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To project power globally in today's increasingly dynamic environment, the U.S. military requires more efficient and expeditious fielding of technologically superior capabilities. In today's environment, it is commonplace for private industry to be the first to develop and deploy technologies that can be adopted for defense systems. The result is that the Department of Defense (DoD) is largely a consumer, seeking secondhand access. DoD acquisition strategies have gradually evolved, progressively incorporating some creative approaches for acquiring emerging technologies, and improving response time to address urgent operational needs. DoD must tailor acquisition processes to ensure emerging technologies support the force

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NATIONAL DEFENSE UNIVERSITY

JOINT FORCES STAFF COLLEGE

JOINT ADVANCED WARFIGHTING SCHOOL

Technology Proliferation: Acquisition Strategies and Opportunities for an Uncertain Future

by

Heather A. Reuter

Colonel, United States Army

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TECHNOLOGY PROLIFERATION: ACQUISITION STRATEGIES AND OPPORTUNITIES FOR AN UNCERTAIN FUTURE

By

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A paper submitted to the Faculty of the Joint Advanced Warfighting School in partial satisfaction of the requirements of a Master of Science Degree in Joint Campaign Planning and Strategy. The contents of this paper reflect my own personal views and are not necessarily endorsed by the Joint Forces Staff College or the Department of Defense.

This paper is entirely my own work except as documented in footnotes.

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Abstract

To project power globally in today's increasingly dynamic environment, the U.S. warfighter requires more efficient and expeditious fielding of technologically superior capabilities. Emerging technologies and disruptive capabilities required to outsmart, outmaneuver, and overwhelm the enemy often arrive months or years too late. The challenges to fielding the correct technology in the shortest time possible, with the most efficient and accurate results, reside within the acquisition process. In today's environment, it is commonplace for private industry to be the first to develop and deploy technologies that can be adopted for defense systems. The result is that the Department of Defense (DoD) is largely a consumer, seeking secondhand access. As a result of competition with private industry, DoD acquisition strategies have gradually evolved, progressively incorporating some creative approaches for acquiring emerging technologies, and improving response time to address urgent operational needs. Traditional DoD acquisition process restricts timely contracting of emerging technologies, which often prevents rapid procurement. Multiple options exist that provide more responsive solutions. Technology is advancing at a rapid pace, and DoD must tailor acquisition processes to ensure emerging technologies support the warfighter.

Dedication

To my husband.

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Introduction

To project power globally in today's increasingly dynamic environment, the U.S. warfighter requires more efficient and expeditious fielding of technologically superior capabilities. In the current operational environment, emerging technologies and disruptive capabilities required to outsmart, outmaneuver, and overwhelm the enemy often arrive months or years too late. The challenges to fielding the correct technology in the shortest time possible, with the most efficient and accurate results, reside within the acquisition process. This process involves identification of needs (requirements generation), proposal and contract award cycles, and delivery of warfighting equipment. The Center for Strategic and International Studies (CSIS) asserts that, "while the United States still holds the leading position in military technology innovation, the gap with the rest of the world is shrinking."[1]

Today, the U.S. Department of Defense (DoD) competes with private industry to foster emerging technologies in order to maintain a competitive advantage. Although DoD operates multiple scientific research laboratories, the private sector often outpaces DoD efforts. As a result, DoD has become increasingly dependent on the private sector to sustain most of the effort for development of technologies that serve relevant military uses. This is a significant change from past years when products borne of DoD research migrated to the consumer market. For example, in the 1990s, the global positioning system (GPS) was developed in DoD research facilities and deployed only for

[1] Gabriel Coll, "Leveraging Innovation," Center for Strategic and International Studies. https://www.csis.org/programs/international-security-program/defense-industrial-initiatives-group/leveraging-innovation (accessed December 30, 2017).

government use. The system was subsequently de-classified and repurposed for civilian use as well.[2]

Now, it is commonplace for private industry to be the first to develop and deploy technologies that can be adopted for defense systems. The result is that DoD is largely a consumer, seeking secondhand access. It is significant that as a consumer, DoD is competing with a global marketplace. DoD must seek to cooperate with public and commercial institutions, to limit or deny certain products from being distributed to the global marketplace, as these new technologies could be adapted to military use by potential adversaries, threatening U.S. national security as well as that of its allies and partners.

As defense spending stays relatively constant, DoD must find creative ways to stretch dollars to afford acquiring new technology. As a result of competition with private industry, DoD acquisition strategies have gradually evolved, progressively incorporating some creative approaches for acquiring emerging technologies, and improving response time to address urgent operational needs. However, to ensure compliance with Government Accountability Office (GAO) procedures, Federal Acquisition Regulations (FAR), and the Defense Federal Acquisition Regulations Supplement (DFARS), as well as multiple edicts from countless subordinate agencies, DoD remains obligated to follow these stringent and complex procurement procedures. Although these compliance rules certainly apply to many large acquisition programs, the Department of Defense must use

[2] Note: Other purely military innovations that were adopted for civilian use include microwave ovens, the Walkie Talkie, Penicillin, canned food, and the Jeep. Rod Green, *100 Military Inventions That Changed the World*, (Skyhorse Publishing, Inc.: New York, NY: 2012), 11, 71, 94, 105, 162.

more flexible approaches to acquisition to ensure timely fielding of high technology systems necessary for the US military to maintain its superiority over any threat.

The Department of Defense traditional acquisition process, however, limits timely contracting of emerging technologies, which often prevents rapid procurement. How can the DoD leverage commercial technology and industry best practices to remain competitive against technologically savvy adversaries? Multiple options exist that provide more responsive solutions. Three types of acquisition concepts (traditional and hybrid acquisition, public-private partnerships, and disruptive technology organizations) represent how the U.S. Department of Defense can adopt, collaborate with, and recruit researchers for new technology. Each strategy potentially benefits the government, the private company, and the taxpayer, or a combination thereof. As a result of the subject research, the analysis herein provides suggestions on how DoD can apply different strategies to concepts that differ from normalized contracting actions. This research does not include reviews of, or provide suggestions for, modifying the laws or regulations governing acquisition strategies. Rather, it focuses on rapid advancement and adoption of key technologies that provide significant revolutions on the battlefield.[3] The research intends to analyze historical and current processes to determine efficiencies and opportunities for the acquisition process to embrace the technology before it becomes obsolete. The following is a summary of these acquisition concepts that this paper will follow.

Options for U.S. Department of Defense rapid acquisition strategies:

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[3] Yuna Huh Wong, "Approaching Future Offsets," Rand.org, https://www.rand.org/blog/2016/12/approaching-future-offsets.html (accessed December 17, 2017).

1. Partner with private industry to expedite the development of new technologies. For example, the United States Air Force (USAF) has introduced the hybrid acquisition strategy to integrate new technologies more rapidly and earlier in the development cycle.
    a. Discuss the use of other transaction agreements, as appropriate, to provide expedited fielding opportunities.
2. Use technology already developed by commercial industries. For example, Defense Innovation Unit Experimental works with emerging technology providers to coordinate and engage with industry prior to fielding.
    a. Benefits include limited research and development cost to the government.
    b. Allows for fielding with commercial and consumer markets.
3. Engage with communities of interest and industry to provide insight and gauge industry capabilities.
    a. Partner with communities of interest to engage with private companies using federal research and development along with private funding.
4. Decrease the concept of wholesale technical data package requirements.
    a. Influence decision making on practices that benefit the taxpayer while expediting fielding strategies.

b. Discuss the need to negotiate rights for delivering technical data after determining military utility and only after entering full rate production program, as necessary.

5. Request and recruit engagement from private sector for disruptive technologies or items which compete with military assets.
    a. Discuss groups internal and external to the government created within the past few years to monitor, advise, or act on disruptive technologies.
    b. Explore how to enable decision makers and service components to adopt, engage, or mitigate these new innovations (e.g. engage, follow, or ignore new technology as it develops).
6. Use monetary incentives to engage public or private industry and educational institutions to allow the Department of Defense an opportunity to participate in public-private partnerships or other options to ensure the safety of military assets and the homeland.
    a. Discuss crowdsourcing, grants, and intellectual forums.

Chapter 1 - A Brief Summary of Traditional Acquisition Procedures

Modern defense contracting rules began with the Armed Services Procurement Act (ASPA) of 1947 and subsequent Armed Services Procurement Regulation (ASPR) in 1948. Both established controls for purchases made by the Army, Navy, Air Force, Coast Guard, and the National Aeronautics and Space Administration (NASA).[1] Acquisition reform has been a topic since acquisition regulations were first established.[2] The Federal Acquisition Regulations (FAR) superseded the ASPA and ASPR in 1984. In 1985, President Ronald Reagan initiated the President's Blue Ribbon Commission on Defense Management (also known as the Packard Commission), which provided recommendations for improving defense management and contracting.[3]

One of the major burdens of acquisition exists during the process of performing checks and balances. The government must continuously strive to ensure industry complies with fair practices and transactions. As with all laws, the FAR has evolved over time in an attempt to confirm that current business policies reflect fair practices, while safeguarding taxpayer dollars.

Over the past thirty years as the FAR has sought to align with current business practices and government policies, it has become an onerous set of requirements to

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[1] Robert C. Gusman, *Book Review: Government Contracts Under the Federal Acquisition Regulation*, 15 Pepperdine Law Review 3, (1988): 435-438.

[2] Sandy Keeney, "The Foundations of Government Contracting," Journal of Contract Management, Summer 2007, www.ago.noaa.gov/acquisition/docs/foundations_of_contracting_with_the_federal_government.pdf (accessed December 15, 2017). The George Washington University Law School, 2000 H Street, NW, Washington, D.C., http://law.gwu.libguides.com/defenseprocurement http://law.gwu.libguides.com/c.php?g=330645&p=2219710 (accessed December 24, 2017).

[3] Government Accounting Office, https://www.gao.gov/products/NSIAD-99-4 (accessed on December 31, 2017). Additionally, multiple documents detailing the history of the modern acquisition system reside with the Historical Office, Office of the Secretary of Defense (http://history.defense.gov/Publications/Acquisition-History/).

follow, further burdened by other regulatory supplements. The current FAR 2017 includes 2,336 pages, in addition to 1,696 pages of defense specific regulations contained within in the Defense Federal Acquisition Regulations Supplement (DFARS).

The large programs of record characteristic of federal acquisition consist of rigorous research, development, testing, and evaluation (RDT&E). Department of Defense Instruction (DoDI) 5000.02 (2015) defines all defense acquisition programs with Acquisition Categories (ACAT), as well as Milestone Decision Authorities (MDA) to tailor regulatory requirements to achieve program objectives.[4] Regulations governing large programs of record often mandate integrated product teams (IPT) from the prime and sub-contractors, government entities, and testing facilities. The representative program of record starts with a set of requirements presented in several forms and usually begin with a statement of work (SOW).

As shown in Figure 1, the milestone schedule assigned to traditional defense acquisition programs follows a specific pattern. First, the user needs are identified, then technology opportunities and resources initiate the materiel solution analysis and technology development activities during the pre-acquisition process. Additionally, the materiel development decision point determines whether or not to proceed with the pre-systems acquisition phase of the program. During this portion of the acquisition process, Milestones A and B establish progress points for moving into the next phase of the program.

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[4] Defense Acquisition University, Department of Defense Instruction (DoDI) Number 5000.02, January 7, 2015, Incorporating Change 3, August 10, 2017, USDAT&L, https://www.dau.mil/guidebooks/Shared%20Documents%20HTML/DoDI%205000.02.aspx (accessed December 24, 2017).

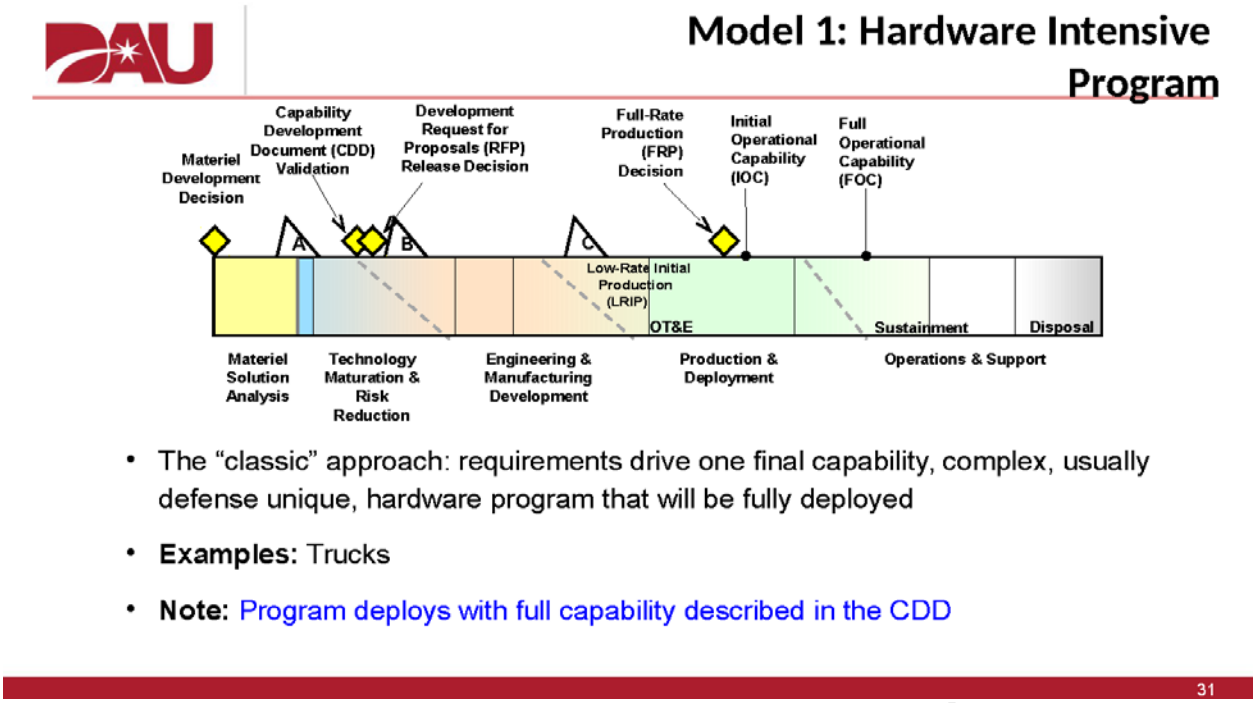

Figure 1: Defense Acquisition Milestone Schedule[5]

Once the program initiation decision is made, the systems acquisition process begins and the engineering and manufacturing development activities commence. During this phase, the preliminary and critical design reviews (PDR and CDR) demonstrate the ability to meet the requirements of the system as well as the manufacturability of the desired products. Milestone C provides the recommendation from engineering to enter the production and deployment phase of the program. The production and deployment phase provides proof of initial operational capability (IOC) as required by the contract. During this phase, low rate initial production (LRIP) and initial operational test and evaluation (IOT&E) activities drive the program toward the decision to enter full rate production (FRP). Finally, in the sustainment phase, the program achieves full

[5] Defense Acquisition University, "Major Defense Acquisition Programs," http://www.logisticsymposium.org/paperclip/speaker_management/16LA/presentation_file_distribution/19051/6fc1478eaeb4460b4f3ebd5f77fc7dd22274ec26.pdf (accessed February 17, 2018).

operational capability (FOC) and moves into operations and maintenance of the system. This phase includes updates to maintenance and operational manuals, logistical support, and eventually depot activities, if required by the contract.

