differently, and not just incrementally improving upon current systems, technologies, and strategies. It implies agility: fast adoption of ideas, and fast transition from the start-up and lab to operational use. And it means taking advantage of ideas generated for the commercial marketplace, to rapidly integrate those capabilities into defense needs. None of these come easy to the DoD. (Hummel & Wurster, 2016, para. 4)

This interpretation runs counter to the DoD's current acquisition process which has been referred to as "slow and antiquated" (Tirpak, 2017, para. 1). The GAO's study of the Air Force's Acquisition process described in Figure 1 is indicative of the defense acquisition process as a whole. Regardless of dollar threshold of the procurement activity the emphasis is on agile delivery, something that the current defense acquisition system significantly lacks. The current process does not afford itself the ability to partner with innovative companies whose concept-to-market timelines are considerably more condensed than that of the defense acquisition system. If non-traditional companies wanted a piece of the defense spending pie, they would become obsolete before they could sign the contract award. Additionally, non-traditional companies considerably lack the administrative capacity to comply with burdensome defense acquisition demands that are inconsistent with commercial practices, such as a government-unique cost accounting system (GAO, 2017). There have been significant efforts by the DoD to capture innovative technologies in the past with organizations like the service research laboratories and DARPA (Bardach, 2008). However, as commercial technology advances the impetus is upon the DoD to adapt and proliferate its partnership role throughout the innovation ecosystem by adopting innovative acquisition practices that accelerate dual-use disruptive capabilities to the warfighter.

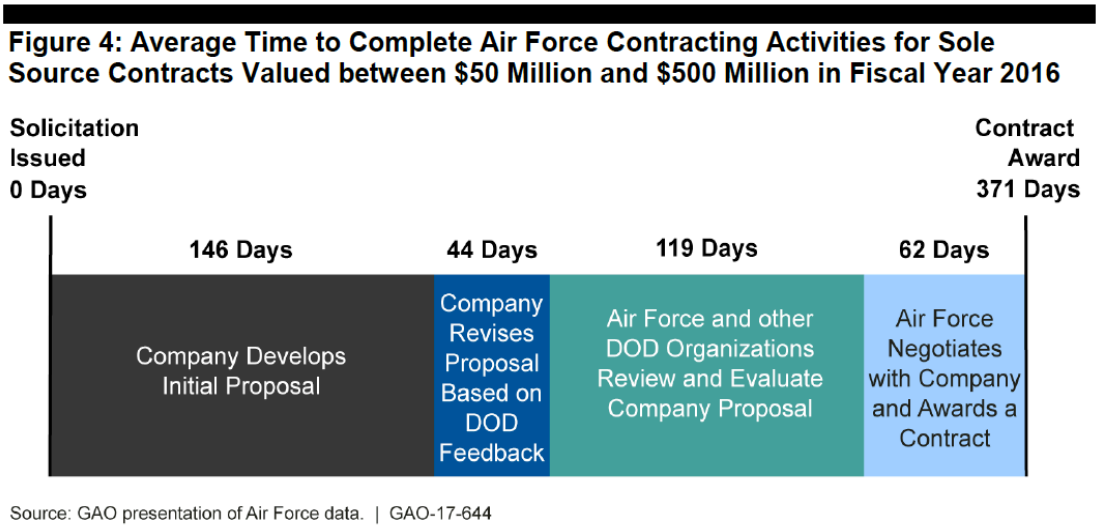

Figure 1. Average Time to Complete Air Force Contracting Activities for Sole Source Contracts Valued between $50 Million and $500 Million in Fiscal Year 2016. Source: GAO (2017).

2. DoD's Perspective

> In the past, research programs funded by the Department of Defense (DoD) often led industry efforts in technology. Today the reverse is largely the case—technology leadership has shifted to industry, where most research and development (R&D) dollars are spent. (OUSD-AT&L, 2001, p. 4)

While the statement above was made over two and a half decades ago, the R&D gap between the DoD and private companies has only grown over the years (see Figure 2).

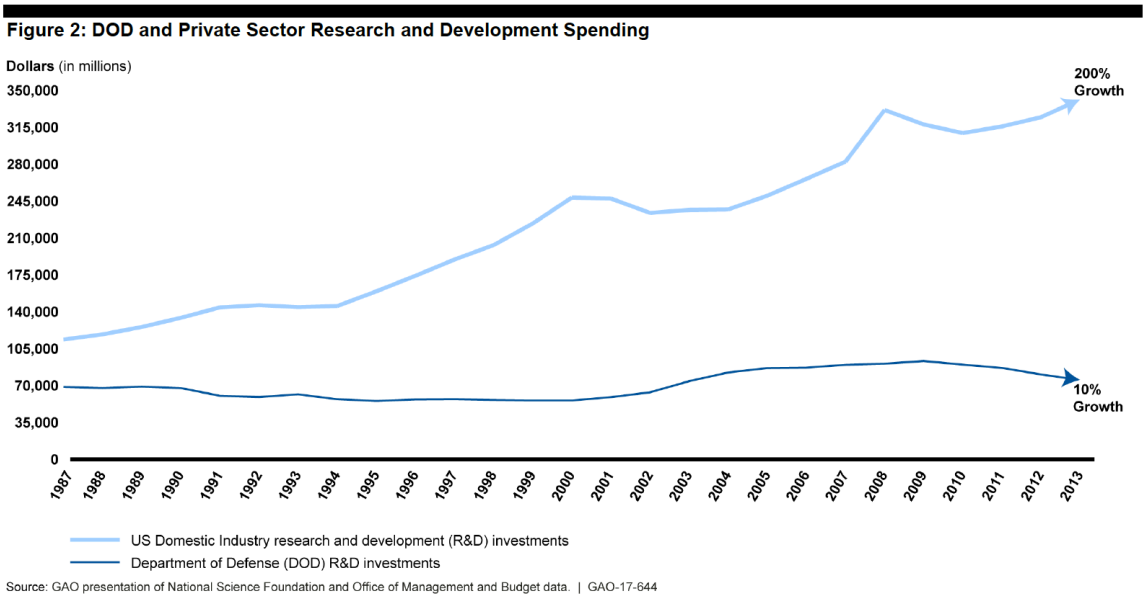

Figure 2. DoD and Private Sector Research and Development Spending. Source: GAO (2017).

Then Under Secretary for Defense for Acquisition, Technology and Logistics, Jacques S. Gansler, in 2001 recognized the expanding gap in R&D spending and sought to identify ways the DoD could adapt to the changing environment to preserve its technological superiority on the battlefield. One of the primary concerns for industries partnering with the government has been the concern over their intellectual property (IP) rights.

> A company's interest in protecting its IP from uncompensated exploitation is as important as a farmer's interest in protecting his or her seed corn. Often companies will not consider jeopardizing their vested IP to comply with the Government contract clauses that have remained in use since the days when DoD was the technology leader and frequent funder of research programs. (OUSD-AT&L, 2001, p. 4)

As the commercial marketplace for technology becomes intensely more competitive, the need for a company to retain its IP, its lifeblood and only sustainable competitive advantage, is more critical than ever. Similar to the IP concern, many of the limitations the government encounters when attempting to acquire innovative technologies are the many arduous regulations and procedures that have amalgamated over the decades. One solution afforded by Secretary Gansler to the acquisition of commercial research

solutions was to explore alternatives to the standard Federal Acquisition Regulation (FAR) (OUSD-AT&L, 2001). Some of the solutions put forth include broader utilization of the authorities at 10 U.S.C. § 2358 Research and Development Projects (Contract, Cooperative Agreements or Grants); 10 U.S.C. § 2371a – Cooperative Research and Development Agreements (CRADA); and 10 U.S.C. § 2371b – Other Transaction Authority (OTA) for Prototypes. These acquisition vehicles operate outside traditional FAR compliance internal controls and thus are not subject to the same burdensome regulations that can hamper the DoD's ability to partner with certain commercial industries (GAO, 2017).

The DoD's investments in research and development have been steadily decreasing since 2010 as depicted in Figure 2. Converse to this decrease in funding, the demand for enhanced military capability through technological superiority continues to grow. The issue becomes how the DoD can "use innovation to turn around the erosion in our technological edge and to thereby create military dominance" (Hummel & Wurster, 2016, para. 6). Dr. Hummel and Ms. Wurster's remarks on the DoD's need to innovate are echoed by Dr. Jeff Decker, a social science researcher at the Center for International Security and Cooperation (CISC).

> Today, the Defense Department undervalues the commercial sector. To illustrate, the Defense Department spent roughly $62 billion on defense R&D and $101 billion on procurements in 2015. In comparison, U.S. businesses spent $345 billion on commercial R&D in 2015, supplemented by the roughly $70 billion U.S. venture capitalists put up in funding. In the 21st century, American adversaries have made better use of the commercial sector than the United States resulting in parity and overmatch. (Decker, 2018, para. 7)

Dr. Decker highlights the need for the DoD to realize the magnitude of investments being made in the private sector and work to capture those values to improve warfighter capabilities before our adversaries apply them first. Russia has been taking advantage of commercial off-the-self technologies in recent years with drone usage in Crimea. Even organizations such as ISIL have utilized commercial capabilities with store bought software and drones to gain advantages over their adversaries (Decker, 2018). The innovative dual-use disruptive capabilities of the private sector are out-pacing the DoD at an alarming rate, but the DoD is adapting its efforts to bridge that gap.

A 2017 GAO report discussed several issues cited by 12 innovative companies that do not typically do business with the Department of Defense and the steps that the DoD is taking to mitigate these issues and create a more conducive environment for these companies (GAO, 2017). One of the companies that participated in the GAO study stated that they "conducted a cost comparison study and found that it took 25 full time employees, 12 months and millions of dollars to prepare a proposal for a DoD contract. In contrast, the study found that the company used three part-time employees, two months, and only thousands of dollars to prepare a commercial contract for a similar product" (GAO, 2017). While the GAO report finds that the DoD is taking steps to alleviate some of the concerns of these companies, they also report that the changes are still in the implementation process and it is too early to determine the effectiveness of the DoD's actions taken.

3. Industry's Perspective

The way companies innovate has changed drastically over time. R&D activities in a corporation have mirrored a pipeline that would maintain innovation concept-through-production activities in-house which companies then use to enhance market position and their ability to compete. Today, private companies build portfolios of technologies through acquisition of smaller tech-based companies. There now exists an entire ecosystem whose sole objective is to develop innovative processes and products to be sold or licensed (Hummel & Wurster, 2016). Companies are no longer interested in scaling large production facilities through their commercial business models. Effective network management through collaborative partnerships is of greater value to the small high-tech company than the traditional business models of industrial giants.

