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Keeping the Technological Edge

Leveraging Outside Innovation to Sustain the Department of Defense's Technological Advantage

By Andrew P. Hunter and Ryan A. Crotty

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Technology innovation in the Department of Defense (DoD) has delivered unmatched national security capability for the United States for the greater part of the last seven decades. Federal research and development (R&D) funding is the grain of sand at the heart of the U.S. high-technology pearl, delivering that technological superiority. However, the circumstances that underpinned U.S. advantages over that time have eroded, and the rise of new systems and a new global innovation environment challenge DoD's way of doing business. Therefore, while a strong DoD R&D program remains a necessary foundation for maintaining military technological dominance, it is no longer sufficient for ensuring future DoD technology superiority.

DoD R&D leadership remains necessary because there will always be military-unique products that do not draw commercial investment. Perhaps even more crucially, the federal government makes strategic investments in basic science and technology that lay the foundation for developments critical to both defense and commercial technologies. As a result, nearly every major technological advancement today has at its heart a technology made possible by government funding—from the internet to microchips to GPS. However, focusing only on innovation resulting directly from DoD's R&D program is insufficient today due to the rapid expansion of innovation occurring outside the DoD sphere of influence. The innovation discussed in this paper is technological development that, when coupled with the processes, concepts of operations, and implementation necessary in DoD, provides improved and/or cheaper capability for the U.S. military. There is no doubt that the internal R&D engine of DoD must keep revving, but this report explicitly targets the additional exploitation of the proliferating availability of defense-relevant outside innovation.

Globalization and privatization have expanded supply and information networks, bringing technology to new players, while also expanding the part of the global innovation base outside of DoD's direct influence. The growing commercial role in military-relevant technology, and the speed at which that technology is advancing, challenges DoD's capacity to keep up with the flood of technologies both for its own adoption, and to counter the technologies adopted by adversaries. In order to harness cutting-edge technology in a world where innovation is increasingly occurring beyond the scope of government investment, DoD must continue to look beyond traditional industrial and geographic boundaries. Leveraging this outside innovation is a key complement to DoD's R&D program, allowing rapid incorporation of technology that is being developed outside the jurisdiction of government investment and traditional government interfaces (universities and defense contractors), but which has significant military relevance, into DoD systems.

DoD leadership has recognized the technology challenge and is working to respond as exemplified by the outreach initiatives announced in Silicon Valley by Secretary of Defense Ashton Carter, the Defense Innovation Initiative launched by Secretary Chuck Hagel, the third iteration of the Better Buying Power Initiative released by Under Secretary Frank Kendall focused on achieving dominant

capabilities through innovation and technical excellence, as well as complementary initiatives in the military services.

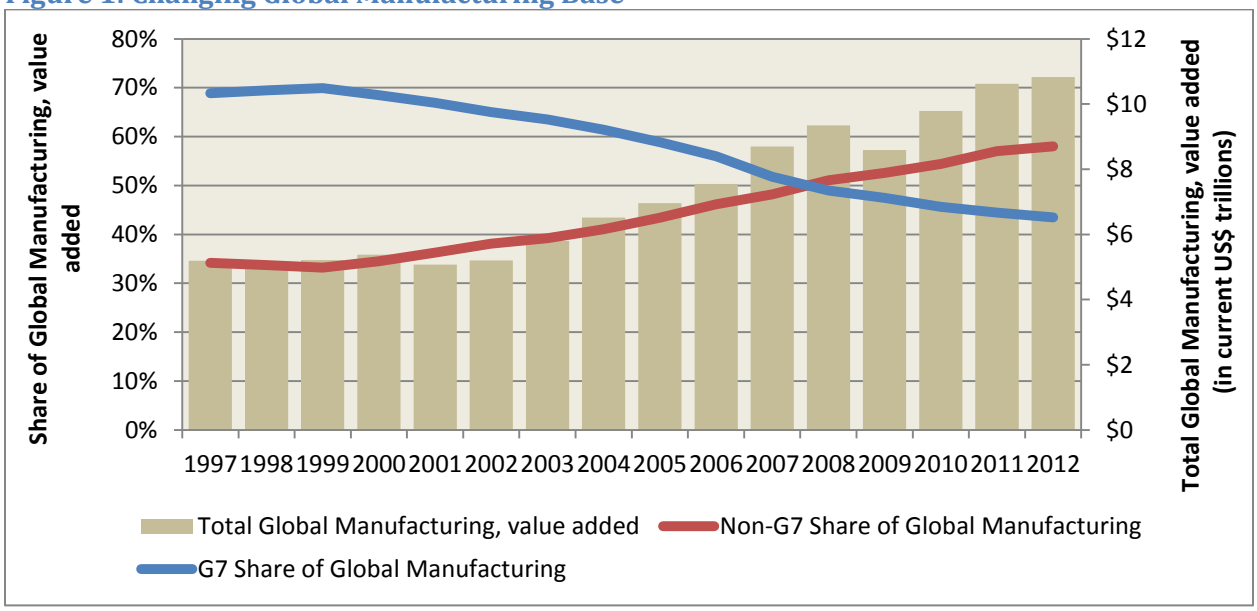
The Imperative for an Outside Innovation Approach