Concurrent with the milestone schedule shown above, prescribed documents, artifacts, and other deliverables are developed, reviewed, revised, and eventually provided to the contracting agency. Many of these documents contain the current status of the cost, technical objectives, and schedule. However, many other contract deliverable documents offer less relevant information, while incurring additional cost and schedule impacts. Some of the requirements within the list of contract deliverables include technical data packages to allow the consumer to repair, replace, or maintain the delivered items, both during and after contract award, and after completion of the program. The timeline shown above typically spans multiple years with deliveries to the warfighter in the final two phases of the contract.

At the end of the systems acquisition phase, DoD procurement practices typically require large programs of record to deliver the technical data packages with unlimited or government purpose rights for the hardware and software items. The practice of requiring the delivery of intellectual property from contractors originated during the First World War when several companies were unable to fulfill the demand required by the military. Consequently, as a historian of federal weapons acquisitions programs has noted, "Congress insisted that the services acquire technical data rights from the winner of the original design competition to put production contracts out for competitive bid."[6]

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[6] Mark A. Lorell, Julia F. Lowell, Michael Kennedy and Hugh P. Levaux, *Cheaper, Faster, Better? Commercial Approaches to Weapons Acquisition, Commercial Approaches to Weapons Acquisition,* (Santa Monica, CA: RAND Corporation, 2000), p. 16, https://www.rand.org/pubs/monograph_reports/MR1147.html (accessed December 27, 2017).

Subsequently, the intellectual property transferred from the government to other competent manufacturers to guarantee timely delivery or fielding.[7] Since then, obtaining the data rights for technology has become commonplace for large programs of record. However, the associated cost of obtaining intellectual property rights increases the overall cost of the program by requiring the contractor to produce a technical data package for delivery with the system, regardless of the potential future of the contract.[8]

Case Studies of Traditional FAR Acquisition Programs

Major Defense Acquisition Programs (MDAP), the formal naming convention for traditional acquisition contracts, typify traditional large defense acquisition programs. While applying the prescribed MDAP structure, the government faces a dilemma that includes a combination of stagnation in defense budgets, and the increase of emerging technologies. Traditional, albeit thorough acquisition practices, limit the ability of DoD to capture the latest technology required to maintain a leading edge. This has led to considerations of alternate paths to solve the better, faster, cheaper quandary. Comparing two typical acquisition programs, the Army's Future Combat Systems (FCS) and the Air Force's Fiscal Year (FY) 2015 Hybrid Acquisition, provides insight into potential options for fielding warfighting equipment.

Future Combat Systems (FCS) serves as an example of the traditional acquisition process for large DoD contracts, and offers an agonizing illustration of how some programs may be too big to manage effectively. The contract awards for FCS to its prime

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[7] Technical data rights are also known as the government's rights to technical data or data rights, see 10 USC 2320, DFARS 252-227-7013, 7014 for additional information.

[8] Technical data packages (TDP) refer to Military Standard 31000 (MIL-STD-31000) and assume that contractors do not necessarily design, create, and maintain their technical data using the military standard instead of company proprietary configuration management tools.

contractors occurred in 2003, during the same time the U.S. Army was engaged in Operations Enduring Freedom and Iraqi Freedom. The timing of FCS appeared to coincide with the military contingency operations in both theaters of operation, taking advantage of initial combat assessments from the battlefield. According to a RAND study, "FCS was the largest, most ambitious planned acquisition program in the Army's history."[9] The FCS contract, "called for fielding not just one system but an entire suite of systems, all organized into a brigade structure that was envisioned to operate under an entirely new (but not yet fully developed) doctrine while integrated by a wireless network."[10] RAND defined six program areas to study, and specified additional challenges within the six program aspects.[11] Since the cancellation of FCS in 2009, most of the original FCS subsystems have developed into products with satisfactory technology readiness levels (TRL) for fielding.[12] By segregating the FCS subsystems into smaller programs, new technologies were able to be successfully introduced.

The FCS program's lessons learned may have influenced an acquisition strategy for the USAF. During fiscal year 2015, the USAF modified the MQ-9 Reaper Unmanned Aerial System (UAS) contract approach to streamline integration of emerging technology. In a concept called "Air Force FY15 hybrid acquisition strategy," the contract tailoring provided a means for new integration of capabilities that met a

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[9] Christopher G. Pernin, Elliot Axelband, Jeffrey A. Drezner, Brian B. Dille, John Gordon IV, Bruce J. Held, K. Scott McMahon, Walter L. Perry, Christopher Rizzi, Akhil R. Shah, Peter A. Wilson, Jerry M. Sollinger. "Lessons from the Army's Future Combat Systems Program," (Santa Monica, CA: RAND Corporation, 2012), p. xvii, https://www.rand.org/pubs/monographs/MG1206.html (accessed December 24, 2017).
[10] Christopher G. Pernin, et al, "Lessons from the Army's Future Combat Systems Program," xvii.
[11] Note: Several lessons learned discovered during the RAND Corporation's study suggest that the program suffered from too many simultaneous variables, creating an unmanageable program. Ibid., xvii-xxix.
[12] Stew Magnuson, "Future Combat Systems Didn't Truly Die," NDIA, *National Defense Magazine*, September 26, 2017, http://www.nationaldefensemagazine.org/articles/2017/9/26/future-combat-systems-didnt-truly-die (accessed December 24, 2017).

designated TRL. The hybrid portion of the contract referred to the integration of software and hardware to meet the urgent operational needs developed outside of the normalized acquisition cycle, to allow for research and development to coexist in parallel to the production contract. The software integration implemented into the program of record used smaller software hybrid release build iterations, designed to control the new feature.

The iterations required only a subset of the full software release methods, simplifying and accelerating the transitions to the integration and test processes. This streamlined, iterative method is shown in Figure 2. If any single software change failed to meet the desired TRL on schedule, integration of the current software build was postponed, while other aspects of the new feature development continued. By using this method, multiple options exist to either continue software development, implement the new feature by a full release at a later date, or halt the development altogether. As stated by the Director of Operational Test and Evaluation, "In FY15, the MQ-9 UAS Program Office adopted a new hybrid acquisition strategy approach in response to changing non-program of record content desired by the Air Force and for delivering desired additional capabilities."[13]

The Hybrid Acquisition strategy allowed for informed decisions to be made in near real time, and resulted in the early adoption of increased warfighting capabilities. When compared with traditional block upgrade programs that may have taken several years to incorporate, the risk reduction approach within the hybrid acquisition strategy provided emerging capabilities to the end user in a much timelier manner. The overall

[13] Office of the Director, Operational Test and Evaluation, Office of the Secretary of Defense, DOT&E FY2015 Annual Report, FY2015, www.dote.osd.mil/pub/reports/FY2015/pdf/af/2015mq9reaperuas.pdf (accessed December 30, 2017).

hybrid approach demonstrated improved timeliness of fielding by integrating the emerging technologies while fulfilling production contract requirements. The new approach improves on the time to deliver disruptive technologies, yet potentially suffers from a subset of historical managerial challenges of MDAP, similar to the FCS delays, where newly added requirements desired by the end user contributed to program delays.

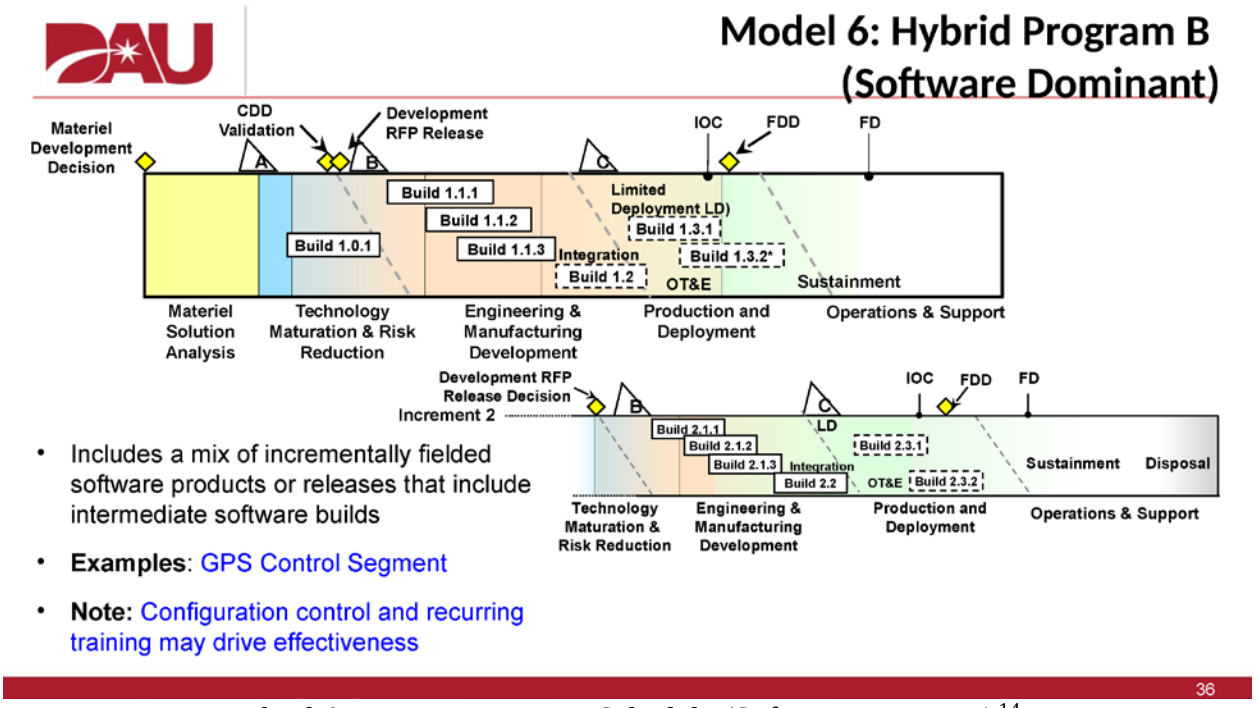

Figure 2: Hybrid Acquisition Program Schedule (Software Dominant)[14]

A Brief Summary of Other Transaction Agreements

A lesser known process for acquisition resides in Other Transaction (OT) agreements, where the regulations dramatically differ from the FAR and pose less programmatic restrictions to the RDT&E phases. This option allows for streamlined

[14] Defense Acquisition University, "Major Defense Acquisition Programs," http://www.logisticsymposium.org/paperclip/speaker_management/16LA/presentation_file_distribution/19051/6fc1478eaeb4460b4f3ebd5f77fc7dd22274ec26.pdf (accessed February 17, 2018).

development and testing, while preserving the private sector's intellectual property. The statutory requirement of OT authority (codified in Title 10 U.S. Code, section 2371) states that "prototype projects must be 'directly relevant to enhancing the mission effectiveness of military personnel and the supporting platforms, systems, components, or materials proposed to be acquired or developed by the Department of Defense, or to improvement of platforms, systems, components, or materials in use by the armed forces.'"[15] For example, in 1958, NASA received authorization to use OT for procurement, and during the same year the Defense Advanced Research Projects Agency (DARPA) was established as a response to Cold War threats. DARPA seized an opportunity by employing the use of OT agreements to accelerate development and fielding of technological breakthrough products.[16]

Gradually, other defense agencies received limited ability to employ OT on prototype contracts. However, from 2010 to 2015, the use of OT in defense contracts remained consistently low, with most contract actions governed by the FAR. Subsequently, in the FY16 National Defense Authorization Act (NDAA), Congress amended the use of OT by DoD, permanently allowing the use of OT for more than prototype contracts. This amendment (10 U.S.C. § 2371b) provides a legal instrument that enables the exploration of innovative technology at a more rapid pace than traditional contracts governed by the FAR. Increased efficiency is obtained, in part, by eliminating

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[15] Defense Advanced Research Projects Agency, "OT Guide," https://www.darpa.mil/attachments/OTGuidePrototypeProjects.pdf (accessed December 30, 2017).
[16] Defense Advanced Research Projects Agency, "About Us – DARPA History," https://www.darpa.mil/about-us/darpa-history-and-timeline (accessed December 30, 2017).

the traditional FAR milestone schedules. Instead, OT agreements use schedules created for the specific agreement, removing unnecessary deliverables.[17]

A Brief Summary of Additional Alternative Acquisition Processes

Concurrent with MDAP, military services developed methods to elevate operational demands to the Office of the Secretary of Defense (OSD).[18] Over time, each service component created a rapid acquisition program office in order to take advantage of another acquisition model, DoDD 5000.71, Rapid Fulfillment of Combatant Commander Urgent Operational Needs.[19] According to GAO, the Army introduced the Urgent Operational Needs Statement (UONS) process in 1987. The process permitted deployed unit commanders to identify needed materiel or new capabilities as urgent to expedite fielding. Prior to September 11, 2001, Army commanders submitted less than twenty UONS to OSD for consideration and fielding per year.[20] Also reported by GAO, the Office of the Deputy Chief of Staff G3/5/7 received over 6,700 UONS (totaling over 21,000 individual urgent needs requested) between September 2006 and February 2010. Each service component continues to maintain their own rapid acquisition or UON capable office.