Corporations are also looking internally for innovation. The most popular way in which commercial companies are attempting to innovate is to form dedicated innovation teams. The objective of these teams is to find opportunities for collaboration outside of the typical R&D environment. In addition to the innovation teams, some organizations are attempting to utilize more of their employee base for innovation through hackathons or intrapreneurship programs (Yeung, 2017). The practices and methods for which the private

sector is innovating have not gone unnoticed within the DoD and many of the innovation programs have been adopted by some organizations within the DoD.

B. TRADITIONAL INNOVATION ECOSYSTEM

"An innovation ecosystem is the term used to describe the large number and diverse nature of participants and resources that are necessary for innovation" (Harrison et al., 2017, p. 7). Harrison et al. (2017) explain the relationship of an innovation ecosystem is between human capital and structural capital. While the DoD is a large organization, there is a great deal of human capital outside of the DoD that can provide a great benefit to the mission and objectives of the organizations within the DoD. Dr. Bardach asserts that "governmental innovation emerges from a months or years-long developmental process, a process that accommodates many players and interests and typically involves many distinguishable subprocesses" (Bardach, 2008, p. 113). Dr. Bardach's observation does not afford any revelations about governmental process as they are notoriously cumbersome. However, in the area of innovation, this idea that innovation is a process is true in any environment whether governmental or in the private sector.

1. Key Players

The government organization most commonly associated with defense technological innovation is the Defense Advanced Research Projects Agency (DARPA). Dr. Dugan and Dr. Gabriel (2013) assert that DARPA has produced an unparalleled number of innovative breakthroughs since their inception in 1958. DARPA's notorious innovations in basic and applied science and technology include the Internet, GPS, and advances in stealth and drone technologies. They have been able to achieve these great advances through partnerships with academia, industry, and the government (Dugan & Gabriel, 2013). While DARPA is among the oldest and perhaps the most well-known innovation organization within the DoD, there are several others.

The Office of Naval Research (ONR) was established in 1946, and since that time they have been a critical source of innovation for the Navy as well as the DoD and beyond. ONR's efforts have been responsible for such advances as the first detailed map of the ocean's floors, which directly contributed to the development of the theory of plate

tectonics to the SEALAB underwater manned habitat. However, ONR's innovation is not limited to maritime specific focus areas. ONR also created the world's most accurate timekeeping device, borne out of extensive research into atomic physics which has contributed to countless other breakthroughs (Office of Naval Research [ONR], n.d.).

The United States Air Force's equivalent of ONR is the Air Force Research Laboratory (AFRL), formally established in 1997. The innovations that have come out of AFRL can be seen in every modern aircraft and weapon system today. Just like ONR, AFRL advancements are not limited in scope to solely aircrafts but include breakthroughs in communications, electronics, medical research and products, and manufacturing (Air Force Research Laboratory, 2014).

Army Research Laboratory (ARL) was established in 1992 as the result of a consolidation of several of the United States Army's research organizations. Among ARL's many successes is their work on the Electronic Numerical Integrator and Computer, the first operational, electrical digital computer. ARL operates similar to that of its sister service counterparts in that it partners with industry and academia to develop cutting edge capabilities (United States Army [USA], 2011a).

2. Acquisition Authorities Leveraged

While the traditional innovation centers within the DoD have an impressive track record for innovation, it is worth exploring how they partner and align themselves with organizations outside of the DoD and acquire these capabilities. The most traditional method of acquiring capabilities within the DoD is the Federal Acquisition Regulation (FAR). While the FAR is widely used throughout the DoD, it is not the only tool that traditional innovation centers utilize in partnering with organizations to acquire capabilities. One method DARPA uses to solicit their requirements to outside organizations is through the use of FAR-based Broad Agency Announcements (BAA). ONR and AFRL use the same approach to advertise their interests to desired partners outside of the DoD. (ONR, n.d.). DARPA has been granted an array of authorities in which it can partner with other organizations to include the authorities at 10 U.S.C. § 2358 Research and Development Projects (Contract, Cooperative Agreements or Grants); 10 U.S.C. § 2371a

– Cooperative Research and Development Agreements (CRADA); and 10 U.S.C. § 2371b – Other Transaction Authority (OTA) for Prototypes; 10 U.S.C. § 2374a – Prizes for Advanced Technology Achievements; and 15 U.S.C. § 3719 – Prize Competitions (Defense Advanced Research Projects Agency [DARPA], n.d.-a). Following a similar path to that of DARPA, AFRL established an OTA consortium in 2016 for prototypes in command, control, communications, and cyber, intelligence, surveillance, and reconnaissance (C4ISR) (United States Air Force [USAF], n.d.). While the organizations discussed in this section utilize some non-traditional acquisition methods, there are organizations in the DoD that were established specifically to operate in the non-traditional innovation ecosystem using non-traditional acquisition authorities and methods.

C. NON-TRADITIONAL INNOVATION ECOSYSTEM

The non-traditional innovation ecosystem refers to those organizations established by the DoD to predominantly utilize non-traditional acquisition methods to partner with non-traditional contractors delivering next generation capabilities to the warfighter. Some of these organizations have been around for almost 20 years while others have been stood up more recently. As emphasized through senior leader highlights in this report, the imperative exists in each DoD organization to establish their own responses to the broader innovation initiative. We detail a few of those organizations and the acquisition authorities leveraged next.

1. Key Players

In-Q-Tel, established by the Central Intelligence Agency (CIA), has been operating in Silicon Valley since 1999. Before the 1990s, the federal government was a major catalyst for innovation. However, "with the advent of the World Wide Web, it is the commercial market that is setting the pace in IT innovation" (Yannuzzi, n.d., para. 6). The increase of private sector funding flooding into this new industry legitimated a tech talent shift from traditional defense R&D to the emerging commercial marketplace. The CIA recognized this shift and became a first-mover in the government to capitalize on this economic shift through the establishment of In-Q-Tel.

The Army Venture Capital Initiative (VCI), formerly known as OnPoint Technologies, came onto the scene shortly after In-Q-Tel. They were established by the Army in 2002 with a similar model. OnPoint demonstrated considerable success through their ability to provide a return on investment to the Army. OnPoint has invested in 23 different companies and is the lead investor in one of them (CrunchBase, n.d.). Another investment by OnPoint has resulted in the successful transfer of and integration into an Army program of record. It was reported to have saved over $281 million, a figure significantly larger than their original investment amount of $62 million (Mara, 2011). These successes have not gone unnoticed by the other services and agencies within the DoD seeking to mimic their modeled success.

Defense Innovation Unit (DIU), formerly known as Defense Innovation Unit Experimental (DIUx), came onto the scene in 2015 as a direct result of the Defense Innovation Initiative. DIUx was created to bridge the gap between commercial sector capabilities and the DoD. They provide commercial capabilities to their customers within the DoD through an accelerated acquisition process that operates outside the traditional government acquisition regulations. DIU was originally founded in Silicon Valley to build trusted partnerships and establish credence against the stigmas of doing business with the DoD. Now DIU has operational offices in Boston, MA, Austin, TX, and Washington, DC (Mitchell, 2018).

MD5 National Security Technology Accelerator (MD5), established in 2016, leverages the knowledge of the private sector and academia to face tough and evolving national security threats and challenges. MD5's model (Figure 3) is different from that of other DoD innovators. Matt Lymann (2018, para. 3) posits that, "MD5 provides a platform to cultivate the people and ideas necessary to build technology-based ventures that align national economic, security and social objectives for the good of the nation." While other innovators provide education to industry on how they do business and the needs of the DoD, MD5 facilitates partnerships between universities and senior defense leaders to provide specific courses that work to solve problems within the DoD. In addition to its distinctive approach to education and collaboration, MD5 is also unique in that it works "to encourage DoD employees and their peers in academia and industry to create startups

based on emerging technology-market opportunities relevant to national security" (Harrison et al., 2017, p. 4). MD5 also utilizes other means of educating and growing their pool of innovators. "Through programs like the hackathon, MD5 aims to educate and build a network of innovators and entrepreneurs equipped with the incentives, expertise, know-how, and resources required to successfully develop, commercialize and apply DoD technology" (DoD, 2016, p. 2). MD5's hackathons are another example of MD5's partnerships with academia and industry to create innovative solutions to DoD problems.

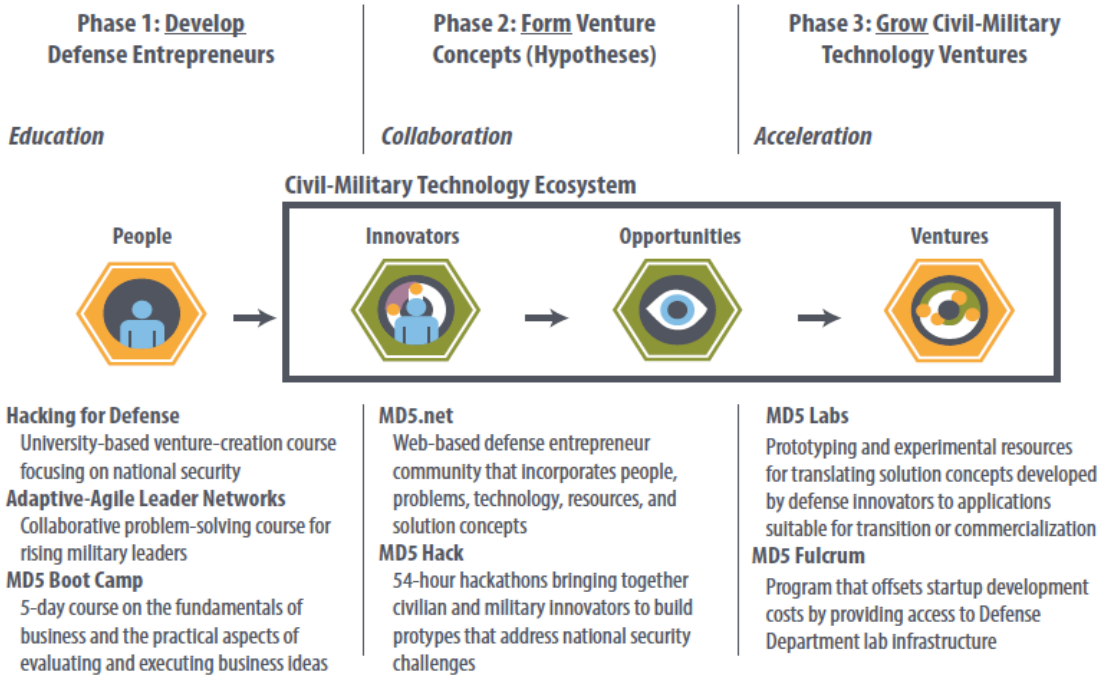

Figure 3. Overview. Source: Harrison et al. (2017).