The primary force driving the necessity of an evolution in DoD's perspective on innovation derives not from failures of the Department of Defense to deliver cutting-edge technology for national security, but from the changing global innovation environment in which the Department now operates and competes. This new ecosystem is characterized by the diffusion of technology, lower barriers to entry, and wider access to information. These trends benefit the global economy, but undoubtedly undermine historical advantages that DoD has exploited to maintain technological dominance for much of the last seven decades. While the United States still holds the leading position in military technology innovation, the gap with the rest of the world is shrinking. Four key characteristics of the global innovation environment—globalization, privatization, commercialization, and acceleration—combine to threaten DoD's future technology dominance.

The profusion of global movement and connectivity in products, services, people, and ideas has fueled a global economic environment that has itself underpinned U.S leadership in the world. In the last 30 years, world trade in goods (as measured in imports and exports of all goods and services) has doubled as a share of GDP. Yet, these same factors have driven an erosion of the U.S. lead in two core inputs to innovation: manufacturing and research and development. In the last seven years, the G7 countries were overtaken by the rest of the world in terms of the share of global manufacturing, as shown in Figure 1.[1] As a microcosm of this shift, China also overtook the United States as the largest single manufacturer. Although it lags the manufacturing indicators, the global role in R&D is also growing, as the global innovation base and knowledge expand along with trade flows and technology transfer.

[1] Source: World Bank and Organization for Economic Cooperation and Development (OECD) data; CSIS analysis. Data definition (per World Bank): "Manufacturing refers to industries belonging to ISIC [International Standard Industrial Classification] divisions 15–37. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs."

Figure 1: Changing Global Manufacturing Base



With the rapid expansion of the global innovation base, DoD is increasingly a smaller player, with less influence on, awareness of, and access to the profusion of new technologies. This trend is amplified by the shift from dominance of governments in funding R&D to the private sector. In the 1960s, U.S. federal spending on R&D was double that of the U.S. private sector.[2] Today the private/public role in U.S. R&D has flipped, with almost two-thirds of U.S. R&D funding coming from the business sector.