Two prominent programs emerged from the UONS process; the Joint Improvised Explosive Devise Defeat Organization (JIEDDO, also known as Joint Improvised-Threat

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[17] Defense Advanced Research Projects Agency, "OT Guide," https://www.darpa.mil/attachments/OTGuidePrototypeProjects.pdf (accessed December 30, 2017).
[18] Multiple instructions and directives provide details on Urgent Operational Needs Statements. See CJCSI 3470.01, Rapid Validation and Resourcing, and service specific documents: DoDI 2000.19, SECNAVINST 5000.2, OPNAVINST 5000.43, SECNAV 5000.42, AR 70-1, AR 71-9, AFI 63-114, MARADMIN 53303, MARADMIN 424/06, MARADMIN 045/06, and MCO 3900.17. See Figure 7 for dates of introduction of each service specific UONS requirements.
[19] Government Accountability Office, "Urgent Operational Needs," https://www.gao.gov/products/GAO-10-460 (accessed February 17, 2018).
[20] Ibid.

Defense Organization or JIDO), and the Mine-Resistant Ambush Protected (MRAP) vehicle. According to a study published by the United States Marine Corps University, the accelerated program schedule averages less than a year for most UONS programs.[21] It should be noted that a typical UONS requires reprogrammed budget, meaning rapid acquisition programs compete with already funded programs for reallocated funding. However, between 2002 and 2012, JIEDDO and MRAP did not require reprogrammed funding, as they received emergency funding from Congress.[22] As shown in Figure 3, quick reaction programs such as JIEDDO and MRAP employ concurrent technology maturation, risk reduction, development, production, and deployment to compress the schedule and improve deployment timeliness.

[21] Jonathan Wong, (USMC University Press,) "Rapid Acquisition," https://www.usmcu.edu/applying-rapid-acquisition-policy-lessons-defense-innovation (accessed on February 13, 2018). Note: Also GAO-11-273 provides additional documentation on JIEDDO and MRAP rapid acquisition programs.
[22] Wong, USMC, "Rapid Acquisition."

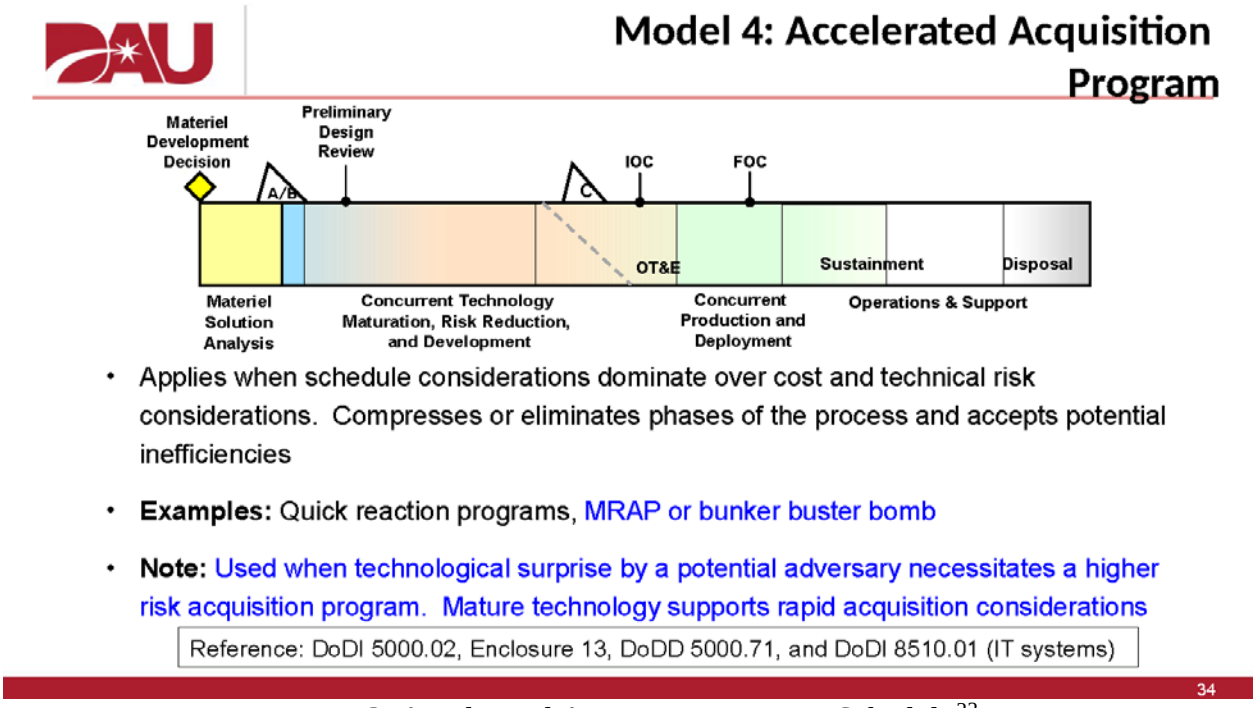

Figure 3: Accelerated Acquisition Program Schedule[23]

In one JIEDDO example, the technology applied to jam improvised explosive devices previously existed in another format developed for the US Navy. The Acorn was a 1980s naval radio frequency protection asset for docked ships.[24] Once modified, the Acorn radio frequency jammer proved to be highly successful in an application against a specific type of remotely detonated IED. Yet, as the techniques, tactics, and procedures of the enemy adapted, the modified Acorn program began to experience issues. The enemy realized the vulnerability of the jammer was its single frequency jamming capability. Thus, the enemy switched frequencies and the modified Acorn became ineffective.

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[23] Defense Acquisition University, "Major Defense Acquisition Programs,"http://www.logisticsymposium.org/paperclip/speaker_management/16LA/presentation_file_distribution/19051/6fc1478eaeb4460b4f3ebd5f77fc7dd22274ec26.pdf (accessed February 17, 2018).
[24] Wong, USMC, "Rapid Acquisition."

Incorporating the lessons learned from FCS and FY15 Hybrid Acquisition, DoD explored additional streamlining opportunities. Also in 2015, former Secretary of Defense Ashton Carter proposed and created an innovation experiment to support emerging and disruptive, high paced technologies, called the Defense Innovation Unit Experimental (DIUx).[25] DIUx is a government entity, similar to DARPA, focused on launching technology at a faster pace than traditional acquisition programs. The goal of DIUx is to ensure America's strategic dominance in technology, while promoting acceleration in commercial innovation to benefit the government.[26] DIUx formed a new relationship between DoD and the private sector. In an effort to capitalize on existing research and development, while bypassing some government bureaucracy, DIUx seeks real-time innovation integration with high technology companies. Unlike most government organizations, DIUx is co-located with high technology companies in Silicon Valley to encourage collaboration and early procurement of emerging technologies. One of the major benefits to DoD includes the ability to adopt new technology without incurring the exorbitant development costs and lengthy schedule durations of traditional acquisition programs.

According to the DIUx home page, DIUx solicits "commercial solutions that address current needs of DoD entities" and responds to industry solution briefs within thirty days, providing "non-dilutive capital in the form of pilot contracts" usually within

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[25] DIUx plan is to accelerate commercial innovation for government use. https://www.diux.mil/ (accessed December 15, 2017).
[26] Fred Kaplan, "The Pentagon's Innovation Experiment," *MIT Technology Review* 01.2017 (December 19, 2016), https://www.technologyreview.com/s/603084/the-pentagons-innovation-experiment/ (accessed on December 26, 2107).

ninety days.[27] Using this business model, DIUx anticipates the pace of technology and inserts itself into the development stream, potentially without creating any delay to fielding the technology. The efficiency of DIUx contracts depends on the use of Other Transaction Authority (OTA) instead of the FAR. OTA allows for prototype projects to enter the operational or deployment environment with less rigor than traditional FAR contracts.[28]

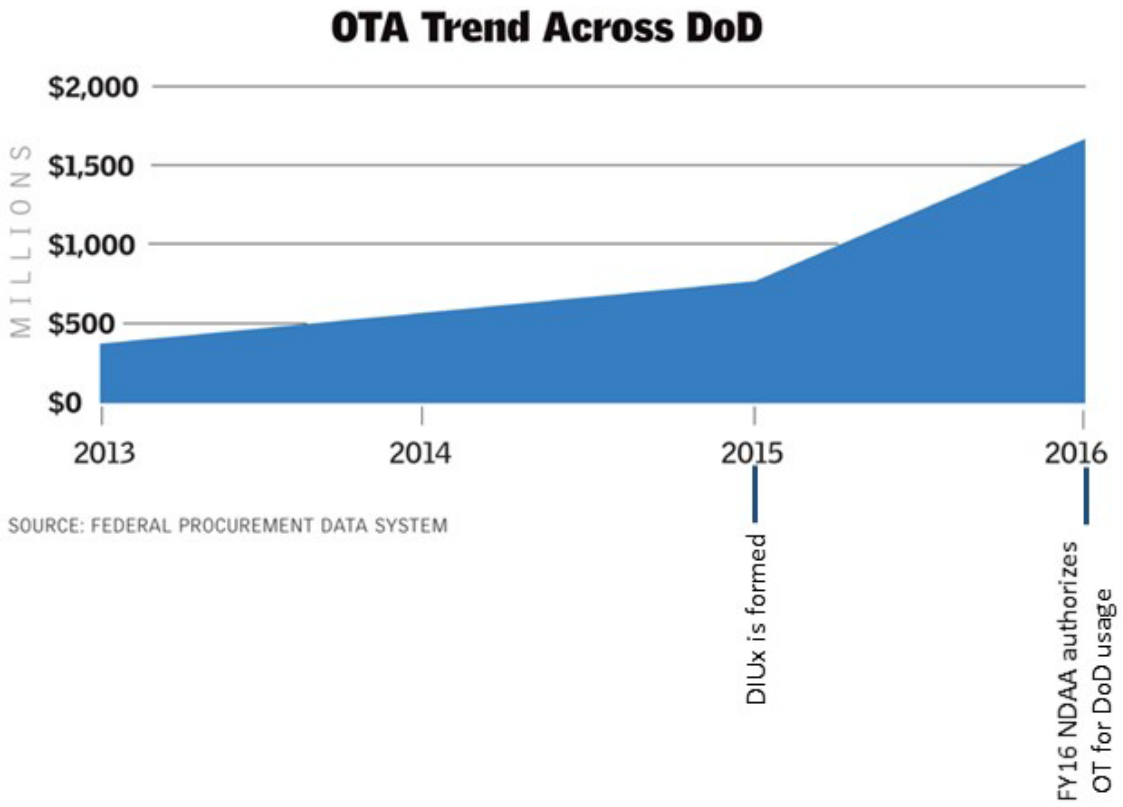

Figure 4: Usage of Other Transaction Authority Funding[29]

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[27] Defense Innovation Unit Experimental, "Work with Us – DoD Entities," https://diux.mil/work-with-us/DoD-Entities (accessed on December 15, 2017).
[28] "Prototype" is defined as "a physical or virtual model used to evaluate the technical or manufacturing feasibility or military utility of a particular technology or process, concept, end item, or system," https://www.darpa.mil/attachments/SBIR-OT-Fact-Sheet-2-Dec-16.pdf (accessed December 15, 2017).
[29] Original graphic from National Defense Magazine. NDIA, *National Defense Magazine*, May 15, 2017. Modified to include specific milestones by author, http://www.nationaldefensemagazine.org/articles/2017/5/15/other-transactions-contracts-poorly-understood-little-used (accessed December 24, 2017).