Most recently, the United States Air Force staked their claim in the innovation ecosystem with the creation of AFWERX in 2017. While AFWERX, like other DoD innovators, attempts to move quickly to answer the call to innovation, Andrew Hunter, former director of the Pentagon's Rapid Acquisition Cell, offers caution as many new initiatives take time to show real results. He also cautions them to not be too quick to shed bureaucratic restraints in the race for capabilities (Machi, 2018). Mr. Hunter brings up an interesting point. Innovation is a process. If innovations are pushed out too fast and not

carefully monitored, there could be unintended consequences. AFWERX is still very much in the beginning stages of its development and time will tell where in the innovation ecosystem they will find success.

2. Acquisition Authorities Leveraged

The authorities leveraged by DoD organizations within the non-traditional innovation ecosystem are as varied as the organizations themselves. The reason for the varied methods of acquisitions is that each authority is authored and intended for a specific set of circumstances. Some of the organizations operate with one primary method of acquisition while others utilize several procurement processes to achieve their objectives.

In-Q-Tel achieves its objective of acquiring new capabilities through two processes.

> In-Q-Tel has two options when making an investment. It can make either an equity investment, where it receives part ownership in the company, or a work program investment. Work programs typically provide funding for a company to develop its technology in a way that suits Intelligence Community needs. (Mara, 2011, p. 2)

The first option mirrors the way in which private venture capital firms fund small technology startups. Venture capital allows In-Q-Tel to invest in an emerging technology that has the potential to develop dual-use disruptive capability for their customers in the intelligence community while also maintaining some control in the strategic direction of the venture. The second option, a work program, allows In-Q-Tel the ability to identify and invest in specific products as opposed to the company as a whole. In-Q-Tel advertises on its site that more than 75% of In-Q-Tel's investments have been successfully delivered and tested in pilot projects by our government partners, and approximately 50% of these have been adopted for use (In-Q-Tel, n.d.). In-Q-Tel's successes over the years has giving rise to other organizations learning from their model and created their own organizations to reap similar rewards.

DIU primarily leverages 10 U.S.C. § 2371b – Other Transaction Authority (OTA) for Prototypes through their Commercial Solutions Opening (CSO) process to partner with companies that demonstrate the potential to develop dual-use disruptive capability for their

customers in the DoD ecosystem. As seen in Figure 4, they can accomplish this at an accelerated pace compared to that of the traditional defense acquisition process. As stated by DIU, "Since June of last year [2016] DIUx has awarded $100 million in contracts for 45 pilot projects in areas including artificial intelligence, autonomous machines and space" (Volz, 2017, para. 6). While the use of OTAs by DIU has been largely lauded by leadership within the DoD, there is still a considerable hesitation with respect to its continued application across the defense enterprise.

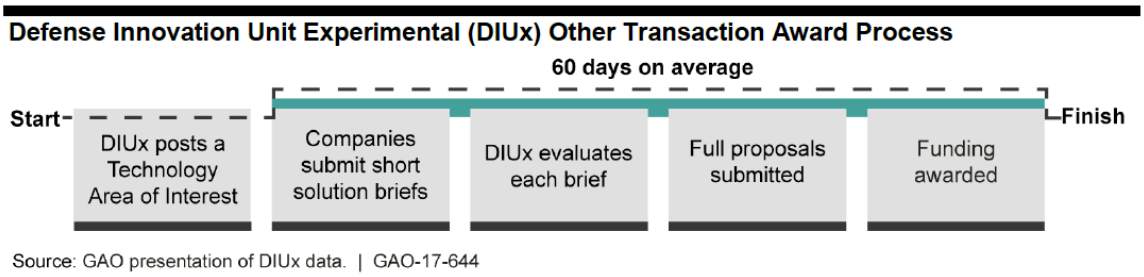

Figure 4. Defense Innovation Unit Experimental (DIUx) Other Transaction Award Process. Source: GAO (2017).

While OTAs are not new, they have been in use in the DoD since 1989. They are only recently being used more frequently as a possible solution to the technology gap occurring throughout the DoD innovation ecosystem. In May 2018, GAO sustained a protest against DIU for deviating from competitive procurement procedures. The GAO ruling is significant because before the ruling, OTAs were considered to be immune to protests as they fall outside the FAR. It will be interesting to see how DIU and similar organizations react and alter their business practices to reflect the ruling.

AFWERX is supported 15 U.S.C. § 3715 – Partnership Intermediary Agreements (PIA)[2] with DEFENSEWERX, an organization that supports innovation within the DoD (Machi, 2018). This agreement allows AFWERX to partner with universities and private industries to collaborate on problems the Air Force is facing and offer innovative solutions with potential to be rapidly integrated into Air Force programs of record.

D. SUMMARY

The DoD used to be at the forefront of innovation. However, over the past couple decades, a seismic shift in the power and influence of the innovation ecosystem has occurred where commercial industry largely dictates the pace of innovation. The DoD has recognized the increased emphasis on and need for the identification of the innovation ecosystem and the broader adoption across its enterprise of the various acquisition authorities, techniques or processes used to accelerate next generation technology to the warfighter. The DoD has taken several strides in the right direction to implement innovation initiatives, but it's taking too long. The DoD must understand the innovation ecosystem before they can attempt to control the winds in the sails of this cut-throat environment. The ability to navigate the DoD's innovation ecosystem through the innovative implementation of traditional and non-traditional acquisition authorities may prove to be a fast, flexible, and collaborative catalyst solution to the DoD's global technological innovation gap.

[2] A partnership intermediary agreement is define as "the term partnership intermediary means an agency of a State or local government, or a non-profit entity owned in whole or in part by, chartered by, funded in whole or in part by, or operated in whole or in part by or on behalf of a State or local government, that assists, counsels, advises, evaluates, or otherwise cooperates with small business firms, institutions of higher education as defined in section 1141(a) of title 20, or educational institutions within the meaning of section 2194 of title 10, that need or can make demonstrably productive use of technology-related assistance from a Federal laboratory, including State programs receiving funds under cooperative agreements entered into under section 5121(b) of the Omnibus Trade and Competitiveness Act of 1988." (Legal Information Institute, n.d.)

III. METHODOLOGY

This report is intended to explore the current state of the DoD innovation ecosystem to understand what communities make up the ecosystem and how they apply various acquisition authorities, techniques or processes to accelerate next generation technology to the warfighter. Our research analyzes the current literature on innovative acquisition practices across the DoD enterprise through review of relevant policy and case studies. Additionally, we utilize qualitative interviews to help synthesize the value that each community delivers to the DoD innovation ecosystem enterprise.

A. DATA COLLECTION

From a purely acquisitions perspective, the primary objective of this research is to analyze the current state of the DoD innovation ecosystem to understand what traditional and non-traditional communities make up the ecosystem and how they apply various acquisition authorities, techniques or processes to accelerate next generation technology to the warfighter. We first examined the history of DoD's implementation of technological innovation efforts enterprise-wide and then present a comparative analysis of acquisition authorities, techniques or processes that various communities utilize to deliver next generation technology to the warfighter. To accomplish the primary objective, the question we attempt to answer is, *"What communities make up the DoD's innovation ecosystem and what acquisition authorities, techniques or processes do they leverage to accelerate next generation technology to the warfighter?"*

Leveraging and building upon an initial network of innovators at a couple of the organizations below, we identified a pool of organizations on the leading edge of technological innovation both internal and external to the DoD. Although not all inclusive, these organizations were identified in the literature as leaders in the innovation space.

- AFWERX
- Air Force Research Lab (AFRL)
- Army Emerging Technologies Office (ETO)

- Army Research Lab (ARL) Open Campus
- Army Rapid Equipping Force (REF)
- Army Venture Capital Initiative (VCI)
- Basic Research Innovation and Collaboration Center (BRICC)
- BMNT Partners
- Comparative Technology Office (CTO)
- Defense Advanced Research Projects Agency (DARPA) Fast Track Programs
- DEFENSEWERX
- Defense Innovation Unit Experimental (DIUx)
- The Doolittle Institute
- The Griffiss Institute
- In-Q-Tel
- Initiatives & Analysis Office - Rapid Innovation Fund (RIF)
- Joint Capability Technology Demonstration (JCTD) Office
- National Security Accelerator
- Marine Corps Warfighting Labs (MCWL) – Experimentation Division
- Marine Corps Warfighting Labs (MCWL) – Technology Initiative Screening Office (TISO)
- Office of Naval Research (ONR)
- Rapid Capabilities Office (RCO) – Air Force, Army, Marine Corps, Navy
- Rapid Reaction Technology Office (RRTO) – Joint Rapid Acquisition Cell (JRAC)
- Small Business Innovation Research (SBIR)
- SOFWERX
- Strategic Capabilities Office (SCO)
- Wright Brothers Institute (WBI)

- Hacking for Defense Incorporated (H4Di)

Traditional program offices that utilize Federal Acquisition Regulation (FAR) based acquisition methods and processes were excluded from our pool of research in order to focus and enhance our understanding in the non-traditional arena. Leveraging and building upon a network of non-traditional entities in Silicon Valley and around the United Sates, we narrowed our list of organizations down to those who specialize in and primarily operate within the non-traditional methods of acquisition. Those organizations include:

- Army Research Lab (ARL) Open Campus
- Army Venture Capital Initiative (VCI)
- BMNT Partners
- DEFENSEWERX/SOFWERX
- Defense Innovation Unit Experimental (DIUx)
- The Doolittle Institute
- The Griffiss Institute
- In-Q-Tel
- National Security Accelerator
- Office of Naval Research (ONR)
- Section 809 Panel representatives
- Wright Brothers Institute (WBI)
- Hacking for Defense Incorporated (H4Di)

Each organization was provided a letter detailing the scope of our research endeavors. The options to complete the survey were manually, electronically, telephonically, video conference or in person. Of the organizations contacted, we held telephonic and personal interviews with thirteen of the identified organizations. Our research sample included respondents such as civil service employees and military officers of different branches and defense agencies at the executive levels of the organizations, Chief Executive Officers (CEOs) of private companies, and organizational presidents and directors of various companies and divisions. The spectrum of acquisition experience

ranges from that of mid-level management to senior leaders in the organization. Their awareness of non-traditional acquisition authorities highlighted in this report range from minimal exposure to full application of such authorities.