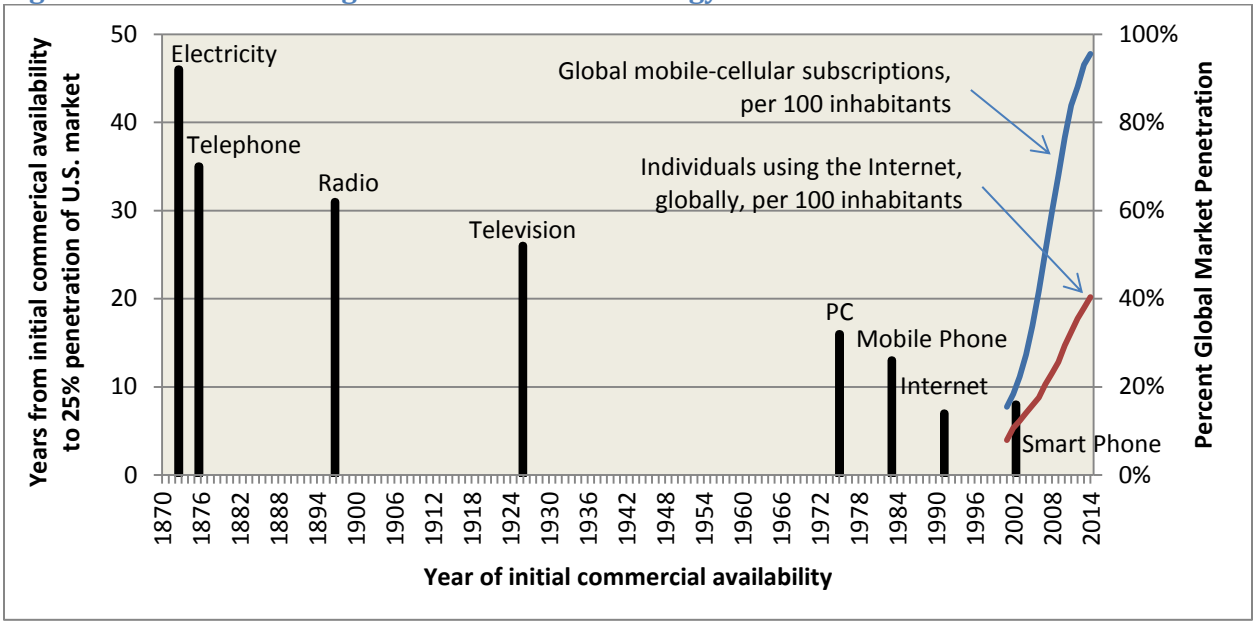
At the same time, the key technologies being developed in the commercial world have greater military significance than possibly any previous period. With the opening up of new domains of warfare, the increasing role of networking and communication, and the development of new concepts of training and operations, new advantages are being found through sensing, big data, simulation, computing, automation, robotics, networking, and communications—all areas where the global commercial market is at the cutting edge of technology. As Al Shaffer, the Pentagon's lead research executive (principal deputy assistant secretary of defense for research and engineering), has made clear, "many technologies of importance to the Department's capability developments are driven by the commercial sector, and have become a global commodity."[3]

Finally, the compression of time and space by the information and transportation technology revolutions, combined with the growing private sector and multiplying loci of innovation have produced an innovation ecosystem where the pace of technology change is accelerating. As the rate of technology change speeds up, it accelerates both the speed at which an organization must adapt to remain in front and the potential competitive response of adversaries' technologies. The speed of technology change and its more commercial nature has markedly decreased the financial

[2] Congressional Budget Office, *R&D and Productivity Growth: A Background Paper* (Washington, DC: Congress of the United States, June 2005), 5, http://www.cbo.gov/sites/default/files/06-17-r-d.pdf.
[3] Alan R. Shaffer, principal deputy assistant secretary of defense for research and engineering, testimony before the Committee on Appropriations, Subcommittee on Defense, U.S. Senate, 113th Congress, May 14, 2014.

investment required to adopt many new innovations, making them more conducive to rapid diffusion.