Within the first year of DIUx employment, OT agreements tripled, and provided DoD with quick access to high technology innovations. Figure 4 illustrates the trends of OTA usage across DoD between 2013 and 2016. According to the DIUx library of accomplishments, "as of September 30, 2017, with the leadership and support of Army Contracting Command of New Jersey (ACC-NJ), DIUx has awarded roughly $184 million for 59 pilot contracts and two follow-on production contracts in the areas of autonomy, artificial intelligence, human systems, information technology, and space."[30]

In addition to DIUx, Secretary Carter established another agile and previously secret technology-consumer organization called the Strategic Capabilities Office (SCO) in 2012. Declassified in 2016, SCO's mission differs from DARPA and DIUx in that it modifies existing technology to address emerging operational needs. The repurposed technology disrupts adversaries by creating a technical, yet unexpected, permutation. For example, one of the few declassified programs modified a U.S. Army Tactical Missile System (ATacMS) with an existing seeker to engage maritime adversaries in a cross-domain solution.[31] This anti-access area denial (A2AD) concept augments terrestrial technology for cross-domain supremacy. The original design of this missile system enabled surface-to-surface capabilities with a precision but fixed targeting solution. The upgrade enables the missile to engage moving targets, at land, or at sea. Thus, land-based missile systems can engage maritime targets up to 300 kilometers away.[32] Creating new methods of employment to supplement existing capabilities into the field with limited

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[30] Defense Innovation Unit Experimental, Library, https://diux.mil/library (accessed on December 15, 2017).
[31] Cheryl Pellerin, Department of Defense, "DoD Strategic Capabilities Office is Near-Term Part of Third Offset," https://www.defense.gov/News/Article/Article/995438/dod-strategic-capabilities-office-is-near-term-part-of-third-offset/ (accessed February 3, 3018).
[32] Ibid.

funding and schedule allows SCO to provide for warfighter needs in terms of months, rather than years.[33]

Because commercial technology is advancing at a rapid pace, DoD must tailor acquisition processes to ensure emerging technologies support the warfighter in a timely and cost effective manner. The options available include using the existing acquisition process concurrent with reform, capitalizing on new acquisition concepts, or reaching out to the general population for a holistic solution.

As of November 2009, the Director of Operational Test and Evaluation proposed several initiatives to address the test and evaluation communities' responsibility for timely acquisition.[34] In June 2017, GAO published a report titled "Adopting Best Practices Can Improve Innovation Investments and Management." For this study, GAO interviewed eight leading companies and evaluated their collective best practices to implement into DoD acquisition strategies.[35] The results of the study found that separating mainstream and mature portfolios from disruptive and innovative investments creates opportunities for a more flexible and agile acquisition process.[36] Figure 5 illustrates the recommended segregation of acquisition organizations.

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[33] Cheryl Pellerin, Department of Defense, "DoD Strategic Capabilities Office Gives Deployed Military Systems New Tricks," https://www.defense.gov/News/Article/Article/712938/dod-strategic-capabilities-office-gives-deployed-military-systems-new-tricks/ (accessed February 3, 2018).
[34] Director, Operational Test and Evaluation, "Current Initiatives," http://www.dote.osd.mil/about/current-initiatives.html (accessed December 23, 2017).
[35] Government Accountability Office, "GAO 17-499: Adopting Best Practices Can Improve Innovation Investments and Management," https://www.gao.gov/assets/690/685577.pdf (accessed December 17, 2017).
[36] Ibid.

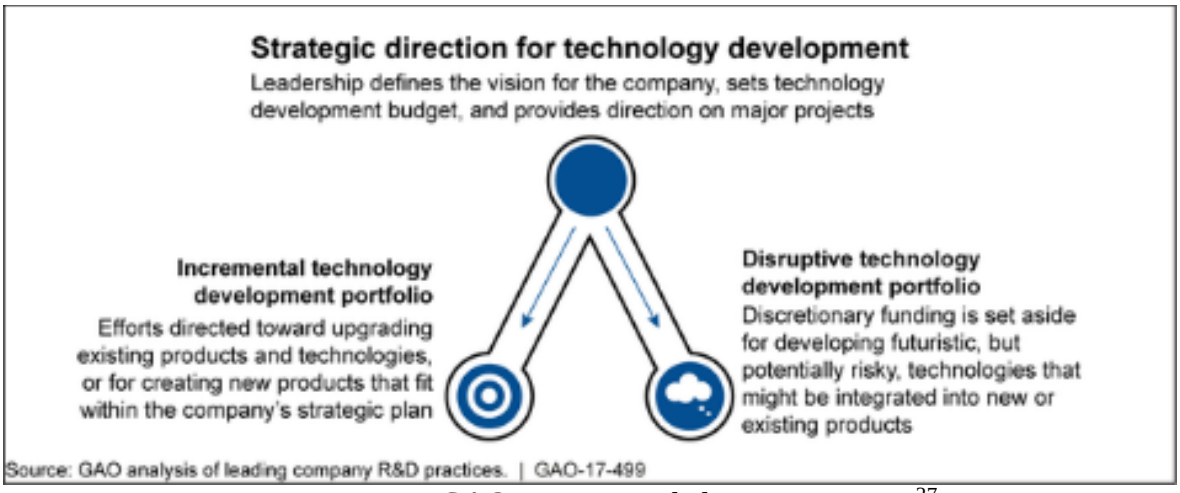

Figure 5: GAO Recommended Reorganization[37]

The GAO report and recommendations closely align with the National Defense Authorization Act (NDAA) 2017, which mandates a reorganization of the Undersecretary of Acquisition, Technology and Logistics (AT&L) into two positions: the Undersecretary of Defense for Research and Engineering (USDR&E), and the Undersecretary of Defense for Acquisition and Sustainment (USDA&S).[38] The NDAA requires the reorganization to be effective February 2018.[39] With this reorganization, the Missile Defense Agency (MDA), Defense Science Board, Strategic Intelligence Analysis Cell, Assistant Secretary of Defense (ASD) for Research and Technology, and Assistant Secretary of Defense for Advanced Capabilities will report to USDR&E.[40] DARPA and the Strategic Capabilities Office will align with the USDR&E office, but the reporting structure has yet to be finalized. USDA&S will include the Assistant Secretary of Defense for Acquisition, Assistant Secretary of Defense for Sustainment, and the Assistant Secretary of Defense

[37] Government Accountability Office, "GAO-17-499: Adopting Best Practices."
[38] U.S. Congress, National Defense Authorization Act 2017, https://www.congress.gov/bill/114th-congress/senate-bill/2943/text (accessed January 3, 2017).
[39] Ibid.
[40] Aaron Mehta, "This is the Pentagon's New Acquisition Structure," Defensenews.com, https://www.defensenews.com/breaking-news/2017/08/02/this-is-the-pentagons-new-acquisition-structure/ (accessed September 9, 2017).

for Nuclear, Biological, and Chemical Weapons. One downside of this reform includes the substantial downgraded reporting structure for DIUx and the Strategic Capabilities Office. These two organizations will fall under the ASD for advanced capabilities. Currently, DIUx and SCO report directly to the Secretary of Defense, several echelons above the new reorganizational structure.

The OSD AT&L reorganization essentially separates new innovation programs and critical national defense organizations from legacy acquisition and sustainment programs, allowing for new technology to be expedited from concept to fielding. However, the OSD AT&L reorganization is combined with an overall 25 percent target for staff reductions, which may complicate the initiation of some of these new positions.

Figure 6 illustrates the reorganization of the USDAT&L into USDR&E and USDA&S. As previously mentioned, one of the most significant changes to the organizational structure includes the move of DIUx and SCO from a direct reporting relationship to the Secretary of Defense to ASD (Advanced Capabilities), essentially four layers lower than the previous reporting structure.

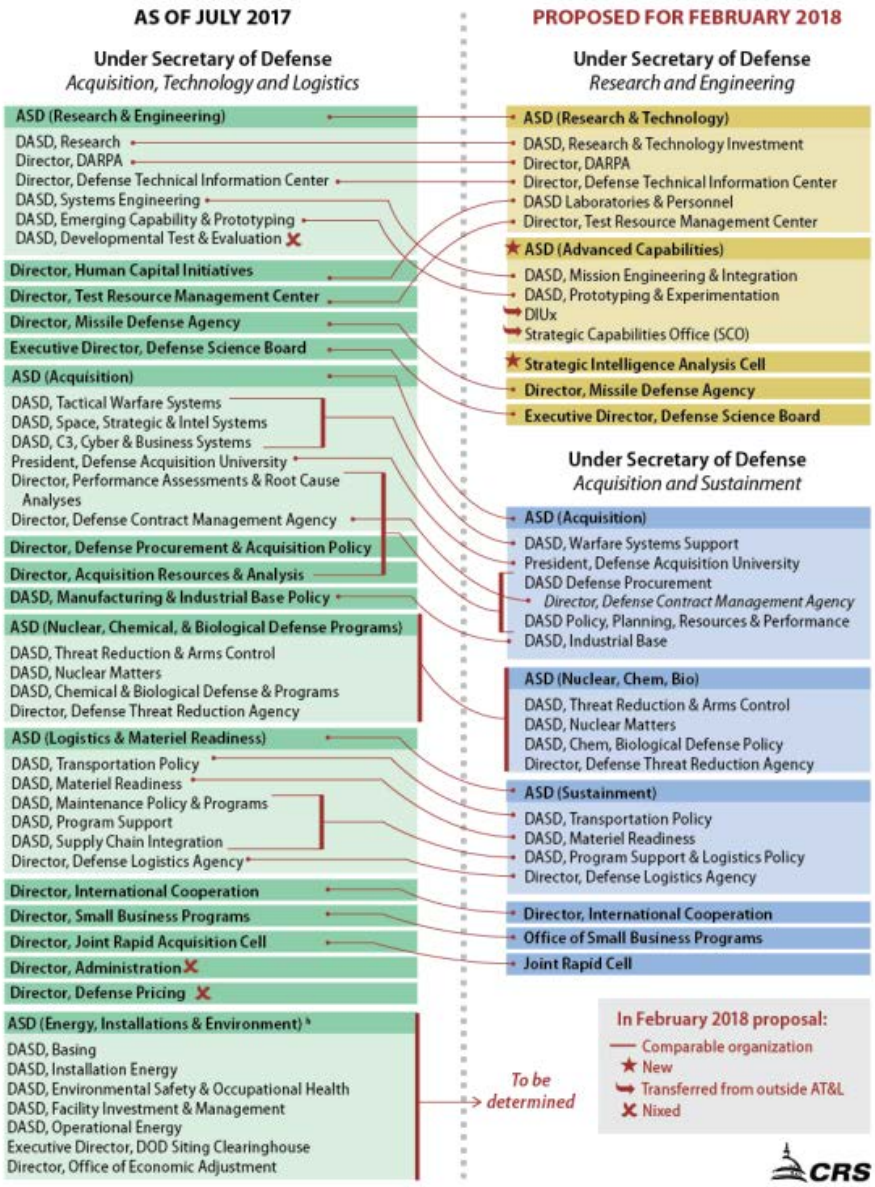

Figure 6: AT&L Reorganization (Proposed)[41]

Finally, acquisition reform as a whole continues to address contracting timelines, use appropriate contracting vehicles (FAR versus OT), and to apply best practices for test and evaluation procedures. These internal reforms, though useful as a concept, have yet

[41] Congressional Research Service, "Acquisition Reform," https://www.everycrsreport.com/files/20170818_IN10755_59b59b056f1d41d5aac6923386dd21265ecd3d9d.html (accessed February 17, 2018).

to be fully implemented, as bureaucratic reorganization has been slow to materialize. DoD must simultaneously take other active measures to continue to find alternate and creative methods to support the warfighter, while meeting the staff reduction requirements of the NDAA.

In compliance with the recommendations from GAO and the directives of NDAA, the AT&L reorganization appears to align with practices and portfolio management of highly successful technology companies. The separation of legacy acquisition and sustainment from research and development potentially streamlines both organizational structures, allowing each to focus efforts on separate portfolios. However, as demonstrated in the defense acquisition reorganization of 1953, also known as Reorganization Plan Number 6, separating these functions may result in another eventual reorganization combining the two organizations together in the future to remove duplication of efforts.[42] Yet, if DoD truly focuses more on regaining the innovative edge and less on bureaucracy and control of private industry, tremendous progress may be achieved.

Several programs and concepts emerged as DoD recognized the technological breakthroughs in commercial innovations. Finding new paths to integrate technology developed in the private sector helped to pave the way for evaluating mature technologies, collaborating with commercial industry leaders, and adopting cutting edge software for defense use.

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[42] Department of Defense, "Defense Acquisition Reorganization 1953," http://history.defense.gov/Portals/70/Documents/key_officials/Key%20Officials_June%202014.pdf (accessed March 6, 2018).

Chapter 2 - Commercial Innovations

Leveraging the innovations of the private sector increases the potential for the Department of Defense (DoD) acquisition strategy to stay relevant. Multiple non-profit organizations publish a variety of reports describing a collection of defense and private industrial partnerships. These partnerships demonstrate the benefits of the defense agencies adopting commercial products to field for government use. In an effort to address real time issues within DoD, many defense agencies collaborate with industry to procure existing technologies that meet government operational needs. Three specific instances that provide examples of how DoD currently engages commercial innovations include portfolios from the United States Navy (USN), National Aeronautics and Space Administration (NASA), and the Defense Advanced Research Projects Agency (DARPA).

Advanced Concept Technical Design – Predator Unmanned Aerial Vehicle.