All information and perspectives gathered through interviews was from an organizational perspective by individuals authorized to represent the organizations and whom could provide valuable insight with respect to our research questions. The questions asked are shown in the Appendix. Although our findings do not explicitly answer these questions, the information gathered was used to synthesize the findings through other methods of data collection that support the primary objective research questions. A determination was approved by the Naval Postgraduate School's Institutional Review Board that our research did not include human subjects research.

B. SUMMARY

This report relies on multiple sources to explore the current state of the DoD innovation ecosystem to understand what communities make up the ecosystem and how they apply various acquisition authorities, techniques or processes to accelerate next generation technology to the warfighter. Our research relied heavily on scrutinizing the current literature on innovative acquisition practices across the DoD enterprise through review of relevant policy and case studies. Additionally, we relied on qualitative interviews to help synthesize the value that each community delivers to the DoD innovation ecosystem enterprise. In the next section, we discuss our findings, namely the discovery of various micro-ecosystems that make up the DoD innovation ecosystem as a whole and the acquisition authorities, techniques, or processes leveraged therein.

IV. FINDINGS

> Mapping innovation: The launch of multiple high-profile offices, initiatives, and strategies to advance innovation, reform, and technological superiority makes for the beginnings of a strong legacy. But though each has their own valid objectives, their proliferation is generating confusion over "who's on first" for each part of your agenda and how these efforts intersect—or not. (Fitzgerald & Schulman, 2016, p. 2)

The primary objective of this research was to analyze the current state of the DoD innovation ecosystem to understand what traditional and non-traditional communities make up the ecosystem and how they apply various acquisition authorities, techniques or processes to accelerate next generation technology to the warfighter. Therefore, the question we attempt to answer is, *"What communities make up the DoD's innovation ecosystem and what acquisition authorities, techniques or processes do they leverage to accelerate next generation technology to the warfighter?"*

The focus of this research sought to identify the various communities and acquisition authorities within the DoD's innovation ecosystem that could be leveraged in response to the call for innovation. The findings are not all-inclusive, but highlight trends discovered across the various micro-ecosystems and acquisition authorities. We need not replace the current acquisition system, but continuously develop and implement innovative acquisition pathways leveraging traditional and non-traditional commercial technology entities and authorities to supplement the gaps creating weaknesses in the existing system.

This chapter highlights many micro-ecosystems and the authorities they leverage to deliver dual-use disruptive capabilities to the warfighter. In this section we attempt to answer the following questions:

- *What communities make up the DoD's innovation ecosystem?*
- *What traditional or non-traditional acquisition authorities are used to acquire innovative technologies?*
- *What technological innovation basis does each community or organization leverage?*

We discuss some key practices discovered that the ecosystem dubs "positive disruptioneering," a term coined by DARPA, which demonstrate potential for widespread adoption across the Defense Acquisition System. In doing so, we attempt to answer the question, "*Are there any specialized acquisition techniques or processes that could be applied across the ecosystem?"* We then discuss lessons learned through our research and interview surveys spurring future research areas for consideration. Here, we attempt to answer, *"What lessons learned are shared across the ecosystem?"* Finally, we close on some future areas at the helm of non-traditional industry's list of challenges and priorities. A brief summary of the findings is exhibited in Table 1.

Table 1. Primary Authorities Leveraged between Micro-ecosystem Community.

Primary Authorities Leveraged between Micro-ecosystem Community	Traditional Programs of Record	FFRDCs	University, Academia, UARCs	DoD Research and Development Laboratories	Non-profit Innovation Institutes	Small Business Administration Programs	Non-traditional Industry
Traditional Federal Acquisition Regulation (FAR)	✓	✓	✓	✓	✓	✓	
10 U.S.C. § 2358 – Research and Development Projects (Contract, Cooperative Agreements or Grants)		✓	✓	✓	✓	✓	✓
10 U.S.C. § 2371 – Technology Investment Agreements (TIA)		✓		✓	✓		
10 U.S.C. § 2371a – Cooperative Research and Development Agreements (CRADA)		✓		✓	✓	✓	
10 U.S.C. § 2371b – Other Transaction Authority (OTA) for Prototypes	✓	✓		✓	✓		✓
10 U.S.C. § 2373 – Procurement for Experimentation Purposes				✓			
10 U.S.C. § 2374a – Prizes for Advanced Technology Achievements		✓	✓	✓	✓	✓	✓

Primary Authorities Leveraged between Micro-ecosystem Community	Traditional Programs of Record	FFRDCs	University, Academia, UARCs	DoD Research and Development Laboratories	Non-profit Innovation Institutes	Small Business Administration Programs	Non-traditional Industry
10 U.S.C. § 2539b – Test Service Agreements				✓	✓		
10 U.S.C. § 2192a – Science, Mathematics, and Research for Transformation (SMART) Educational Partnership Agreements (EPA)			✓	✓	✓		
15 U.S.C. § 3715 – Partnership Intermediary Agreements (PIA)			✓	✓	✓		✓
15 U.S.C. § 3719 – Prize Competitions		✓	✓	✓	✓	✓	✓
Non-traditional Industry Startup Capital Infusion - Incubator - Accelerator - Venture Capital - Angel Investment			✓	✓		✓	✓

A. THE INNOVATION ECOSYSTEM

The DoD's innovation ecosystem, through the implementation of traditional and non-traditional acquisition authorities, is faster, more flexible, and more collaborative than efforts through the traditional defense acquisition system. Various micro-ecosystems, smaller ecosystems within the larger ecosystem, comprise the entire innovation ecosystem. Each playing a part to shore up the DoD's technological innovation gap through many non-traditional acquisition authorities that defy status quo bureaucracies. Below we analyze the current state of the DoD innovation ecosystem to understand what communities make up the ecosystem and how they apply various acquisition authorities, techniques or processes to accelerate next generation technology to the warfighter. Throughout this section we identify the following:

- *What communities make up the DoD's innovation ecosystem?*
- *What traditional or non-traditional acquisition authorities are used to acquire innovative technologies?*
- *What technological innovation basis does each community or organization leverage?*

1. Federally Funded Research and Development Centers (FFRDCs)

A micro-ecosystem of traditional research institutions are federally funded research and development centers, or FFRDCs. These government-owned contractor-operated (GOCO) research institutions include universities, non-profit organizations, and industrial firms (Gallo, 2017). Gallo (2017, summary) assert that, "FFRDCs are intended to provide federal agencies with R&D capabilities that cannot be effectively met by the federal government or the private sector alone and are required to have a long-term strategic relationship with the sponsoring agency." Currently 12 federal agencies sponsor a total of 42 FFRDCs, of which the DoD agencies sponsor 11 (National Science Foundation, 2018).

Inherent to all micro-ecosystems is their specialty niche contributing to the overall innovation ecosystem. Beyond normal contracting relationships FFRDCs are leveraged in a way that they have special access to sensitive and proprietary information and other DoD resources that the private sectors do not. FFRDCs operate in three distinct categories; "R&D laboratories that maintain long-term competencies in technology areas that cannot be met by the government or private sector alone, study and analysis centers delivering independent research analysis and advice, and systems engineering and integration centers that have technical and engineering expertise to fill the gaps where the agency competencies fall short" (Gallo, 2017, p. 3).

Strict governance rules, bound by the FAR, for how the DoD manages FFRDCs to access innovative new technologies may erode the DoD's ability to leverage their niche purpose. The Congressional Research Service outlines four primary issues surrounding the use of FFRDCs; "(1) the effectiveness of federal agency oversight and management of FFRDCs; (2) competition between FFRDCs and the private sector for federal R&D funding; (3) the diversification of FFRDC activities or 'mission creep'; and (4) the award of non-competitive FFRDC management and operation contracts" (Gallo, 2017, summary).

Amid these concerns exists an opportunity for DoD to rethink how we use our FFRDCs. The second, third, and fourth concerns create opportunities for the DoD to reshape the various mission sets of our FFRDCs to better align with rapid pace of commercial technological innovation. Gallo (2017, p. 12) asserts that, "concerns over mission creep are associated not only with the broadening of FFRDC activities into new fields, but also with the broadening of FFRDC clients." FFRDCs are exempt from competition requirements. Even though the traditional contract relationship between the agency and the FFRDC is set up through traditional FAR-based acquisition means, non-traditional authorities such as OTAs, CRADAs, TIAs, and prize competitions can be leveraged throughout this micro-ecosystem to take advantage of the unique advantages FFRDCs have to offer.

2. University Academia

A micro-ecosystem of traditional research institutions also includes University Affiliated Research Centers, or UARCs. UARCs are very similar to FFRDCs. Gallo (2017, p. 4) describes "the defining feature of UARCs, like FFRDCs, is the long-term strategic relationship they have with their sponsoring federal agency." Further, "this relationship is intended to allow for in-depth knowledge of the agency's research needs, independence and objectivity, freedom from conflicts of interest, access to sensitive information, and the ability to respond quickly to emerging research areas" (Gallo, 2017, p. 4). Currently, the DoD sponsors 13 UARCs (Defense Laboratories Office, 2013).

"In recognition of the value of a long-term strategic relationship, the obligation to maintain essential capabilities, and the prohibition to compete with industry, DoD permits the award of sole-source contracts to UARCs under the authority of 10 U.S.C. 2304(c)(3)(B)" (Defense Laboratories Office, 2013). The Defense Laboratories Office (2013) further asserts that the authority, implemented through FAR 6.302-3 as an educational institution, permits the awarding of sole-source contracts "to establish or maintain an essential engineering, research, or development capability to be provided by an educational or other non-profit institution or a federally funded research and development center." As part of a matrixed relationship with this ecosystem each DoD

component's R&D research lab infrastructure has a presence in the academic research micro-ecosystem.

A robust micro-ecosystem of non-traditional academic research institutions has been established by MD5 National Security Technology Accelerator (NSTA). MD5 is an Office of the Secretary of Defense (OSD) innovation unit with direct report to the Under Secretary of Defense (ASD) for Research and Engineering (R&E). Their mission is to "create new communities of innovators to solve national security problems" (M. Plummer, interview with author, July 1, 2018). MD5 is "accelerating the dissemination of innovation knowledge and methods throughout the DoD workforce by building new communities of innovators to create a novel capacity for national security problem solving and helping generate and increase the number and viability of dual-use ventures that serve the needs of our warfighters." These actions are focused through their education, collaboration and acceleration programs that "represent divergent thinking and execute non-traditional approaches to problem solving to increase the permeability between the public and private domains" (MD5, n.d.).