Figure 2: The Accelerating Penetration of Technology



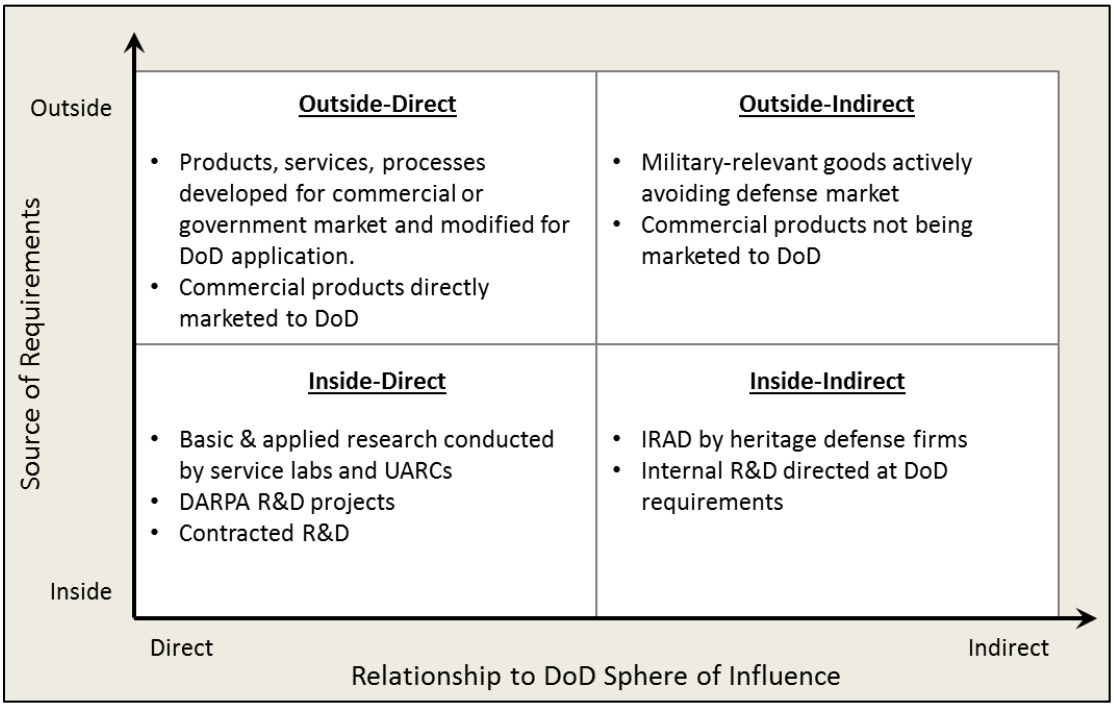
With the speed of technology change today, the long timelines of major defense acquisition programs—which can spend 15 to 20 years in development, and another 50 or more in procurement and in service—can lead to generational gaps in technological components. Figure 2 shows a proxy for this challenge—the speed of penetration of technology into the market. The telephone first became commercially available in the United States in 1875 and took 35 years to penetrate 25 percent of the U.S. market. With each major new technology, this penetration rate has increased. By contrast, mobile phones only took 13 years to go from initial commercial availability to 25 percent adoption in the United States. Looking at the line on the right hand side of the chart, now, after only 32 years, there are 95 mobile phone subscriptions for every 100 people *on the planet*. Near complete global adoption of mobile phones has taken less time than it took for the telephone to gain 25 percent adoption in just the United States.

The Department of Defense is not the first organization to face a world that is changing around it, forcing uncomfortable changes and facing challenging new dynamics. In fact, the challenge driven by this new global innovation environment has caused upheaval and disruption throughout the commercial market over the course of the last two decades. In his seminal book, Henry Chesbrough analyzes the causes and implications of the tectonic shift in the innovation landscape from a system that rewarded *closed innovation*, to a new paradigm that disrupted this system and imposed an environment where *open innovation* thrives.[4] As technology, talent, and capital become more mobile, flexible, and available in the new global innovation environment, the open innovation paradigm is gaining dominance, incentivizing lower barriers between an organization and the global market to better harness the R&D investments occurring outside of the organization.

[4] Henry Chesbrough, *Open Innovation: The New Imperative for Creating and Profiting from Technology* (Cambridge, MA: Harvard Business School Press, 2006).

The Open/Closed Innovation paradigm espoused in the business world is useful for describing defense innovation, but is incomplete. CSIS has expanded this notion with a new taxonomy for categorizing the universe of innovation from a DoD perspective, as pictured in the matrix in Figure 3.

Figure 3: Centers of Innovation Matrix



The matrix of "centers of innovation" frames outside innovation in terms of the universe of defense-relevant innovation. The four "centers" of innovation identified encompass the range of global innovators in reference to 1) their proximity to DoD's existing sphere of influence and 2) the source of requirements driving the innovation. Each of these centers of innovation presents different challenges and maximizing the benefits of each center of innovation requires a different mix of processes.