In July 1993, the Under Secretary of Defense, John Deutch, authored a memorandum for the Assistant Secretary of the Navy for Research, Development, and Acquisition on the subject of "Endurance Unmanned Aerial Vehicle (UAV) Program." The memorandum (also known informally as the Deutch Memo) described the current operational environment and lack of sufficient tactical intelligence assets. The memo additionally defined the requirements for a high endurance UAV with an accelerated demonstration and acquisition cycle.[1] Specifically, the scope of the memo included the following: capability to fly at least 500 nautical miles from its originating airport and

[1] The George Washington University, The National Security Archive, https://nsarchive2.gwu.edu/NSAEBB/NSAEBB484/docs/Predator-Whittle%20Document%201%20-%20Deutch%20Endurance%20UAV%20Memo%2012%20July%201993.pdf (accessed December 30, 2017).

remain on station for twenty four (24) hours or more, with a nominal altitude of 15,000 ft. above ground level (AGL) up to 25,000 ft. AGL; capability to carry an integrated payload or sensor of 400-500 pounds; an integrated electro-optical/Infrared sensor (EO/IR) system and a Synthetic Aperture Radar (SAR) suite; and a satellite communication system capable of streaming sensor data, in addition to providing full command and control of the aircraft. Additionally, the UAS would need to be demonstrated within six months, with a prototype available for delivery to the government within twelve months.

In order to meet this demand, the Program Executive Office for the Cruise Missiles Project and Unmanned Aerial Vehicles Joint Project, PEO (CU), set out to identify a supplier with existing capabilities, and who could demonstrate the specified UAV system within 24 months.[2] This concept eventually became known as Advanced Concept Technology Demonstration (ACTD).[3] The Predator Program was the first ACTD program to transition to the formal acquisition process.[4] "By limiting consideration to prototypes that featured mature technology, the ACTD program avoided the time and risks associated with technology development, concentrating instead on technology integration and demonstration activities.[5] The most distinct advantage to the ACTD program is the ability to determine military utility before making a commitment to move into formal acquisition. Using this concept, the USN purchased the system without

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[2] PEO (CU) is a Program Executive Office for Unmanned Systems and Cruise Missiles under the Department of the Navy, Naval Air Systems Command (NAVAIR). For more information regarding this program office, see http://www.navair.navy.mil/index.cfm?fuseaction=home.NAVAIRNewsStory&id=193.
[3] Note: According to the GAO, the 1986 Packard Commission and a 1991 Defense Science Board study sparked the 1993 creation of the ACTD program concept. "Defense Acquisition: Advanced Concept Technology Demonstration Program Can Be Improved," NSIAD-99-4: Published: Oct 15, 1998. Publicly Released: Nov 17, 1998, https://www.gao.gov/products/NSIAD-99-4 (accessed December 31, 2017).
[4] Michael R. Thirtle, Robert V. Johnson and John Birkler, T*he Predator ACTD: A Case Study for Transition Planning to the Formal Acquisition Process*, (Santa Monica, CA: RAND Corporation, 1997), p. xiv.
[5] Ibid., 4.

a government research and development investment, evaluated the performance, and ultimately determined product integration feasibility.[6]

The benefits to DoD for ACTD programs include reduced monetary risk to the government, fewer research and development costs up front, and a compressed development schedule. Conversely, the disadvantages to DoD involve less control of specific system requirements, and less opportunity to negotiate intellectual property, which may result in decreased ability to solicit for competition of the technical solution. The transition to a formal acquisition process, however, may correct some of these perceived disadvantages.

However, ACTD programs are not true acquisition programs; but they are key enablers to sending prototypes into the field and benefit from warfighter assessment and feedback. The key accomplishments of the Predator ACTD include flying the first three aircraft within the first six months, and ten fully capable aircraft within thirty months of contract award.[7] As a field tested asset, the Predator ACTD concept spawned from prototype to one of the most successful and mission ready unmanned platforms.[8]

With the ACTD ending in 1996, the United States Air Force (USAF) Big Safari program office awarded the contract to the manufacturer in the form of a Production Rate Verification (PRV) contract for the RQ-1 Predator.[9] Since the ACTD program, the Predator UAV sustained a very high readiness rate from 2009 through 2013, averaging

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[6] Note: The Predator MQ-1B program is now managed by USAF.
[7] Michael Thirtle, Robert Johnson, John Birkler, *The Predator ACTD*, p. 1, 21.
[8] *Air Force Times*, "MQ-1 Predator Readiness Rates," https://www.airforcetimes.com/news/your-air-force/2018/03/05/fewer-planes-are-ready-to-fly-air-force-mission-capable-rates-decline-amid-pilot-crisis/ (accessed March 6, 2018).
[9] Michael Thirtle, Robert Johnson, John Birkler, *The Predator ACTD*, p. 70.

93.4 percent, according to the Military Times.[10] Additionally, as cited by Air Combat Command, the Predator UAV maintains one of the highest mission completion rates, boasting 95.4 percent from April 2013 to April 2014.[11] Although USAF plans to retire Predator in 2018, the ACTD program enabled the advancement of hardware and software development, and eventually the creation of both the USAF MQ-9 Reaper and US Army MQ-1C Gray Eagle UAV systems in widespread use today.

The benefits to the private sector in using the expedited concepts approach, such as ACTD, include accelerated schedules with early to market demonstrations, control of the intellectual property of the new technology, and the potential for creating revolutions in military affairs. Disadvantages to the private sector include financial risk (in the event the product demonstration fails or is not selected as the winner, the private company assumes financial responsibility), and the possibility of the technology being categorized as a defense article which may be subjected to export restrictions. The benefits of the expedited field testing of a system borne of an ACTD program often outweigh the risks. For the Predator program example, the ability to bring new technology to the warfighter incentivized GA-ASI to deliver on time using private funding.[12]

NASA and FAA Sense and Avoid.

Another example of leveraging technology from commercial enterprises includes a public-private partnership between NASA, the Federal Aviation Administration (FAA), and industry. In May 2012, the Sense and Avoid Public - Private Partnership created a

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[10] *Military Times*, "MQ-1 Predator Readiness Rates," https://www.militarytimes.com/2013/10/02/readiness-declines-in-aging-overworked-fleet/ (accessed February 19, 2018).
[11] United States Air Force, "Mission Readiness," http://www.af.mil/News/Article-Display/Article/485651/rpas-meet-mission-goals-safe-and-on-time/ (accessed on February 18, 2018).
[12] Michael Thirtle, Robert Johnson, John Birkler, *The Predator ACTD*, p. 13.

roadmap for integration of unmanned aerial vehicles into the National Air Space (NAS) for routine operations.[13]

The collaboration between the FAA, NASA, Massachusetts Institute of Technology – Lincoln Laboratories, Honeywell, and General Atomics Aeronautical Systems, Inc. (GA-ASI) demonstrated new hardware and software integration in multiple phases. The program achieved the ability for each aircraft to sense the distance between them, calculate the requirements to maintain proper air space separation, and to autonomously perform avoidance maneuvers to avoid all aircraft that may compromise these proper air space separation boundaries. This concept is similar to how a pilot would see another aircraft, and if necessary, maneuver away from that aircraft to ensure proper separation. The MQ-9 Ikhana unmanned aerial system (UAS) owned and operated by NASA, has been used to conduct Earth science missions, firefighting surveillance, and more recently, to test the suitability for sense and avoid integration into the NAS.[14] For this program, Honeywell designed an upgraded avionics suite including an Automatic Dependent Surveillance-Broadcast (ADS-B) system, which provides the UAV with existing air traffic control (ATC) technology.[15] GA-ASI modified hardware and software to upgrade the NASA MQ-9 Ikhana for this program, while also privately funding

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[13] Note: The FAA classifies UAS in multiple categories. The UAS described herein refers to systems designed to satisfy the Sense and Avoid (SAA) requirement necessary to comply with the Code of Federal Regulations (CFR) 14 CFR Part 91, https://www.faa.gov/uas/research/reports/media/UAS-SAA-Multi-Sensor-Data-Fusion-Strategies.pdf, https://www.faa.gov/uas/research/reports/media/Integration-of-ACAS-X-into-SAA-for-UAS.pdf (accessed December 23, 2017).

[14] NASA, "NASA Armstrong Fact Sheet: Ikhana Predator B Unmanned Science and Research Aircraft System," https://www.nasa.gov/centers/armstrong/news/FactSheets/FS-097-DFRC.html (accessed December 31, 2017).

[15] Note: ADS-B is an aircraft tracking technology that all planes operating in U.S. airspace must adopt by January 2020 to comply with Federal Aviation Administration regulations. See https://www.faa.gov/nextgen/equipadsb/ for more information regarding the FAA regulations and ADS-B.

development of the sense and avoid radio detection and ranging (RADAR) architecture.[16] FAA supported the program with guidance, approvals, and policies to ensure UAS integration into the NAS can be accomplished by 2020.[17]

Using test plans developed together with the FAA and NASA, Honeywell and GA-ASI built on proof-of-concept testing to "engage the core air traffic infrastructure and supporting software components through both live and virtual environments to demonstrate how an autonomous aircraft can interact with Air Traffic Controllers (ATC) and other aircraft."[18] According to NASA, the aircraft systems equipped with these technologies have accomplished several milestones. Specifically, the MQ-9 Ikhana executed automated maneuvers successfully while being subjected to more than 200 various encounters with approaching aircraft during execution of eleven test flights.[19]

In collaborating with private industry, DoD benefitted from private research and development funding by GA-ASI and Honeywell to develop unmanned solutions to integrate UAS into the NAS through cooperation and input from NASA and the FAA. Additionally, the certification process and associated artifacts may provide increased confidence within the Foreign Military Sales (FMS) markets for unmanned aircraft. The disadvantages of DoD collaborating with private industry may include lack of unlimited government intellectual property rights or final ownership of the physical hardware.

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[16] NASA, "NASA Armstrong Fact Sheet."
[17] Ibid.
[18] Juliet VanWagenen, *Aviation Today*, "NASA, Industry Flight Test UAS Sense-and-Avoid Technology," http://www.aviationtoday.com/2015/07/06/nasa-industry-flight-test-uas-sense-and-avoid-technology/ (accessed October 31, 2017).
[19] NASA, "Industry Complete Third Phase of UAS Flight Testing," https://www.nasa.gov/centers/armstrong/features/detect_and_avoid.html (accessed October 31, 2017).

Blockchain Technology adapted for DARPA.

Blockchain, the software framework for Bitcoin, uses a transaction authentication algorithm for security and traceability of digital assets. Similar to a GPS tracker, this software tracks digital assets through each transaction from origin to destination.[20] The technology presented by Blockchain establishes trust networks for each transaction. Realizing the power this software provides to commercial financial institutions, DARPA awarded a $1.8M contract to Galois, the firm that invented Blockchain, to use the proprietary software tracing program to record information integrity for cybersecurity.[21] According to DARPA, adding this technology to the cybersecurity infrastructure would allow military and intelligence authorities to know when a system is being hacked, surveyed, or modified, while also recording the transactions.[22] The benefits to DoD are countless. Unauthorized access to secure or sensitive networks within the government and DoD potentially exposes national security information. A DARPA program manager summarized the innovative use of this software by stating, "Instead of trying to make the walls of a castle as tall as possible to prevent an intruder from getting in, it's more important to know if anyone has been inside the castle, and what they're doing there."[23] Blockchain type software will not only provide relevant diagnostic information when a system is compromised, but may also act as a deterrent to help discourage hacking. One

[20] Blockchain, "About Blockchain," https://www.blockchain.com/about/index.html (accessed January 1, 2018).
[21] National Association of Securities Dealers Automated Quotations, "DARPA Advancing Cybersecurity Infrastructure with Blockchain," http://www.nasdaq.com/article/darpa-and-advancing-cybersecurity-infrastructure-with-blockchain-cm783507 (accessed December 23, 2017).
[22] Ibid.
[23] Ibid.

potential disadvantage for this concept may exist in the government selecting a sole source for the entire cybersecurity infrastructure.

If Galois fails to maintain Blockchain, or if Blockchain exhibits any flaws, much of DoD cybersecurity infrastructure could be compromised. However, this program also presents a hedging opportunity for government to practice frugality by not purchasing data rights. The benefits to Galois include additional contracts, confidence in their product, and a game-changing advantage to every technology applying their software. The disadvantage to Galois could be the burden of such a serious responsibility for the financial and cybersecurity domains they protect. However, if they are successful, Galois and Blockchain will become household names.

As DoD explores new ways to incorporate emerging technologies and uses more agile acquisition concepts outside of the FAR, the time to field commercial innovation improves dramatically. As the examples above demonstrate, defense and commercial collaborations present an exceptional method to meet urgent needs. The next chapter will explore additional methods for earlier adoption of new technologies.

Chapter 3 – Competitive Edge Approaches

With the history of acquisition progression from Federal Acquisition Regulations (FAR) to Other Transaction (OT) agreements to Advanced Concept Technical Design (ACTD), the Department of Defense (DoD) has made tremendous strides to keep pace with commercial innovations. Additionally, DoD continues to interact with industry to adapt commercial technology for government use. However, other options for staying ahead of adversaries exist, but may be underutilized. Taking DoD's acquisition role further using methods such as crowdsourcing, trolling for disruptive technologies, and interfacing with communities of interest expands the possibilities of technology proliferation. Instead of waiting for a technology to be developed without input, DoD engages in a more networked approach by soliciting those who may be the best, albeit non-traditional, candidates for solving a challenge. Creating incentives for individuals or groups to compete to deliver the required product first, enables DoD to acquire the technology without incurring the research and development costs.