Through their Hacking for Defense (H4D) university-based venture-creation program, MD5 collaborates with 15 leading universities to aid in accomplishing their mission, all of which is wholly accomplished through the non-traditional use of Partnership Intermediary Agreements (PIAs). The use of this acquisition agreement tool has enabled MD5 to leverage their network of innovators and act as a value-added conduit between the DoD and commercial sectors. One example of a success is Capella Space,

> Capella Space formed following Stanford University's inaugural Hacking for Defense class in Fall 2016. To date, they've raised more than $25M in private capital and secured a USAF contract through DIUx. Their Synthetic Aperture Radar (SAR) microsatellite persistent earth imagery allows for near-real-time awareness of man-made and natural threats, despite weather conditions. (M. Plummer, interview with author, July 1, 2018)

3. DoD Research Labs

The Office of the Assistant Secretary of Defense for Research & Engineering has established the Defense Laboratory Enterprise (DLE) consisting of in-house laboratories, warfare centers, and engineering centers. The DLE operates with emphasis on technology

innovation by partnering with leading innovators in academia and industry as well as technology surprise by seeking cutting edge technology development before it falls in the hands of our adversaries. Below is a brief description of the leading agency laboratories that comprise this DLE micro-ecosystem.

a. Defense Advanced Research Projects Agency (DARPA)

Perhaps the most prolific and obvious R&D component of the Department of Defense for generations has been the Defense Advanced Research Projects Agency (DARPA). DARPA's mission is "to make pivotal investments in breakthrough technologies for national security" (DARPA, n.d.-b). DARPA invests in basic, applied, and advanced technology research in order to deliver on its mission through transformational change rather than incremental advances along the technological innovation spectrum. DARPA "works within an innovation ecosystem of diverse collaborators that includes academic, corporate and governmental partners, with a constant focus on the Nation's military Services, which work with DARPA to create new strategic opportunities and novel tactical options" (DARPA, n.d.-b). DARPA supports a bottoms-up discovery and management approach to accomplish their mission with an emphasis on rewarding risk and is comprised of six technical offices and one Special Projects Office called the Aerospace Projects Office.

DARPA (n.d.-c) asserts that, "traditional defense contractors, corporations and startups alike are critical parts of the innovation ecosystem in which DARPA operates and all of these, whether large and small, can serve as performers of DARPA-funded R&D to generate revolutionary technologies and capabilities." DARPA's contracts management office prides itself on developing innovative acquisition business practices that cut out complex contracting overhead bureaucratic barriers with traditional and non-traditional partners to accomplish its agile mission set. DARPA utilizes various traditional and non-traditional authorities such as the FAR, OTAs, TIAs, CRADAs, grants, prize competitions, BAAs, and the SBA's SBIR/STTR program. These authorities are not all-inclusive, but pivotal in understanding DARPAs ability to bridge rapid innovation technological gap in

today's high-demand environment. DARPA maintains all of its processes and procedures with examples and guides on their website for maximum transparency and competition.

b. Air Force Research Laboratory (AFRL)

The leading R&D component of the United States Air Force is the Air Force Research Labs (AFRL). AFRL's mission is "leading the discovery, development, and integration of warfighting technologies for our air, space and cyberspace forces" (USAF, 2014, para. 2). AFRL invests in basic, applied, and advanced technology research confronting large-scale technology issues beyond the scope of major defense acquisition programs while providing a collaborative environment of services within government, industry and academic ecosystems. AFRL is comprised of eight component Technology Directorates, the 711th Human Performance Wing, and the Air Force Office of Scientific Research.

AFRL has created "The Air Force Challenge: Think big, start small, scale fast" to challenge its government, industry, and academia partners to team up and enhance multi-domain operations by delivering rapid innovative technological solutions. AFRL primarily accomplishes their mission through the use of PIAs with innovation institutes. AFRL also utilizes various other traditional and non-traditional FAR and non-FAR authorities including grants, cooperative agreements, BAAs, TIAs, CRADAs, prize competitions and OTAs. These authorities are not all-inclusive, but pivotal in understanding AFRLs ability to bridge rapid innovation technological gap in today's high-demand environment.

c. Army Research Laboratory (ARL)

The leading R&D component of the United States Army is the Army Research Labs (ARL). ARL's mission is "to discover, innovate, and transition science and technology to ensure dominant strategic land power" (USA, 2011a, para. 4). ARL invests in basic and applied research and survivability/lethality and human factors analysis. ARL's technical strategy is focused on exploring, better understanding, maturing, and exploiting Science and Technology (S&T) developments from its government, industry, and academia partners to ensure dominance of its operational environments (W. Leonard, interview with author, October 3, 2018). ARL's traditional structure consists of six directorates focusing

on Army-specific key technology areas. Additionally, ARL has the Army Research Office that "initiates the scientific and far reaching technological discoveries in extramural organizations: educational institutions, non-profit organizations, and private industry" (USA, 2011b, para. 2).

ARL has developed a "diversified national hub-and-spoke infrastructure to more effectively partner across the national and international S&T ecosystem through its ARL Open Campus initiative" (W. Leonard, interview with author, October 3, 2018). ARL's Open Campus ecosystem model is based on three primary tenets: "1) modern government workforce and management; 2) shared facilities between government, academia and the private sector; and 3) a collaborative culture that fosters an entrepreneurial and innovative environment" (W. Leonard, interview with author, October 3, 2018). ARL primarily accomplishes their mission through the use of various traditional and non-traditional FAR and non-FAR authorities including grants, cooperative agreements, BAAs, TIAs, CRADAs, OTAs, test service agreements, prize competitions, international agreements, patent license agreements, and PIAs. To enhance their non-traditional ecosystem, ARL leverages Educational Partnership Agreements (EPAs) another form of a PIA, as well as CRADAs through the academic and S&T community partners exampled below. These authorities are not all-inclusive, but pivotal in understanding ARLs ability to bridge rapid innovation technological gap in today's high-demand environment.

d. Marine Corps Warfighting Laboratories (MCWL)

The leading R&D component of the United States Marine Corps is the Marine Corps Warfighting Laboratories (MCWL). MCWL's mission is "to identify future challenges and opportunities, develops warfighting concepts, and comprehensively explores options in order to inform the combat development process to meet the challenges of the future operating environment" (United States Marine Corps [USMC], n.d.-a). MCWL makes clear that it "does not procure material for the Marine Corps… rather, it assists those organizations that do so by helping to establish Marine Corps requirements through technology demonstrations, assessments, and experimentation" (USMC, n.d.-b, para. 7). Through the use of BAAs, MCWL generally pursues technologies at more mature

a technology readiness levels and will "typically engages in 2–4 year agreements with performers that consist of a combination of actions such as development, testing, assessment, demonstrations, and experimentation" (USMC, n.d.-b, para. 7). Following favorable acceptance, MCWL facilitates the transfer of the technology to a program of record using traditional FAR-based authorities. MCWL's latest initiative to tap into the non-traditional ecosystem is the Phase Zero initiative. Phase Zero was established to "discuss ideas, identify problems, learn something new, and develop networks to facilitate future success in a crowd-sourcing, collaboration engine for innovative Marines" (USMC, n.d.-a).

e. Naval Research Laboratory (NRL)

The leading R&D component of the United States Navy is the Navy Research Labs (NRL). NRL's mission is "conducting a broadly-based multidisciplinary program of scientific research and advanced technological development directed toward maritime applications of new and improved materials, techniques, equipment, systems and ocean, atmospheric, and space sciences and related technologies" (United States Naval Research Laboratory [NRL], n.d., para. 3). NRL's traditional structure consists of six directorates sequentially broken down into divisions, branches, and sections focusing on Navy-specific key technology areas.

All encompassed under the Office of Naval Research (ONR), NRL has established the Future Naval Capabilities (FNC) Office whose process is designed to rapidly transition cutting-edge technologies to acquisition programs of record utilizing traditional ecosystems and FAR-based acquisition authorities. NRL also has the Technology Transfer Office (TTO) TechTransfer program that facilitates the implementation of innovative technologies to benefit the public by engaging with non-traditional commercial entities developing collaborative strategic partnerships to bridge the rapid innovation technological gap in today's high-demand environment (NRL, n.d.).

NRL primarily accomplishes their mission through the use of various traditional and non-traditional FAR and non-FAR authorities including grants, cooperative agreements, BAAs, TIAs, CRADAs, OTAs, test service agreements, prize competitions,

international agreements, patent license agreements, and PIAs. These authorities are not all-inclusive. ONR understands that partnership with educational institutions, non-profit organizations, and private industry are critical to the effective execution of its mission. Therefore, the Naval Innovation Advisory Council has implemented its Lean Startup Approach to Capability Development to bridge the gap in streamlining the adoption and transfer of dual-use disruptive technologies. The lean startup approach will be discussed further in the next section of this report.

4. Non-profit Innovation Institutes

Becoming increasingly more prevalent among the innovation ecosystem is the micro-ecosystem of innovation institutes. Innovation institutes are non-profit 501(c)(3) organizations designed and established to serve the unique needs of DoD agencies in four primary competencies: Collaboration, Innovation, Workforce Development, and Technology Transfer. Innovation institutes act as force multipliers by creating collaborative physical and business environments between academia, industry and government. They advance innovative technologies through effective problem curation and solution discovery. They enhance workforce development through collaboration, training and experiential partnerships with various traditional and non-traditional communities. Lastly, they facilitate bimodal technology transfer through agile and adaptive technology development and commercialization by discovering tech-transfer opportunities, structuring partnerships, and identifying solution providers.

Innovation institutes are typically governed by a board of directors that are in a relationship with the partnering agency through the use of a PIA. With the innovation institutes as neutral facilitators, tech transfer is accomplished between the sponsoring agencies and the third parties through various traditional and non-traditional FAR and non-FAR authorities. These authorities include grants, cooperative agreements, BAAs, TIAs, CRADAs, EPAs, prize competitions, OTAs and interagency agreements. These authorities are not all-inclusive, but pivotal in understanding the role of innovation institutes and the agency's ability to bridge the rapid innovation technological gap in today's high-demand environment.

Although there are hundreds of leading 501(c)(3) non-profit organizations partnering with DoD agencies catalyzing disruptive pathways toward technological futures, the following is a short list of those with broader impacts at the DoD level:

- Wright Brothers Institute (WBI)
- Griffiss Institute
- Doolittle Institute
- The Basic Research Innovation and Collaboration Center (BRICC)
- Virginia Tech Applied Research Corporation (VT-ARC)

Another disruptor of the ecosystem is a non-profit organization called Analytic Services Incorporated (ANSER) and their wholly owned subsidiary Advanced Technology International (ATI). These organizations play a pivotal role in the innovation ecosystem by building, leading and managing technology development collaborations through flexible collaboration consortium models bringing together various government, industry and academic partners. They have traditional FAR-based consortiums, industry-based consortia with set membership access, open source collaboration consortia competed for government approval, and more widely known, OTA consortia comprised of traditional and non-traditional partners. These models are widely leveraged by our DoD research laboratories, but not our traditional programs of record across the defense acquisition system.