Inside innovation is where DoD's requirements have driven the creation of the innovation. It is direct work performed under supervision by DoD through the labs, the Defense Advanced Research Projects Agency (DARPA), or by contractors. This innovation is directed predominantly, if not solely, for DoD consumption. It also includes indirect work performed without express direction from DoD, but targeted at DoD requirements. This is the part of the market where DoD really is the dog, and the market is the tail. These baskets of innovation require little effort for DoD to be aware of and stay abreast of developments in, as the Department is the primary target and customer. DoD's requirements, acquisition, and contracting structures are currently optimized to best leverage inside innovation. This is the innovation that has sustained DoD throughout much of the last 70 years. This innovation is not going away—in fact, it remains critical for military-unique requirements—but the global innovation environment is putting significant pressure on these centers of innovation.

It is the innovation coming out of the global innovation ecosystem that is untethered from DoD that provides the biggest challenges and opportunities for the Department today. This outside innovation comes from nontraditional performers outside of DoD's direct sphere of influence. These technologies derive from the perceived requirements, not of DoD, but of the global commercial market. These firms range from Google and Apple to small Indian software designers and Israeli drone-makers. Some may be avidly seeking to sell their solutions in to the defense market, while others may actively avoid the pitfalls of defense procurement, and still others may be unaware of the defense application of their work. It is these centers of innovation that DoD must continue to improve its capability to interact with and access in order to successfully assimilate cutting-edge and/or cost-saving Outside Innovation.

DoD is not ignorant of this challenge, nor is it standing pat. With high-level visibility from both Secretary Carter and Secretary Hagel, new initiatives have sprung up around the Department to address this challenge. In spring of 2015, Secretary of Defense Carter announced the creation of the Defense Innovation Unit Experimental (DIUX), to interface with Silicon Valley and connect to the talent and technology resident there, as well as an investment in the In-Q-Tel venture capital initiative to better harness startups. This is in addition to the numerous existing DoD initiatives in emerging/operational capabilities acquisition, rapid acquisition, and support for small business innovation.[5] The newest iteration of the Better Buying Power initiatives (BBP 3.0) is centered on "achieving dominant capabilities through innovation and technical excellence,"[6] through commercial technology utilization, open architectures, improved outreach, and others. Each of the military services has developed initiatives focused on addressing the challenges of this new innovation environment, including the Air Force's Bending the Cost Curve initiatives, the Army's Rapid Equipping Force, and the Navy's Rapid Innovation Cell. This report seeks to build on that foundation by proposing recommendations to expand and enhance DoD's awareness of and access to outside innovation.

DoD also faces unique circumstances that make the task of penetrating and leveraging this market even more difficult. The scope, timelines, and responsibilities inherent in the wide variety of critical missions facing DoD present serious challenges to rapid innovation. DoD capabilities often face strict standards and complicated logistics and integration challenges. There are also significant statutory and regulatory barriers arising from an acquisition, R&D, testing, requirements, and contracting bureaucracy that was developed to support an innovation model predicated on internal development, monopsony market control, and a captive industry. And yet, it is clear that to continue to drive innovation in the twenty-first century, awareness of and access to outside innovation will only become more important.

Recommendations for Leveraging Outside Innovation in DoD

The new global innovation environment requires an expanded set of tools for improving awareness and gaining access to these technologies. This study explored how to develop processes for DoD to

[5] Including the Rapid Innovation Fund and Small Business Innovation Research (SBIR) program.
[6] Frank Kendall, "Better Buying Power 3.0 White Paper," Washington, DC: Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, September 19, 2014, 2, http://www.acq.osd.mil/fo/docs/Better_Buying_Power_30-091914.pdf.

better identify, set requirements for, fund, and access innovation developed outside traditional pathways and loci of innovation. Through 18 months of interviews with experts, practitioners, and senior officials, as well as workshops and research, the study team developed a set of recommendations divided into proposals that address: 1) encouraging better awareness of outside innovation, and 2) enabling better access to that outside innovation once it has been identified.