Crowdsourcing typically involves obtaining needed services, ideas, or content by soliciting contributions from a large group of people and especially from the online community rather than from traditional employees or suppliers. Crowdsourcing for aviation firsts originated almost one hundred years ago with the Orteig Prize.[1] Historically, prizes awarded for the advancement of technology include the United Kingdom's Daily Mail prizes, the Ansari XPRIZE, and other, more recent government

[1] Tim Brady, "The Orteig Prize," *Journal of Aviation/Aerospace Education & Research*, 12 (1). http://search.proquest.com.nduezproxy.idm.oclc.org/docview/1689453386?accountid=12686 (accessed January 3, 2018).

prizes.[2] Several other prizes awarded to drive innovation and tap into resources within the population, or "citizen scientists," include humanitarian, environmental, and medical challenges. Today, myriad examples of monetary incentives demonstrate new methods for DoD to solicit ideas for products that either industry or private citizens can conceive and develop. These prizes allow for greater opportunities to recruit a more diverse resource complement than ever before.

According to the Brookings Institution's Hamilton Project, the role of prizes in promoting research and development should be reviewed and reintroduced to stoke technological innovation.[3] The proposal describes how the old idea of prizes and competitions provided a complement to government contracts and grants while generating enthusiasm in the science and technology fields.[4] The Stevenson-Wydler Technology Innovation Act of 1980 introduced legislation to engage the public and enhance technological innovation.[5] Since then, the introduction of the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science (COMPETES) Act in 2007 reignited this competitive spirit within the public sector. Similar to the Orteig Prize won by Charles Lindbergh in 1927 for his transatlantic flight, America COMPETES awards prizes for innovations and creativity.

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[2] Obama White House, "Fact Sheet: The White House Releases New Strategy for American Innovation, Announces Areas of Opportunity from Self-Driving Cars to Smart Cities." https://obamawhitehouse.archives.gov/the-press-office/2015/10/21/fact-sheet-white-house-releases-new-strategy-american-innovation (accessed January 3, 2018).
[3] Thomas Kalil, "Prizes for Technological Innovation," The Brookings Institution. *The Hamilton Project*, http://www.hamiltonproject.org/papers/prizes_for_technological_innovation (accessed December 23, 2017).
[4] Ibid.
[5] U.S. Senate and House of Representatives, "Stevenson-Wydler Technology Innovation Act of 1980," https://legcounsel.house.gov/Comps/Stevenson-wydler%20Technology%20Innovation%20Act%20Of%201980.pdf (accessed February 13, 2018).

First introduced by President Barak Obama in 2009, *A Strategy for American Innovation*, outlines six fundamental ways to improve the capacity for technology innovation, encouraging federal agencies to identify their needs and promote challenges with prizes.[6] The six components include federal investments in research and science, technology, engineering, and mathematics (STEM) education; empowering private-sector innovators with tax credits for research and experimentation; establishing incentives and prizes for innovations; creating more high technology career opportunities within the United States; pursuing specific technologies to enhance survivability and improve health care innovations; and providing public access to Innovation Laboratories through federal agencies.[7] The National Economic Council and Office of Science and Technology Policy emphasizes that "the American innovation ecosystem requires not only the risk-taking and vision of the entrepreneur and the ability of the corporation to scale these innovations, but also the foundational 'building blocks' of innovation in which the Federal Government invests."[8] Possibly the most poignant statement from the executive branch's *Strategy for American Innovation* strikes directly at the core of American innovation by stating that it must "address new threats to our national security and strengthen the technological superiority of our military."[9]

In 2010, Challenge.gov launched an interactive website to engage, energize, and inform the public sector of open competitions within the entire government. As of December 2017, Challenge.gov had posted over eight hundred open competitions

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[6] America COMPETES competitions can be found at https://www.Challenge.gov
[7] The White House, "Strategy for American Innovation 2015," https://obamawhitehouse.archives.gov/sites/default/files/strategy_for_american_innovation_october_2015.pdf (accessed January 3, 2018), 3-9.
[8] Ibid., 14.
[9] Ibid., 12.

encouraging interaction between federal agencies and the public to solve real world challenges. According to the website, over $250 million in prize money and other incentives have been offered.[10]

Multiple governmental agencies also offer prizes to accelerate advances in science and technology. For example, the Department of Homeland Security (DHS) seeks participation from "citizen inventors, the Makerspace Community, university students, inspired individuals and communities, and persons who do not traditionally participate in government contracts."[11] Some previous challenges for DHS innovation include disaster preparedness, hidden signals detection for biohazards, and passenger screening algorithms.[12]

The United States Naval Institute (USNI) collaborates each year with the Leidos defense company, challenging entrants to compose an essay to predict future emerging and disruptive technologies, and to explain how those technologies will be used by, or against, the US military.[13] The prizes awarded to the top three essays equate to an extremely small fee when compared to the tremendous benefits DoD typically realizes. The concept of probing the brain trust of the collective population expands the resource pool into a much larger array of concerned citizens who share their insights, through a process that creates a greater potential to identify future capabilities.

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[10] Challenge.gov, Listing of Challenges for Department of Homeland Security, https://www.Challenge.gov (accessed January 3, 2018).
[11] Makerspace Community represents the democratization of design, engineering, fabrication, and education, https://spaces.makerspace.com/ (accessed December 29, 2017). Department of Homeland Security prize award offerings can be found at: https://www.dhs.gov/science-and-technology/prize-competitions.
[12] Challenge.gov, Listing of challenges for Department of Homeland Security, https://www.Challenge.gov (accessed January 3, 2018).
[13] Note: Leidos an American defense company headquartered in Reston, Virginia, that provides scientific, engineering, systems integration, and technical services. Leidos originated from Science Applications International Corporation (SAIC).

The Global Challenges Foundation, a Sweden based non-profit, explores global catastrophic risks, threats to humanity, and other scientific research-worthy causes. Similar to America COMPETES and XPRIZE, Global Challenges awards prizes to "incite deeper understanding of global risks and promote more urgent discussion of how they are collectively managed."[14] According to their website, Global Challenges Foundation received over 2,700 entries from 122 countries. Their latest challenge, The New Shape Prize focuses on "threats posed by four interlinked 'mega-risks:' climate change, environmental damage, conflict (including the use of nuclear and other weapons of mass destruction) and extreme poverty."[15]

According to the Department of Defense Research and Engineering Enterprise, two computer programs currently in use to identify emerging disruptive technologies are Technology Watch and Horizon Scanning, which use sophisticated algorithms to automatically catalogue new technology concepts for further study.[16] Analysts scan the list for details of emerging technologies, and determine whether or not there are any potential threats or benefits for the government to consider. Discovery of threats becomes easier with the use of these tools, and often leads to follow-on activities such as formal contracts, informal acquisition, prizes, or other crowdsourced activities.

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[14] Global Challenges Foundation, "Global Challenges," https://globalchallenges.org/en/about/about-us (accessed on February 13, 2018).
[15] Global Challenges Foundation, "New Shape," https://globalchallenges.org/the-prize/materials/brochures-new-shape-prize (accessed on February 13, 2018).
[16] Technology Watch and Horizon Scanning for the Department of Defense are organizations that use scanning as a technique for detecting early signs of potentially important developments through a systematic examination of potential threats and opportunities, with emphasis on new technology and its effects on the issue at hand. See https://www.oecd.org/site/schoolingfortomorrowknowledgebase/futuresthinking/overviewofmethodologies.htm (accessed February 19, 2018).

Another area where DoD can become aware of emerging technologies lies within communities of interest. Previously, the Defense Federal Regulations Supplement (DFARS) 231.205-18 mandated that all new independent research and development (IR&D) projects (beginning with fiscal year (FY) 2017) would be briefed to the communities of interest through a technical interchange meeting (TIM) prior to the start of each project. Although this requirement has been repealed, many companies within the private sector still provide briefings to appropriate communities of interest. The practice allows DoD entities to gain access and knowledge of requirements for emerging technologies, and to eventually determine if any of these technologies meet the needs of one or more of the communities. Reintroducing this mandate, or using available artifacts created as a result of DFARS 231.205-18 would offer another avenue for DoD to engage industry early, and if necessary, immediately move the technology to one of the fast track development and fielding programs.

Each official IR&D program submits a summary of every project and all pertinent data to the Defense Technical Information Center (DTIC). However, if the TIM requirement remains repealed, DoD communities of interest will have to data mine the DTIC database for applicable IR&D projects. Without the face-to-face briefings and the ability for DoD and private sector innovators to directly collaborate, the conceptual projects lack end user input and true requirements generation. The decades of military experience and hands-on knowledge from DoD professionals regarding a certain technology cannot be replaced by an eager and well-meaning engineer alone; technical interchanges between designers and DoD experts provide clarity to the needs of the end user.

University interactive grants provide hands-on experience to students, while contributing to the needs of government agencies. One prominent example is Hacking for Defense, which is a university level course allowing students to learn about defense issues and needs, while assisting government sponsors in the Department of Defense and the Intelligence Community.[17] Hacking For Defense offers both faculty and students an opportunity to work on real-world problems for DoD, while gaining experience and working directly with agency sponsors.[18]

The National Science Foundation coordinates federally funded research grants through Research.gov, an interactive website, which promotes scientific engagement from primary and secondary educational institutions, as well as private industry.[19] Previously awarded grants vary from humanitarian assistance and disaster relief (HA/DR) to Tunable Wide Bandwidth Sensor Arrays. In FY17, NSF granted funding to over 12,000 programs, totaling over $5 billion to be spent over the next five years (2017-2022). The grants, fellowships, and graduate work funded by the NSF translate largely into potential opportunities for disruptive technologies, urgent operational needs, and repurposed technology for new applications made available to the warfighter.

Similarly, the FAA Centers of Excellence Grant Awards competitively seek university involvement in order to complete specified projects. Grants awarded since 2008 encompass multiple aviation and aerospace related projects, many of which benefit

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[17]Hacking For Defense, "Hacking For Defense," https://www.h4di.org/about.html (accessed December 15, 2017).
[18] Ibid.
[19] National Science Foundation, "Research.gov," https://www.research.gov/research-portal/appmanager/base/desktop?_nfpb=true&_eventName=viewQuickSearchFormEvent_so_rsr (accessed February 18, 2018).

military, civilian, and academic institutions.[20] The FAA also participates in The Secretary of Transportation Student Recognizing Aviation & Aerospace Innovation in Science and Engineering (RAISE) Award, which honors high school and college students for achievements in aerospace science and engineering.[21] Incorporating high school and college students into DoD innovation challenges increases the potential for finding appropriate solutions to current issues. These solutions may eventually become programs of record as DoD evaluates the output from these efforts.

Conceived in 1995, the Ansari XPRIZE ignited innovators with a private sector space race, inspiring entrepreneurs from all walks of life to launch their own spaceship into orbit, with the first successful team winning a $10 million dollar prize and global recognition.[22] Since 2005, the XPRIZE Foundation has awarded $27.65 million dollars in six global competitions, from a lunar lander, to multiple super fuel efficient vehicles. [23] As of February 2018, XPRIZE announced an additional eight global competitions valued at $86.75 million dollars.[24] The time from competition announcement to monetary award averages just over three years.[25] The challenges proposed on the XPRIZE Foundation's

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[20] Federal Aviation Administration, "Centers of Excellence Grant Awards," https://www.faa.gov/about/office_org/headquarters_offices/ang/offices/management/coe/grant_awards/ (accessed January 3, 2018). COE Research Grants - require matching funds mandated by Congress Cost-share contracts may be awarded following competitive process authorized by the White House Reinvention Lab Centers may receive funding from any public or private source As set forth in P.L. 101-508: Centers may contract with others as appropriate.
[21] Federal Aviation Administration, "Centers of Excellence Opportunities," https://www.faa.gov/about/office_org/headquarters_offices/ang/offices/management/coe/opps/ (accessed January 3, 2018).
[22] Julian Guthrie, *How to Make a Spaceship: a Band of Renegades, an Epic Race, and the Birth of Private Spaceflight*, (New York: Penguin Books, 2017), 1-7.
[23] XPRIZE Foundation, XPRIZE Prizes, https://www.xprize.org/prizes (accessed February 17, 2018).
[24] Ibid.
[25] Ibid.

official site promote private team innovation to meet global needs, which may ultimately contribute to achieving enduring national interests.

Finally, several other organizations offer alternative approaches to problem solving. Non-profit organizations such as In-Q-Tel and the Defense Entrepreneurs Forum (DEF) provide funding, intellectual collaboration, and networking services to assist in the resolution of defense issues. Established in 1999, In-Q-Tel acts as a bridge between the government, venture capitalists, and startup companies to help assemble the appropriate technology and funding for government challenge programs.[26] In-Q-Tel focuses strategic investments and assists in translating needs between the government and technology providers. In comparison, DEF consists of military members from all branches of service and civilians from the defense industry.[27] DEF hosts networking sessions, collaboration events, and conventions to facilitate the exchange of ideas, information, and challenges facing the defense industry.[28]

Similarly, Begin Morning Nautical Twilight (BMNT), a for-profit veteran owned startup company, provides intermediary support between companies and the government. BMNT dispatches teams to the client's location to assist in framing problems, determining possible solutions, and developing multiple options to validate the proposed solutions.[29]

With multiple emerging technical options available to DoD, a reorganization of the Undersecretary of Acquisition, Technology, and Logistics appears to be required. To

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[26]In-Q-Tel, "About In-Q-Tel," https://www.iqt.org/about-iqt/ (accessed December 23, 2017).
[27] Defense Entrepreneurs Forum, homepage, http://defenseentrepreneurs.org/ (accessed December 23, 2017).
[28] Ibid.
[29] Begin Morning Nautical Twilight, "FAQ," http://www.bmnt.com/faq-2/ (accessed January 3, 2018).

take advantage of these options, a highly responsive acquisition team is required in order to engage the finest research and engineering professionals.