5. Small Business Administration Programs

The Small Business Administration's Office of Investment and Innovation manages a phenomenal micro-ecosystem consisting of three distinct programs that focus on the commercialization of early stage technologies. These programs are the Small Business Innovation Research (SBIR), Small Business Technology Transfer (STTR), and Small Business Growth Accelerators programs. As mandated by the Small Business Act, 15 U.S.C. 631, There are 11 governmental agencies that participate by committing a percentage of R&D spend to advance economies achieved through these programs.

a. Small Business Innovation Research (SBIR)

The SBIR program is an effort by the SBA to embolden domestic small businesses to explore and expand upon R&D opportunities that satisfy federal requirements and have the potential to be commercially viable. "Through a competitive awards-based program, SBIR enables small businesses to explore their technological potential and provides the incentive to profit from its commercialization" (Small Business Administration (SBA), n.d.-a, para. 1). The mission of the SBIR program is "to support scientific excellence and technological innovation through the investment of Federal research funds in critical American priorities to build a strong national economy" (SBA, n.d.-a, para. 2).

This program targets entrepreneurial startup companies while giving preference to those that satisfy socioeconomic criteria to stimulate economic objectives. It's aimed to provide small businesses an equal footing when competing with large businesses for government investment dollars. SBIR is an incremental three-phased program that nurtures the company and technology through maturation to commercialization. Phase I is considered a prototype where the organization establishes technical merit and commercial potential, phase II stimulates extensive R&D to develop and mature the technology, and phase III assists in commercialization objectives by facilitating production transition with sponsoring agencies (SBA, n.d.-a). Awards or agreements are made between the small business and the sponsoring agency. Depending on the maturity of the company and its business systems the contract or agreement authorities may be FAR-based or through grants and other cooperative agreements.

b. Small Business Technology Transfer (STTR)

The STTR program is similar to the SBIR program. The STTR program emphasizes "public/private sector partnership to include the joint venture opportunities for small businesses and non-profit research institutions" (SBA, n.d.-a, para. 1). "The unique feature of the STTR program is the requirement for the small business to formally collaborate with a research institution in Phase I and Phase II and its most important role is to bridge the gap between performance of basic science and commercialization of resulting innovations" (SBA, n.d.-a, para. 1). STTR enables a critical link between private small businesses and

robust innovation research institute laboratories. With the end goal of advancing technologies in a lab-to-market model the STTR program follows the same competitive incremental three-phased program. Awards or agreements are made between the small business and the sponsoring agency. Depending on the maturity of the company and its business systems the contract or agreement authorities may be FAR-based or through grants and other cooperative agreements.

c. Small Business Growth Accelerators

The SBA has established a program that acts as a conduit to leverage another micro-ecosystem. The Small Business Growth Accelerator program hosts fund competitions for "accelerators, incubators, and other entrepreneurial ecosystem models that help support small businesses and startups compete for monetary prizes" (SBA, n.d.-b, para. 1). The goal of the competition is to enable capital infusion opportunities to qualified accelerators "which, in turn, provides resources to boost the startup and entrepreneurship communities around them" (SBA, n.d.-b). "Several panels containing expert judges from the private and public sector with collective experience in early stage investing, entrepreneurship, academia, startups and economic development will select the winners" (SBA, n.d.-b, para. 2). The program prides itself on the diversity of applicants to include "accelerators, incubators, co-working startup communities, shared tinker-spaces or other models" (SBA, n.d.-b, para. 2).

6. Non-traditional Industry

As examined in the literature review, the government has largely defined what a non-traditional company is, and the various authorities used to leverage the non-traditional ecosystem. With vastly different business systems and practices the only commonality keeping government and industry economically viable and prosperous is capital. Where that capital comes from, the stage at which they are funded, and by how much is a determining factor in the success or failure of early-stage technological development. Therefore, supplemented by networks of partnering ecosystems, non-traditional industry looks to incubators, accelerators, angel investors, multi-series venture capital, and equity

crowdfunding to kickstart technology development and accelerate growth of their businesses more in line with industry norms.

a. Incubators

Incubators are largely focused on development of early-concept disruptive ideas with the hopes of building a business model or company around the technology. Incubators operate indefinitely and may be sponsored by various echelons of capital infusion such as those discussed later in this section. Incubators will typically host teams or companies that are innovating in similar markets. Startups that seek incubator programs often collocate to collaborate with other companies in the incubator. "Within the incubator, a company will refine its idea, build out its business plan, work on product-market fit, identify intellectual property issues, and network in the startup ecosystem" (Forrest, 2018, para. 16). "While many programs are government-funded, some incubators do take equity for incubation services and usually offer mentorship, access to legal, accounting and/or HR services, and connect their portfolio companies to large investor-networks" (Perlman, 2016, para. 6). However, most incubators do not take a share of equity from the company. Examples of leading incubators include TechFire, Idealab, Y Combinator, Matter, Sandbox Suites, 500 Startups, and Tech Liminal, DefTech, and Ground Floor.

b. Accelerators

Accelerator programs are largely focused on mentorship networks and the scalability of existing companies. "Accelerator programs usually have a set timeframe in which individual companies spend anywhere from a few weeks to a few months, in what usually takes a few years, working with a group of mentors to build out their business and avoid problems along the way" (Forrest, 2018, para. 6). Accelerators typically offer a small fixed amount of capital for a small share of equity in the company. Examples of leading accelerators include AngelPad, Techstars, Y Combinator, Brandery, National Security Technology Accelerator, and MassChallenge.

c. Angel Investment

Gust (n.d.) defines an angel investor as "an accredited investor who invests his or her personal capital in early stage, potentially high-growth companies." Angel investors typically have extensive entrepreneurial experience and act more as a partner-mentor due to their personal stake in the business relationship. Angel investors can either invest by themselves or pool together a network of angel investors to contribute to the success of the startup business or technology. Angel investors typically require very simple and general terms and seldom require any control of the company. This offers flexibility in risk-taking and quicker decisions for the company. An example of a platform that links investors to companies is Gust.com.

d. Venture Capital

Venture capital funding is a highly competitive level of funding for more mature startups seeking additional capital to reach the next stage of their business plan. At this stage, most companies will have already proven their concept or idea, but lack the next level resources to cross the chasm. "In exchange for funding, venture capital firms generally receive a seat on the board of directors and have a significant say in the strategic direction of the company while generating exposure, networking, and partnerships opportunities" (Perlman, 2016, para. 16). Therefore, venture capital offers clear paths for follow-on and continuous rounds of investment. Examples of leading venture capital firms include Tencent Holdings, Andreesen Horowitz, Sequoia, Point Nine, and Redpoint.

e. Crowdfunding

Crowdfunding programs are when crowds of investors, large and small, donate to an endeavor. Crowdfunding can be identified in two categories, reward-based and equity. "With reward-based crowdfunding, monetary contributions are exchanged for products or services and with equity crowdfunding, non-accredited investors can invest in an early-stage company in exchange for equity" (Perlman, 2016, para. 12). Crowdfunding can happen at any stage in startup technology development and offers the most flexibility in raising capital while maintaining complete control of their business. Examples of leading

crowdfunding platforms include Kickstarter, CrowdCube, Indiegogo, Crowdfunder, and Seedrs.

B. ACQUIRING INNOVATION: POSITIVE DISRUPTIONEERING

> The current acquisition system functions as intended. It competently acquires military unique systems based on rigorous competition between defense specialist corporations. However, the DoD has new technology needs that must be met from sources that do not conform to that model. The DoD's acquisition challenge is therefore less a question of the capacity of the system than one of its design and appropriateness. The result of creating an additional acquisition pathway would be an acquisition system that supports the nation's traditional military advantages, while also allowing the DoD to build on its military-technical superiority in new and innovative ways. (Fitzgerald et al., 2016, pp. 20–21)

Those new and innovative ways that Fitzgerald et al. reference in their claim is commonly referred to as positive disruptioneering across the innovation ecosystem. The idea is transformational change versus incremental advances. With a collaborative focus across the ecosystem, academia, industry, and the government partner together to develop, leverage and advance innovative dual-use disruptive technologies to solve the nation's toughest national security challenges. Positive disruptioneering yields high-risk, high-reward investment opportunities. This section will highlight a couple leading positive disruptioneering practices and initiatives discovered through this research that have the potential for broader adoption across the DoD. This section highlights a few concepts that address the question, *"Are there any specialized acquisition techniques or processes that could be applied across the ecosystem?"*

1. ARL Open Campus Initiative

In 2014, ARL's Open Campus was launched with the goal of bridging the gap between government labs, academia and the non-traditional private industry to form a collaborative network to address the Army's toughest challenges. The model is based on three primary tenets: "1) modern government workforce and management; 2) shared facilities between government, academia and the private sector; and 3) a collaborative culture that fosters an entrepreneurial and innovative environment" (W. Leonard, interview with author, October 3, 2018). ARL has developed a "diversified national hub-and-spoke

infrastructure to more effectively partner across the national and international S&T ecosystem" (United States Army, 2011). ARL has established regional hubs in California (ARL West), Texas (ARL South), Illinois (ARL Central), and Massachusetts (ARL Northeast). They have also co-located open campuses with its ARL laboratories as well as opened offices in Japan, England, and Brazil. ARL Open Campus actively leverages nearly all micro-ecosystems and innovative acquisition authorities identified in this report.

> ARL Northeast was officially opened in April 2018. As the office has begun to engage across New England, ARL has worked hard to leverage the significant regional investment in innovation. Over the last few months ARL has engaged with a range of innovation activities and plan to increase these efforts as the office matures. Initial engagements have included the MIT Sandbox (an initiative supporting MIT students to develop startup concepts and plans), The Engine (a venture fund and accelerator space focused on 'hard tech' working with MIT and Harvard founders currently, but looking to expand), TechStars (an accelerator supporting tech companies, specifically working with Air Force support at the moment), DIUx (funding commercial solutions for DoD challenges), and MassRobotics (a space that bridges the incubator/accelerator models to full scale development for robotics based companies—works with complementary verticals in the region). (W. Leonard, interview with author, October 3, 2018)

2. BMNT Innovation Pipeline

BMNT Partners is a private consulting company serving primarily defense and intelligence agencies. BMNT does not acquire capabilities but acts as a conduit or facilitator between the various parties to solve the nation's toughest challenges (P. Newell, interview with author, September 27, 2018). One of the ways BMNT is able to achieve successes in this environment is their ability to operate as a dual-use incubator that builds the right team of stakeholders and provides the space to solve the curated problem (P. Newell, interview with author, September 27, 2018). In this incubation process, BMNT teaches the Mission Model Canvas innovation process, as seen in Figure 5, where BMNT works with these organizations to curate problems into a common language that can be understood by multiple different parties from various backgrounds in order to facilitate a larger ecosystem of people and organizations that can support problem validation and early solution testing (P. Newell, interview with author, September 27, 2018).