Awareness

The globalization and privatization of R&D has resulted in immense diffusion of both science and technology and development activities. Once centered on government-owned labs and government-funded research centers in academia, in a small number of countries, global R&D is proliferating and diffusing, making maintaining awareness of the leading edges of science and technology as well as technological advances in products and software increasingly challenging. As changes in the nature of the global economic system have made advanced technologies and technical know-how widely available, many key technologies are increasingly being developed outside the traditional sphere of defense technology development, but these technologies are increasingly applicable for military purposes. This new environment requires expanded tools for improving awareness of these technologies. The aperture of horizon scanning must be widened, and DoD must maximize existing outreach efforts through information sharing. Competitive technology analysis will increasingly need to take into account publicly available science and technology as adversary states and nonstate actors will find novel uses for commercially available technologies. The first step to leveraging outside innovation is greater awareness of the universe of innovation by increasing the points of connectivity between the Department and the outside innovators.

Recommendations for expanding awareness of outside innovation:

1. While many parts of DoD are highly conversant with the latest advances in technology, this awareness is not universally shared by critical elements of the acquisition, resource, and requirements communities. DoD should create and share a better knowledge base of emerging technologies and processes across the Department.
2. DoD should more extensively utilize efforts to promote operational innovation and support the use of small "demonstration" projects and operational experimentation to identify and incorporate outside innovation in the field. This includes encouraging and supporting more warfighter-innovator collaboration, and expanded use of field testing for quicker evaluations of outside innovations.
3. DoD should expand and connect initiatives at the Office of Secretary of Defense and in the military departments that search for specific technology development from outside innovation.

Access

While awareness is an enabling capability, access is ultimately the goal of these proposed awareness capabilities. Once better awareness is achieved, the goal must be to break down the many barriers (statutory, regulatory/policy, cultural, methodological) that hinder DoD's ability to access outside innovation. The centers of friction that arose in the investigation as inhibitors to access to Outside Innovation can be divided into three categories: requirements, acquisition, and funding. The study team found that DoD's requirements process does not take full advantage of

refining draft requirements to leverage the technological, timeliness, and/or affordability benefits associated with utilizing available outside innovation. Acquisition processes can be rigid and risk-averse, and can make it harder for DoD entities to consider outside innovation. Funding for outside innovation is often difficult to find.

Recommendations for improving access to outside innovation:

1. DoD should develop forcing functions within the warfighter and acquisition communities that identify capability gaps, match available and emerging technologies and concepts with those gaps, and rapidly pull those technologies and concepts into operational use.
2. DoD policy and practice should create and foster requirements flexibility that allows consideration of potential solutions that don't fit existing programs or requirements. This could be enabled by focusing on expanding modularity and use of open systems architectures, which can provide flexibility in approaches to meet specified outcomes.
3. DoD policy should, as part of identifying options to address capability gaps, support consideration of disposability (i.e., planned obsolescence), not updating, as a viable acquisition strategy where circumstances warrant such an approach.
4. DoD must capture and leverage wartime rapid fielding lessons learned, under which DoD has accepted more risk, and accept commercial/civil solutions for operationally essential capabilities and adjusted acquisition incentives to entice commercial and non-U.S. firms.
5. DoD should continue to expand mechanisms for warfighters to fund urgent and emerging operational capability needs, including Joint Urgent Operational Needs/Joint Emerging Operational Needs (JUONs/JEONs) funds, Joint Capabilities Technology Demonstrations (JCTDs), Emerging Capabilities Technology Development (ECTDs), Rapid Innovation Fund, and others.
6. DoD should expand Better Buying Power goals and encouragement of prototypes to include prototypes for proof of concept, validating requirements, defining requirements, and as a basis for experiments and tests.
7. DoD needs to create separate funding (at appropriate levels) for warfighter initiatives. Warfighters in particular need a way to fund innovation without waiting for the Planning, Programming, Budgeting, and Execution (PPBE) cycle to provide money. DoD needs a limited amount of prearranged funds to be available to verify, evaluate, and begin to incorporate outside innovation discoveries.

Ultimately to succeed in leveraging outside innovation, DoD must become a proactive participant in harnessing the power of the market and the "global brain." In order to maximize returns from this proliferating global innovation environment, DoD must organize itself to enhance information flows both in and out, and actively engage. The Department must utilize its existing proprietary networks of scientists and suppliers to grow information pathways, and find new ways to tap into the open networks of problem-solvers and technologists that are growing across the networked globe. These organizing principles must center on the development of institutionalizing and enabling processes that will help optimize for DoD, increasing its awareness of and access to the fount of global innovation.

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