To this end, Secretary of Defense Ashton Carter created the Defense Innovation Board (DIB), comprised of a plethora of highly qualified educators, former military members, executives, and private sector experts in their fields.[30] Established in 2016, the DIB charter requires renewal every two years and includes a membership balance plan to ensure highly qualified members are selected to advise the Secretary of Defense.[31] DIB serves as an independent federal advisory committee, working closely with DIUx and other DoD entities.[32] The extremely diverse and concentrated intelligence pool identifies gaps within DoD systems and recommends solutions to close them.[33] This approach combines people and culture, technologies and capabilities, and practices and operations.[34] Perspectives from the DIB members vary from common sense to highly inventive solution sets, and appear on the DIB recommendations webpage with executive summaries and background with recommended solutions. Incorporating these industry and academic experts into DoD problem solving expands the knowledge base and best practices across the DoD enterprise.

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[30] Department of Defense, Defense Innovation Board, http://innovation.defense.gov/Members/ (accessed February 17, 2018).
[31] Ibid.
[32] Ibid.
[33] Ibid.
[34] Ibid.

Chapter 4 - Streamlining Acquisition Strategies

The traditional government acquisition system for large-scale defense programs remains cumbersome and bureaucratic. Acquisition reform and supplementary guidance continues to expand, creating additional opportunities and challenges for insertion of emerging technology into the Department of Defense (DoD).

As shown in Figure 6, each service component, including DoD itself, continues to find ways to circumvent the main stream, bureaucratic acquisition system with rapid acquisition capabilities.

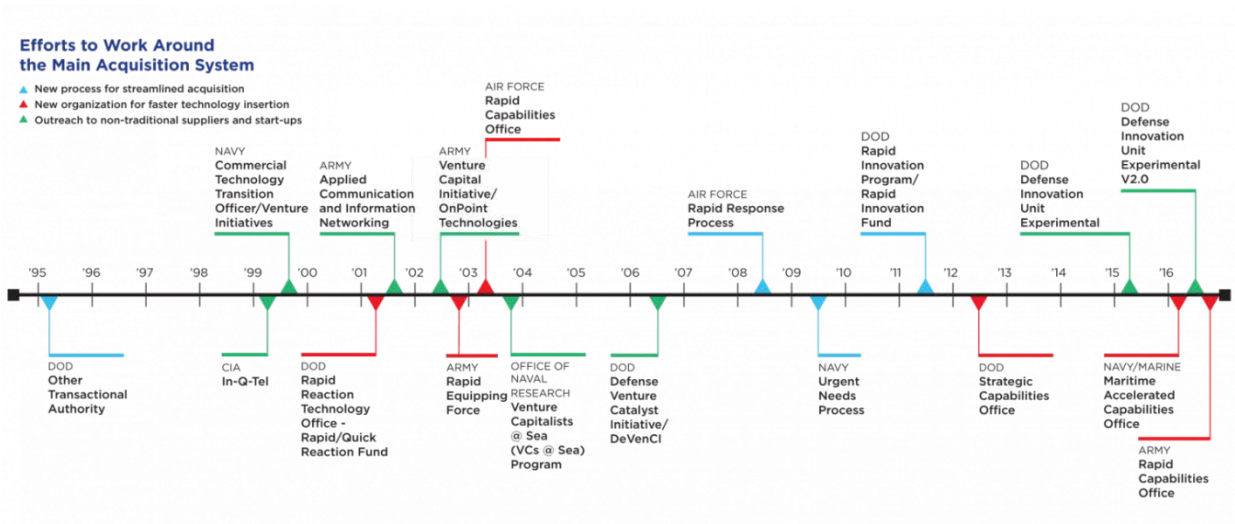

Figure 7: History of Acquisition System Work-Arounds[1]

Concepts such as Defense Innovation Unit Experimental (DIUx), *A Strategy for American Innovation* (crowdsourcing), and non-profit forums solicit the population in myriad opportunities. The enlistment of citizen-scientists taps into the talent of secondary

[1] Real Clear Defense, "Efforts to Work Around the Main Acquisition System," https://www.realcleardefense.com/articles/2016/12/15/future_foundry_110492.html (accessed February 17, 2018).

school students, college students, and industry entities not previously contributing to the civil military integration (CMI) support of national enduring interests.

Emerging technology to support urgent operational capabilities necessitates agile methods of procurement. With the split of the responsibilities of the Undersecretary of Defense for Acquisition, Technology, and Logistics (USDAT&L) into the Undersecretary of Defense for Research and Engineering (USDR&E) and the Undersecretary of Defense for Acquisition and Sustainment (USDA&S), the incorporation of procurement and expedited fielding appears on track for February 2018.

Recommendations

The tremendous amount of work accomplished within DoD to streamline procurement suggests that DoD is transforming the methods for fielding emerging technologies in part by segregating development from sustainment. However, addressing several potential changes would create a more focused approach.

First and foremost, the Secretary of Defense must continue to endorse DIUx and must continue to renew the charter for the Defense Innovation Board (DIB) to extend their role well into the future. Partnering with industrial and institutional experts to solve DoD and global challenges ensures strong technical representation of the civilian population. As described in the DIB membership balance plan, DIB should continue to seek the most qualified and diverse members. Additionally, introducing DIB members to the Defense Entrepreneurs Forum (DEF) and In-Q-Tel (as permitted by U.S. Code) might assist in fusing more innovative approaches to other unsolved dilemmas.

Second, DoD must expedite the creation, capabilities, and programmed budget of USDR&E. With the current USDAT&L poised to assume the role of USDA&S, the

preponderance of new organization and collaboration resides in the processes established for USDR&E. Without clear guidance and focused intent, USDR&E may resort back to the rigid and bureaucratic stovepipes created over the past decades. With a fresh start and clear perspective, USDR&E should embrace Other Transaction (OT) authorities, DIUx efficiencies, and urgent service mindsets. USDR&E should establish decision points for graceful transition of programs (when maturity and need dictate) to traditional contracting with USDA&S. Finally, USDR&E should avoid negotiations for rights in technical data while a program is under their purview. Only after the transition to USDA&S should a program be subjected to Federal Acquisition Regulations (FAR) or Defense Federal Acquisition Regulations Supplement (DFARS) requirements.

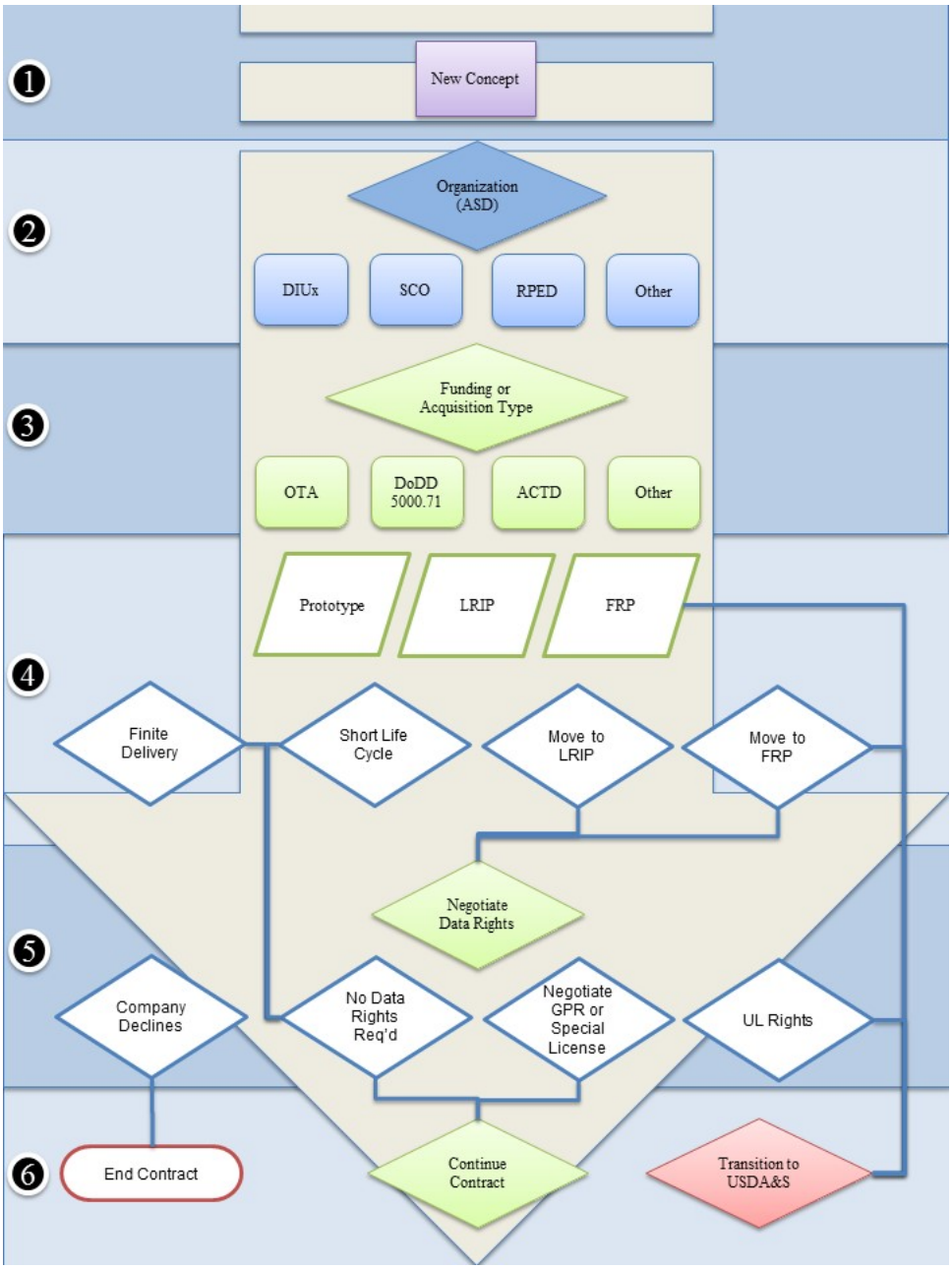

Figure 8: Proposed Concept Process Flow for USDR&E

In Figure 8 proposed above, a new concept or technology flows through the development cycle within USDR&E. After identifying a managing organization, the fielding and lifespan choices assist in determining how to proceed through major milestones. In this proposed chart, negotiating of rights in technical data occurs after decisions to continue production and life cycle, instead of up front. Not all programs will

become permanent fixtures in the military evolution, some will become obsolete or no longer useful. In this case, obtaining rights in technical data does not provide return on investment. If a program moves from low-rate initial production (LRIP) to full-rate production (FRP), it should transition to USDA&S, who will ultimately manage any negotiations for rights in technical data. Adopting an acquisition model for USDR&E similar to the figure above provides incentive for private industry to engage in DoD acquisition with set expectations. The main idea offered in this chart is simplification of the process. While a technology develops in USDR&E, the program remains focused on the progression from concept to fielding only. Once a technology is deemed mature, USDA&S process and requirements apply.

In comparison to Figures 1-3, Figure 8 proposes simple and flexible means to meet the urgent needs required to capture emerging technologies for government use. Figure 1 shows a classic model, constrained by rigid milestones, design reviews, and decision points, in an effort to qualify requirement for a single capability for fielding. Figure 2 offers a hybrid approach, introducing new features throughout the development cycle with similar constraints as Figure 1. Figure 3 improves the delivery process further by focusing primarily on schedule, while accepting additional cost and risk to ensure urgent fielding. All three acquisition strategies provide DoD opportunities, but lack transparency in contracting and intellectual property rights, which ultimately hinder fielding considerations between DoD and private industry. Instead, Figure 8 proposes that no contracting commitments should be made until the technology reaches the appropriate maturity level to advance to formal acquisition and sustainment activities.

Third, with respect to the independent technology-seeking goals of innovation prizes and strategies, the public web interface and implementation plan need much more robust marketing strategies to compete with global challenges. To fully engage, enlist, and employ citizen scientists, students, and defense industry partners, each must be made aware of all open projects. In the past five years, Challenge.gov offered over $250M in prize money for innovations, but there are still many opportunities for interaction with the private sector.[2] Defense agencies need to use these opportunities to recruit researchers, especially outside of military services or DoD agencies. Reaching out to those who may be interested in supporting DoD without a military obligation could potentially improve participation. Using faculty in the science and technology departments at universities to support senior design projects, thesis or dissertation requirements, or graduate work for students and professors, could contribute tremendously to spreading awareness and fulfilling challenges offered by DoD. Campaigning for Challenge.gov must grow and reach interested researchers for better results.

Fourth, defense agencies and USDR&E need to revisit the technical interchange meeting (TIM) requirement for defense contractors to present new IR&D programs. The TIM concept provides a face-to-face or virtual collaboration environment that allows for interaction and coherent discussion. Without requiring TIMs, DoD will not have the same influence or partnership with industry on emerging independent research and development (IR&D) projects. Moreover, defense agencies need to reach out to non-

[2] Challenge.gov, "About Challenge.gov," https://www.challenge.gov/about/ (accessed December 22, 2017).

profit organizations, such as In-Q-Tel and DEF, to socialize their needs with an audience that can offer alternative solutions.

Finally, USDR&E should partner with DIB, private sector communities of interest for research and development, and other organizations such as DEF and In-Q-Tel to facilitate innovative solutions to support the warfighter. Identifying the gaps in fielded capabilities is only the immediate step, collaborating with industry to outsmart adversaries and protecting enduring national security interests must be the long-term focus for USDR&E. Promoting a more revolutionary America COMPETES campaign and institutional engagement through programs such as the Federal Aviation Administration (FAA) grants and the National Science Foundation will inspire and ignite the next generation of innovators.