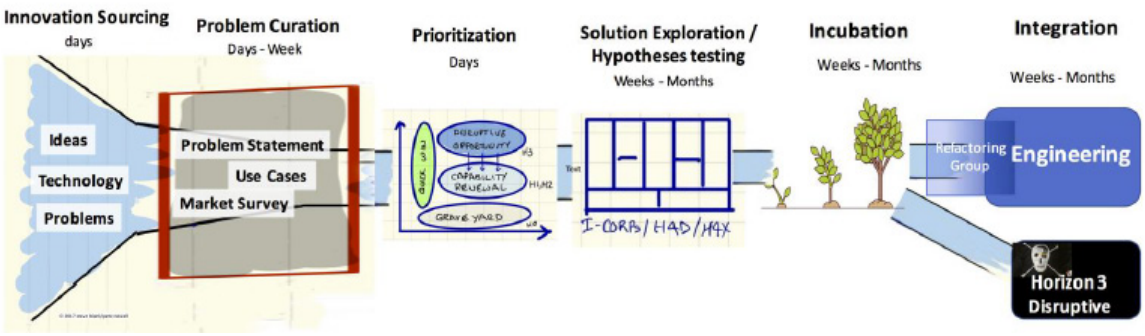

Figure 5. Innovation Pipeline. Source: P. Newell (interview with author, September 27, 2018).

The problem curation phase is critical to the Mission Model Canvas process. What may have started out as one problem, can really be five separate problems. BMNT will work with their clients to do a "technical terrain walk" to understand the true nature of the problem (P. Newell, interview with author, September 27, 2018). This process is different from other organizations, because it comes before a requirement is drafted or an attempt to find a solution has occurred. Once the problem has been curated and the ecosystem of stakeholders has been established, BMNT teaches organizations that mission success must be defined as it relates to the end-user as opposed to the acquiring activity (P. Newell, interview with author, September 27, 2018).

To accomplish their mission, BMNT leverages several different innovation bases. Hacking for "X" (H4X) is BMNT's process of consulting various organizations, acting as a third-party ombudsman, building networks to solve problems rather than developing an all-encompassing capability in-house. These networks can include government or defense organizations, small-business commercial start-ups, or academia. BMNT utilizes Hacking for Defense (H4D) to partner national security organizations with students across multiple universities throughout the Unites States. This partnership is then leveraged to curate problems and incubate potential solutions. The solutions can then be transferred as a capability through a variety of acquisition vehicles. The vehicle of choice is dependent upon the type of capability, preference of parties involved, as well as the acquisition authorities afforded to the acquiring agency.

3. Office of Naval Research Naval Innovation Process Adoption (NIPA)

NIPA is a lean-startup concept adopted by ONR's Naval Innovation Advisory Council (NIAC) in an effort to accelerate the delivery of innovative capabilities to Naval warfighters. Dr. Richard Carlin, Director of ONR's Sea Warfare and Weapons Department emphasized that "it is essential to energize how naval innovation takes place, and to empower novel ideas." (Smalley, 2018, para. 3). While NIPA is a recent effort, they have already pushed out a report to the Office of Strategy and Innovation on the importance of adopting a lean approach to capabilities development. The report breaks down their analysis into five separate efforts.

The first effort analyzed was the creation of unity of effort in positive disruptioneering. In this process, unity of effort was created utilizing a problem-solving framework, BMNT's Innovation Pipeline. Through this framework, problem identification, curation, and prioritization are accomplished through accelerated learning. The learning is validated through fallible hypothesis testing as opposed to slower methods such as requests for information or proposals. The end state for this process should be a minimum viable product (MVP) and solution incubation which involves rapid iterations and competing solutions.

NIAC's second effort analyzed was to initiate streamlined agile capability development for dual-use and disruptive technologies. This process requires unity of effort by aligning requirements, acquisition strategies, and assessments with dual-use opportunities, for the problem in a mission, benefit, and threat framework. This effort emphasizes the need to seek high-payoff prospects as well as competing MVP solutions before drafting requirements to test baseline assumptions in relation to the curated problem. The success of this process is dependent upon rapid testing of hypotheses and intrapreneur education.

Another way NIAC attempts to provide parallel acquisition pathways to the traditional acquisition system is its efforts to implement limited life cycle, small batch or scalable production of capabilities that could evolve with changes in the operator's environment. This strategy allows for high-payoff programs to either adapt with the

changes in requirements or terminate them before it's too late. The evolution in their adapt-or-die concept is achieved through the dual-use technologies' ability to change and scale in relation to the mission and threat.

NIAC argues that programs' effectiveness should be evaluated in metrics by the end-user as opposed to top-down policy and guidance. Additionally, funding justification documents for R&D and procurement should iterate capabilities desired alongside mission area gaps. These dual-use capabilities allow threats to identify known vulnerabilities over time and should evolve as they become a liability to the end-user.

The report expounds on what can be the most cumbersome aspect of a program; contracting. Contracting must evolve to increase its agility to acquire advancing capabilities for the warfighter. Some of the areas analyzed to achieve this end include cultivating a culture that promotes outcome-based results and encourages people to find innovative pathways to success. This change in culture would also include educating acquisition personnel and leveraging various authorities to increase procurement agility, to include increasing the implementation of the various authorities identified in this report.

NIAC's purpose is to find innovative ways to provide enhanced capabilities to the warfighter. This effort will take more than the issuance of a report of findings and recommendations. However, NIAC's intent was to add to and move the conversation forward with a holistic view of the existing authorities, challenges, and conceivable solutions to the issues faced by capability development and acquisition (R. Carlin, interview with author, October 4, 2018). While NIAC has only been recently implemented, its adoption is rapidly spreading throughout the innovation ecosystem and time will tell what it can bring to the table in terms of capabilities to the warfighter.

4. DIU OTA CSO Process

In May of 2016, then Secretary of Defense Ashton Carter directed DIU to cultivate new relationships and partnerships within the private sector communities in America's innovation ecosystems. DIU has accomplished this task through the use of their Commercial Solutions Opening (CSO) process. DIU, with the authority of 10 U.S.C. § 2371b – Other Transaction Authority (OTA) for Prototypes, is able to award funding

agreements to both traditional and non-traditional entities to preform prototype projects that will provide direct enhancement of warfighter effectiveness. An organization with OTA authority is afforded the flexibility to design a process to award OTs for prototyping. The CSO was created by DIU to work in tandem with non-traditional entities at the accelerated pace of private sector practices.

DIU solicits solutions similar to that of the traditional acquisition system in that they create a public posting on their website for potential partners to see. This constitutes competition kind of like a BAA does. The posting does not include requirements or specifications, but rather a description of the problem to be solved or particular areas of interest. This broad issuance of a problem allows DIU to keep themselves open to any potential vendor with a possible solution. The postings are generally limited to a paragraph or less and utilize a common language as opposed to military-centric jargon or terms. Once DIU receives responses from vendors, they utilize a three-phased approach in evaluating solutions.

In the first phase, DIU evaluates the vendor's submission based on relevance, technical merit, business viability, and innovation. If a company does not pass though this phase, they will receive a letter of non-selection, detailing the rationale for the decision. Companies that do pass the initial phase, will receive an invitation to pitch their proposal to DIU leadership, DoD customer, and the agreements officer. The pitch allows the vendor to discuss their solution in more detail and provide a rough order of magnitude cost and schedule. The pitch is evaluated on the same criteria as the initial phase to include cost, schedule, and data rights. If the team recommends progressing with the potential solution, a Request for Prototype (RFP) will be issued by the agreements officer and ask the company to submit a proposal. Following the RFP, DIU will work with the companies to walk them through the proposal, OT process, as well as the concepts of collaborative design, collaboration between the customer, DIU and the developer. The final phase is the evaluation of the proposal. The evaluation team will assess whether or not the proposal meets the statutory requirements of an OT for award as well as a price determination to ensure that the endeavor is in the best interest of the DoD.

Following the evaluation phases, DIU enters into negotiation of the terms and conditions and the agreement is finalized. DIU's OT process does not end at award, but authority is also afforded in the modification process as flexibility is critical in the innovation ecosystem. Limited follow-on production is also authorized through the authority at 10 U.S.C. § 2371b without additional competition but is still relatively new in its adoption as a technology transfer mechanism.

C. LESSONS LEARNED

> One of the key strengths of DARPA's CMO is its contracting officers' ability to recognize that there are many contracting options available and that situations need to be assessed individually to determine the best fit. The unthinking application of any one contracting vehicle is discouraged. Instead, contracting officers realize that each technology situation, each proposing company, and each DARPA office has its own goals and expectations, and it is up to those officers to find the contracting tool that will satisfy and appropriately balance those sometimes-conflicting needs. Their high levels of expertise and training, supportive management, and the open-minded atmosphere that the CMO is able to maintain all contribute to successfully meeting that challenge. So does frequent conversation among contracting officers, who informally share their expertise and inventive problem solving. (DARPA, n.d.)

In this section we discuss some lessons learned through our research and interview surveys. We entertain the question, *"What lessons learned are shared across the ecosystem?"* Innovation starts small from the bottom-up. Whether it be basic or applied science and technology research at a government or university lab, small garage startup company, or traditional defense contractor, contracting officers need to be empowered with the proper acquisition authorities to leverage the acquisition and transition of non-traditional cutting-edge technological development towards its intended application across the DoD. Removing high barriers to entry into the defense market will provide non-traditional defense companies and international defense industry new opportunities for business with the DoD, shifting the composition, and consequently the structure, of the defense industrial base. "Where defense specialists have a distinct advantage in producing complex, military unique systems, commercial companies entering the market can offer

fast production cycles and innovative, leading-edge technologies ready to deploy off-the-shelf or be adapted for military use" (Fitzgerald et al., 2016, p. 38).

This is seldom possible in the overly cumbersome and bureaucratic traditional defense acquisition system construct due to our inability to adapt and keep pace. Modern innovation ecosystems are very much attracted to the opportunities that defense dollars present, however they are very much unattracted to the challenges of working in the traditional defense acquisition system. Conflicting objectives result in a costly detriment to these non-traditional businesses not poised to meet bureaucratic demands. Therefore, the DoD must educate and empower its contracting officers to leverage the innovation ecosystem by taking risks and enabling innovative acquisition solutions and pathways that aid the execution of non-traditional methods in parallel with the traditional construct.

The first lesson learned concerns the "what." There are many innovation ecosystems hard at work non-traditionally developing cutting-edge technologies to solve the nation's toughest national security problems, however there lacks a significant acquisition pathway to transition such technologies to meet the DoD's desired scalability and commercialization objectives. The Center for a New American Security advocates that "if the department implements an additional acquisition pathway and initiates associated reforms to policies regulating industry behavior, it would create new market conditions in which a diverse and dynamic ecosystem of businesses could better support national security objectives" (Fitzgerald et al., 2016, p. 38). An acquisition pathway backed by senior leader imperative provides the exact flexibility needed in the current defense acquisition system linking non-traditional solutions to complex national security challenges.

The next lesson learned concerns the "where" and "when." This acquisition pathway should allow for collaboration across the entire innovation ecosystem aligning public and private objectives along the way. Depending on the stage of funding needed by the industry partners at varying technology maturity levels many of the micro-ecosystems identified in this report specialize in niche areas that are all critical to the development of the technology and its market adoption. For example, early stage concepts or ideas that morph into a minimum viable product (MVP) or a prototype require very low amounts of

capital and partnership. In the commercial environment this is supported by seed or series funding rounds before early market movers attempt to claim stake.

Of critical importance to the startup company is equity control and the need for mentorship to scale fast once proven and market adoption swells. Of critical importance to investors providing infusion of capital is return on investment. Depending on the stage of development and capital infusion the startup will eventually be required to relinquish equity and control, broadly stated. This is exactly where the DoD needs to figure out at what stage to invest.

The Government's competitive advantage as a customer is that the government requires no equity stake in the company and has significant resources to provide adequate mentorship at all stages of development. One important note for this section, the success of disruptive technologies and startup ventures is not measured by the amount of funding it receives up front all at once, like traditionalists would argue through the traditional defense acquisition system. Conversely, the opposite is truer and more effective. The higher the surge of capital infusion, the more risk you impart on any company that is simply not ready to scale to meet demand. If we do this carelessly through the traditional acquisition framework, we risk losing the company and the technology to failure. As highlighted in the literature review, the factors that the GAO uncovered are true across the entire acquisition system and not just for major defense acquisition programs. The emphasis should not be on the amount of funding provided to the technological innovation endeavor. It should be on how the government can alleviate the administrative burdens and bureaucracies by structuring a partnership that is beneficial to both parties. The government must adapt these commercial models if they expect to be successful in today's innovation ecosystem. Additionally, where and when along the traditional acquisition process does the government implement and utilize a parallel acquisition pathway capitalizing on dual-use disruptive opportunities is critical.

The last lesson learned concerns the "how." Like DARPA, contracting officers across the DoD must be able to think critically and entrepreneurially. An agile mindset with the ability to recognize the many non-traditional contracting authority options available will directly support the advent of an acquisition pathway linking various

networks of ecosystem innovators to tangible results throughout the traditional construct. Our acquisition workforce must develop and maintain a heightened level of business acumen to manage network collaboration and determine best fit for risk-reward payoffs at various stages. With that education and empowerment, mid-level management across acquisition workforce should leverage their decision-making authorities and expand the use of the various acquisition authorities identified in this report to facilitate adoption and transition of non-traditional solutions to traditional acquisition construct challenges.

D. SUMMARY

The ability to navigate the DoD's innovation ecosystem through the implementation of traditional and non-traditional acquisition authorities may prove to be a fast, flexible, and collaborative solution to the DoD's technological innovation gap. The purpose of this research was to analyze the current state of the DoD innovation ecosystem to understand what communities make up the ecosystem and how they apply various acquisition authorities, techniques or processes to accelerate next generation technology to the warfighter. The research question we attempted to answer was, *"What communities make up the DoD's innovation ecosystem and what acquisition authorities, techniques or processes do they leverage to accelerate next generation technology to the warfighter?"*

Through a review of the literature, we first examined the history of DoD's implementation of technological innovation efforts enterprise-wide and then conducted a comparative analysis of acquisition authorities, techniques or processes that various communities utilized. We sought to bring greater awareness to these traditional and non-traditional acquisition authorities, techniques or processes implemented across the DoD's innovation ecosystem that have potential for greater application throughout the Defense Acquisition System. The findings are summarized in Table 1of this.

What communities make up the DoD's innovation ecosystem? We found that there are dozens of micro-ecosystems comprised of hundreds of organizations. Mapping them out individually would be nearly impossible. We highlighted primary micro-ecosystems that play a pivotal role in the transition of cutting-edge technology to the warfighter. They are FFRDCs, University/Academia/UARCs, DoD R&D Labs, Non-profit Innovation

Institutes, SBA Programs, and Non-traditional Industry. Each containing organizations that employ the various acquisition authorities discussed, thus attracting non-traditional defense contractors in an effort to expand their network of capability developers. While the acquisition authorities being leveraged are not new, the capacity in which they are being used is expanding as the need to acquire cutting-edge capabilities is becoming ever more critical to the effectiveness of the warfighter.

What traditional or non-traditional acquisition authorities are used to acquire innovative technologies? We were able to identify primary acquisition authorities leveraged by each micro-ecosystem as well as the networks they exploit to provide capabilities to their customers across the DoD. Aside from traditional FAR authorities, there are several non-traditional acquisition authorities at the Contracting Officer's disposal waiting to be leveraged in the correct capacity. Whether grants, cooperative agreements, BAAs, TIAs, CRADAs, OTAs, test service agreements, prize competitions, international agreements, patent license agreements, EPAs, PIAs, or start-up commercial investment partnerships, all have the potential for broader adoption and exploitation across the enterprise to bridge rapid innovation technological gap in today's high-demand environment.

What technological innovation basis does each community or organization leverage? This question related to the micro-ecosystems discovered through our research. Does technological innovation happen in the traditional constructs of the defense acquisition system or does it happen externally? There is no binary answer. The innovation ecosystem is comprised of hundreds of traditional and non-traditional entities all serving their roles to enhance technological superiority objectives. These roles are carried out by traditional and non-traditional, government, industry, and academic collaborative partnerships throughout the ecosystem.

Are there any specialized acquisition techniques or processes that could be applied across the ecosystem? Although not all-inclusive, there are some leading positive disruptioneering practices highlighted in this report that have proven their potential for widespread adoption across the innovation ecosystem. ARL's Open Campus Initiative has proven its success within existing acquisition constructs. BMNT's Innovation Pipeline and

Mission Model Canvas are stimulating rapid adoption across both traditional and non-traditional partners throughout the ecosystem. These models not only have the potential to change dynamics of the Defense Acquisition System, but the JCIDS and PPB&E processes as well. These lean startup approaches to capability development have already been embraced by ONR through their NIPA initiative. Lastly, DIU is trailblazing success through its non-traditional use of OT authority with non-traditional partners, its CSO process. OT authority has found its application fitness pathway in the traditional system as most MDAP PEO's are now modeling the use of this authority off of DIU's success. If we can only adopt all the other authorities outlined in this report, the DoD will be one step closer to closing the technological innovation gap between the DoD and its adversaries.

Finally, *what lessons learned are shared across the ecosystem?* Aside from positive disruptioneering practices modeling success across the ecosystem, we summed up our lessons learned from an acquisitions perspective in terms of what, where, when, and how. The *what* is an acquisition pathway backed by senior leader imperative that provides a flexible parallel conduit linking non-traditional applications to the current defense acquisition system. The *where* and *when* concern the stage of technological maturity and when we should exercise specific authorities to capitalize on its application to DoD objectives. Lastly, the *how* suggests empowering our mid-level management Contracting Officers and decision makers with the proper authorities to think and act entrepreneurially, positively disrupting status quo bureaucracies that inhibit rapid innovation throughout the current system.

E. FUTURE RESEARCH CONSIDERATIONS

The primary objective of this research was to analyze the current state of the DoD innovation ecosystem to understand what traditional and non-traditional communities make up the ecosystem and how they apply various acquisition authorities, techniques or processes to accelerate next generation technology to the warfighter. We sought to bring greater awareness to the traditional and non-traditional acquisition authorities, techniques or processes implemented across the ecosystem that have potential for greater application throughout the Defense Acquisition System. Throughout our interviews we discovered

three primary of interest that are on the minds of our senior leaders charged with implementing innovation initiatives across the enterprise.

The first future research consideration is to take any one of the acquisition authorities, techniques or processes identified in this report and quantitatively measure the effectiveness of their utilization across the innovation ecosystem. Being able to quantitatively measure utilization may unearth causal links between the effectiveness of authority implementation to DoD spend.

The second future research consideration is case studies regarding technology transfer from the use of the non-traditional authorities identified in this report and their integration into existing programs of record. What are the implications on the types of funding used for certain authorities? The authority at 10 U.S.C. § 2359, science and technology program transfer authority, is of particular interest in this regard.

Lastly, a third and final future research consideration is focused on creating metrics for success in innovation. MITRE Corporation, an FFRDC, is studying this endeavor as we wrote this report. Evaluating the success of an organizations ability to transfer technology, or broader, even the establishment of standard metrics will provide senior leaders more confidence in formulating better-informed policy decisions regarding innovation initiative implementation.

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APPENDIX. SURVEY QUESTIONS

1. Describe your organization's position within the defense innovation ecosystem, including key suppliers and customers, your organization's mission, its higher headquarters and any subordinate organizations.

2. How do you work with similar organizations to avoid redundancy and duplication of acquisition efforts?

3. What technological innovation basis does your organization leverage?

4. What strategic advantages does your organization advertise to its customers with regards to DoD acquisition process and technological innovation?

5. What statutory or acquisition and contracting authorities does your organization utilize?

6. What methods of acquisition or procurement processes does your organization use to acquire capability?

7. Does your organization utilize Other Transaction Authority (OTA) under 10 USC 2371b authority, and if so please describe your procedures?

8. Does your organization utilize prizes for advanced technology achievements under 10 USC 2374a authority, and/or Prize Competitions under 15 USC 3719 authority, and if so please describe your procedures?

9. Does your organization utilize Partnership Intermediary Agreements (PIA) with organizations such as state or local governments, educational institutions, or non-profit organizations for leading edge technology development, and if so please describe your procedures?

10. What emerging acquisition practices/processes is your organization pursuing to deliver capabilities to the warfighter faster?

11. How does your organization share lessons learned (successes and failures) across the DoD?

12. Please provide any additional description or documentation in regard to the acquisition procedures or practices your organization leverages to provide capabilities to your customers.

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