Although the government and DoD recognize the need for acquisition reform, several opportunities remain. Specifically, DoD must review the process for the future of USDR&E with respect to flexible contracting options to ensure highest value to the warfighter, and most efficient use of limited funding. With many technologies applying to only a precise, time-sensitive need, obtaining technical data packages provides little to no benefit to DoD. Creating a healthy competition for innovation inspires many industries to participate, but a "government takes all" approach stunts growth and creativity if the private sector believes their hard work, innovation, and private funding will result in a loss of intellectual property.[3]

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[3] W. Jay DeVecchio, "Data Rights Assault: What In The H (Clause) Is Going On Here? Air Force Overreaching On OMIT Data," *The Government Contractor*, Vol. 60, No. 2 (January 17, 2018), https://media2.mofo.com/documents/180117-air-force-omit-data.pdf (accessed February 6, 2018).

Acquisition reform benefits DoD, private industry, and the taxpayer by streamlining processes and focusing on regaining the competitive edge with superior technology. DoD must embrace the opportunity to align with leading technology companies by truly separating acquisition and sustainment from research and engineering. Promoting, fostering, and developing greater capabilities within USDR&E by focusing on DIUx, SCO, and DARPA processes and innovations must be the emphasis of the reorganization, without reverting back to the comfortable status quo of traditional acquisition strategies for large defense programs.

The mindset must change within DoD for USDR&E to meet the needs of the warfighter, while simultaneously embracing technology proliferation. As the opportunities for acquisition transformation appear endless, the tendency of the acquisition community to remain tied to traditional processes potentially undermines recent progress. If DoD fails to leverage commercial technologies through innumerable competitions, innovative solutions, and commercial industry leadership best practices, the competitive edge will be lost. Now is the time for leaders at all levels to understand the available paths of acquisition and demand to use the opportunities created with ATL reorganization to meet the needs of the warfighter, the logistician, the diplomat, and those who benefit from the innovations within DoD.

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Appendix A - Acronyms

A2AD	Anti-Access Area Denial
ACAT	Acquisition Categories
ACC-NJ	Army Contracting Command of New Jersey
ACTD	Advanced Concept Technical Demonstration
ADS-B	Automatic Dependent Surveillance-Broadcast
AGL	Above Ground Level
ARPA	Advanced Research Projects Agency
ASD	Assistant Secretary of Defense
ASPA	Armed Services Procurement Act
ASPR	Armed Services Procurement Regulation
ATacMS	Army Tactical Missile System
ATC	Air Traffic Control
ATC	Air Traffic Controllers
AT&L	Acquisition, Technology, and Logistics
BMNT	Begin Morning Nautical Twilight
CDD	Capability Development Document
CDR	Critical Design Review
CFR	Code of Federal Regulations
CMI	Civil Military Integration
COMPETES	Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science
CSIS	Center for Strategic and International Studies

CU	Cruise Missile and Unmanned Aerial Systems
DAA	Detect and Avoid
DARPA	Defense Advanced Research Projects Agency
DAU	Defense Acquisition University
DEF	Defense Entrepreneurs Forum
DFARS	Defense Federal Acquisition Regulation Supplement
DHS	Department of Homeland Security
DIUx	Defense Innovation Unit Experimental
DoD	U.S. Department of Defense
DoDD	Department of Defense Directive
DoDI	Department of Defense Instruction
DOT&E	Director, Operational Test and Evaluation
DTIC	Defense Technical Information Center
FAA	Federal Aviation Administration
FAR	Federal Acquisition Regulation
FCS	Future Combat Systems
FMS	Foreign Military Sales
FOC	Full Operational Capability
FRP	Full Rate Production
FT	Feet
FY	Fiscal Year
GA-ASI	General Atomics Aeronautical Systems, Inc.
GAO	Government Accountability Office

GPS	Global Positioning System
H4Di	Hacking For Defense
IOC	Initial Operating Capability
IOT&E	Initial Operational Test and Evaluation
IR&D	Independent Research and Development
JIEDDO	Joint Improvised Explosive Device Defeat Organization
JIDO	Joint IED Defense Organization
JROC	Joint Requirements Oversight Council
LRIP	Low Rate Initial Production
MDA	Milestone Decision Authority
MDA	Missile Defense Agency
MDAP	Major Defense Acquisition Program
MIL-STD	Military Standard
MQ	Multi-Mission Unmanned (Aircraft Designation)
MRAP	Mine-Resistant Ambush Protected
NAS	National Airspace
NASA	National Aeronautics and Space Administration
NASDAQ	National Association of Securities Dealers Automated Quotations
NAVAIR	Naval Air Systems Command
NDAA	National Defense Authorization Act
NSIAD	National Security and International Affairs Division
OMB	Office of Management and Budget
OSD	Office of the Secretary of Defense

OT	Other Transaction
OTA	Other Transaction Authority / Agreement
PDR	Preliminary Design Review
PEO	Program Executive Office
POM	Program Objective Memorandum
PPBE	Planning, Programming, and Budgeting Execution
PRV	Production Rate Validation
R&D	Research and Development
RADAR	Radio Detection and Ranging
RAISE	Recognizing Aviation & Aerospace Innovation in Science and Engineering
RDT&E	Research, Development, Test, and Evaluation
RFP	Request for Proposal
RPED	Rapid Prototyping Experimentation and Demonstration
RQ	Reconnaissance Unmanned (Aircraft Designation)
SAA	Sense and Avoid
SAR	Synthetic Aperture Radar
SBIR	Small Business Innovation Research
SCO	Strategic Capabilities Office
SOW	Statement of Work
STEM	Science, Technology, Engineering, and Mathematics
TDP	Technical Data Package
TIM	Technical Interchange Meeting

TRL	Technology Readiness Level
UAS	Unmanned Aircraft (or Aerial) System
UAV	Unmanned Aerial Vehicle
UON	Urgent Operational Need
UONS	Urgent Operational Needs Statement
USAF	United States Air Force
USC	United States Code
USD	Undersecretary of Defense
USDA&S	Undersecretary of Defense Acquisition and Sustainment
USDR&E	Undersecretary of Defense Research and Engineering
USMC	United States Marine Corps
USN	United States Navy
USNI	United States Naval Institute

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Appendix C - Glossary

Commercial Computer Software Licenses: "Applies to any commercial computer software or software documentation. Managed as specified in the commercial license offered to the public."[1] Urgent Services Task Order (USTO)

Commercial Technical Data License Rights: "Applies to technical data related to commercial items (developed at private expense). Managed in the same manner as Limited Rights."[2]

Crowdsourcing: "Obtaining needed services, ideas, or content by soliciting contributions from a large group of people and especially from the online community rather than from traditional employees or suppliers."[3]

Disruptive Technology or Disruptive Innovation: "Describes a process by which a product or service initially takes root in simple applications at the bottom of a market—typically by being less expensive and more accessible and then relentlessly moves up market, eventually displacing established competitors."[4]

Government Purpose Rights: "This right involves the right to use, duplicate, or disclose technical data for Government purposes only, and to have or permit others to do so for Government purposes only. Government purposes include competitive procurement, but do not include the right to permit others to use the data for commercial purposes."[5]

Independent Research and Development: "For nearly 80 years, firms have been allowed to recover Independent Research & Development (IR&D) costs as long as these efforts are of potential interest to the Department of Defense (DoD). Independent Research and Development, or IR&D, is R&D initiated and conducted by defense contractors independent of DoD control and without direct DoD funding. IR&D includes: (1) basic research, (2) applied research, (3) development, and (4) systems and other concept formulation studies. IR&D does not include R&D performed under grants or contracts from the Government or third parties and

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[1] Defense Acquisition University, "Data Rights," https://www.dau.mil/acquipedia/Pages/ArticleDetails.aspx?aid=bc8736d5-0c9a-4296-8541-a2e9e120c725 (accessed February 19, 2018).
[2] Defense Acquisition University, "Data Rights," https://www.dau.mil/acquipedia/Pages/ArticleDetails.aspx?aid=bc8736d5-0c9a-4296-8541-a2e9e120c725 (accessed February 19, 2018).
[3] Merriam-Webster, "Crowdsourcing," https://www.merriam-webster.com/dictionary/crowdsourcing (accessed December 31, 2017).
[4] Christensen Institute, "Disruptive Innovation," https://www.christenseninstitute.org/disruptive-innovations/ (accessed February 14, 2018).
[5] Defense Acquisition University, "Data Rights," https://www.dau.mil/acquipedia/Pages/ArticleDetails.aspx?aid=bc8736d5-0c9a-4296-8541-a2e9e120c725 (accessed February 19, 2018).

does not include technical efforts in the support of bid or proposal activities. IR&D is defined under FAR 31.205-18."[6]

Intellectual Property: "(IP) Broadly refers to intangible "creations of the mind" – inventions, literary and artistic works, unique business names and symbols, and so forth. Owners are granted certain exclusive rights to control the use and dissemination of their intellectual properties."[7]

Limited Rights: "A limited rights agreement permits the Government to use proprietary technical data in whole or in part. It also means that the Government has to obtain the expressed permission of the party providing the technical data to release it, or disclose it, outside the Government."[8]Limited Rights typically refer to technical data rights in hardware.

Prototype: "A physical or virtual model used to evaluate the technical or manufacturing feasibility or military utility of a particular technology or process, concept, end item, or system."[9]

Restricted Rights: "Developed exclusively at private expense."[10] Restricted Rights specifically refer to technical data rights in computer software.

Small Business Innovative Research (SBIR) Data Rights: "All technical data or computer software generated under a SBIR contract. Government users cannot release or disclose outside the Government except to Government support contractors."[11]

Specifically Negotiated License Rights: "This right pertains whenever the standard license arrangements are modified to the mutual agreement of the contractor and the Government. In this case, the exact terms are spelled out in a specific license agreement unique to each application."[12]

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[6] Defense Acquisition University, "Independent Research and Development," https://www.dau.mil/acquipedia/Pages/ArticleDetails.aspx?aid=91c3c93b-968b-492f-af08-c1c34f88a0fe (accessed on February 19, 2018).
[7] Defense Acquisition University, "Intellectual Property," https://www.dau.mil/acquipedia/Pages/ArticleDetails.aspx?aid=7bfcfeee-b24b-4fdd-ad7b-046437729519 (accessed February 19, 2018).
[8] Defense Acquisition University, "Data Rights," https://www.dau.mil/acquipedia/Pages/ArticleDetails.aspx?aid=bc8736d5-0c9a-4296-8541-a2e9e120c725 (accessed February 19, 2018).
[9] Defense Advanced Research Projects Agency, "OT Guide," https://www.darpa.mil/attachments/OTGuidePrototypeProjects.pdf (accessed December 30, 2017).
[10] Defense Acquisition University, "Data Rights," https://www.dau.mil/acquipedia/Pages/ArticleDetails.aspx?aid=bc8736d5-0c9a-4296-8541-a2e9e120c725 (accessed February 19, 2018).
[11] Defense Acquisition University, "Data Rights," https://www.dau.mil/acquipedia/Pages/ArticleDetails.aspx?aid=bc8736d5-0c9a-4296-8541-a2e9e120c725 (accessed February 19, 2018).
[12] Defense Acquisition University, "Data Rights," https://www.dau.mil/acquipedia/Pages/ArticleDetails.aspx?aid=bc8736d5-0c9a-4296-8541-a2e9e120c725 (accessed February 19, 2018).

Technical Data: "Technical data are recorded forms of information of a scientific or technical nature pertaining to products sold to the government. Product specifications, engineering drawings, and operating or maintenance manuals are examples of technical data. The term does not include computer software or financial, administrative, cost, pricing or other management data."[13]

Technology Readiness Level: "Technology Readiness Levels (TRL) are a type of measurement system used to assess the maturity level of a particular technology. Each technology project is evaluated against the parameters for each technology level and is then assigned a TRL rating based on the projects progress. There are nine technology readiness levels. TRL 1 is the lowest and TRL 9 is the highest."[14]

Unlimited Rights: "Developed exclusively at Government expense, and certain types of data (e.g., Form, Fit, and Function data [FFF]; Operation, Maintenance, Installation, and Training [OMIT]). These rights involve the right to use, modify, reproduce, display, release, or disclose technical data in whole or in part, in any manner, and for any purpose whatsoever, and to have or authorize others to do so."[15]

Unmanned Aerial Vehicle: An aircraft, typically part of an Unmanned Aircraft System (UAS), which is remotely operated by a pilot or series of operators who are physically on the ground.

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[13] Ibid.
[14] National Aeronautics and Space Administration, "Technology Readiness Level," https://www.nasa.gov/directorates/heo/scan/engineering/technology/txt_accordion1.html (accessed on February 19, 2018).
[15] Defense Acquisition University, "Data Rights," https://www.dau.mil/acquipedia/Pages/ArticleDetails.aspx?aid=bc8736d5-0c9a-4296-8541-a2e9e120c725 (accessed February 19, 2018).

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Appendix D - Vita

Colonel Heather A. Reuter (US Army Reserve) received her commission from the Army ROTC program at Embry-Riddle Aeronautical University. COL Reuter is a multi-functional logistician (90A), with qualifications as a Quartermaster Petroleum and Water Officer (92F) and Marine Terminal Transportation Officer (88C). COL Reuter is currently assigned as the G-7 for a Theater Sustainment Command. COL Reuter has served overseas in Operation Enduring Freedom/Operation Iraqi Freedom, Yama Sakura, Ulchi Freedom Guardian, and Key Resolve. COL Reuter currently serves as the director of engineering for a private aerospace company in her civilian capacity.