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Reclaiming U.S. Defense Leadership on Innovation: Three Priorities for the New USD(R&E)

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Abstract

Throughout the Cold War and the 1990s, the U.S. military had a significant technological advantage over its adversaries. But this advantage has been steadily eroding over the past two decades. Conversely, America's adversaries have made asymmetric strides in building technological advantages. This is not happening because U.S. investments in defense science and technology have decreased, but because the technology investments outside the defense sector have grown. The fruits of this commercial innovation are available equally to U.S. competitors and adversaries without any significant investment on their part. At the same time, the inability of U.S. defense innovation agencies to absorb and exploit this freely available commercial technology is leading the United States down the path of innovation isolationism. Coupled with the lack of an updated R&D strategy, inefficiencies in the U.S. defense technology pipeline are crippling the technology advantage of the U.S. military. Today, there is no systematic or continuous effort to identify over-the-horizon threats, to identify the missions needed to defeat them, or the cornerstone technologies that will give the U.S. military the decisive technological advantage in conflicts to come. Congress has created a golden opportunity to address this critical gap with the creation of the USD(R&E) and the consequent reorganization of the OSD. The United States must act with urgency to reclaim its leadership in defense innovation and restore America's technological advantage.

Key Points

- U.S. technology advantages have been eroding over the past two decades, while U.S. adversaries have made asymmetric strides in building technological advantages.
- There is no systematic effort to identify future threats, how to defeat them, or technologies to give the U.S. military a decisive advantage.
- Congress has created a golden opportunity to address this critical gap with the creation of the Under Secretary for Defense for Research and Engineering.

The Technology Advantage of the U.S. Military Is Eroding

Throughout the Cold War and the 1990s, during conflicts in the Middle East and elsewhere, the U.S. military operated with a signifi-

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cant technology advantage over its adversaries. This superiority was, for example, deployed with devastating effect during the first Gulf War. Coalition losses in terms of tanks destroyed, prisoners captured, and casualties incurred were roughly a thousand to one—a ratio for which there is virtually no historical precedent.

But the U.S. technological advantage has been steadily eroding over the past two decades. Conversely, America's adversaries have made asymmetric strides in building technological advantages. This is not happening because U.S. investments in defense science and technology have decreased. It is happening because the technology investments outside the defense sector have grown. The ratio of commercial to traditional defense technology innovation has steadily increased over the past two decades, and now commercial innovation dwarfs defense-driven innovation. The fruits of this commercial innovation are available equally to U.S. competitors and adversaries without any significant investment on their part. Advanced microelectronics, information-technology breakthroughs, mobile devices, and commoditized connectivity are the foundations on which America's adversaries are building their technology advantage. At the same time, the inability of U.S. defense innovation agencies to absorb and exploit this freely available commercial technology is leading the United States down the path of innovation isolationism.

Coupled with the lack of an updated defense research and development (R&D) strategy to help focus U.S. investments and rally the U.S. R&D community, inefficiencies in the U.S. defense technology pipeline (where decades can elapse before an innovation finds its way into the hands of the warfighter), are crippling the technology advantage of the U.S. military. The United States must act purposefully and with urgency to reclaim U.S. leadership in defense innovation and restore America's technological advantage.

Congress Has Set the Stage for Action

The stage is set for acting decisively to regain and safeguard the defense technology advantage by building on the reform of the technology leadership function in the Department of Defense as mandated by Congress. The National Defense Authorization Act (NDAA) of 2017 disestablished the Under Secretary of Defense for Acquisition, Technology and Logistics, dividing the duties between a new Under Secretary of Defense for Research & Engineering (USD(R&E)) and the renamed Under Secretary Under Secretary of Defense for Acquisition and Sustainment. The NDAA defined the primary mission of the new USD(R&E) as the restoration, elevation, and enhancement of defense technology innovation. To enable the USD(R&E) to focus on the innovation mission, the NDAA also created a new Under Secretary of Defense for Acquisition and Sustainment (USD(A&S)), focused on setting defense-wide acquisition and industrial policy and delivering weapons and national security technology. This is the single most important reorganization of the Office of the Secretary of Defense since the landmark Goldwater–Nichols act in 1986, and it must not be squandered.

The way that the Department of Defense chooses to pursue the USD(R&E) innovation mission will have far-reaching consequences for the technological superiority of the country's military forces. The incoming USD(R&E) must take immediate steps to formulate a national security R&D strategy that has been updated to reflect this Administration's priorities and assessments, to create an efficient and responsive technology innovation pipeline to implement the strategy, to align innovation with acquisition to ensure that the latter does not choke the former, and to ensure that the U.S. harvests innovation from commercial sources in support of the technological advantage of the military. In doing so, the Secretary of Defense and the USD(R&E) will be well advised to adopt current commercial technology business principles and practices.

Priority 1: A Defense Research & Development Strategy

Absent a defense R&D strategy, it is impossible for the Defense Department to focus and prioritize its technology investments. Conversely, when the department had a clearly articulated overarching technology strategy in the 1950s and the late 1970s, U.S. investments translated to dramatic and lasting superiority. The return on those investments has been evident in the dramatic improvements demonstrated from one campaign to the next. While these R&D strategies of the past served the country well, the U.S. now lacks a clearly articulated and crisply prioritized vision to bring clarity and focus to defense R&D. So, despite significant investments,

the U.S. technological advantage has been steadily eroding.[1]

What Constitutes an R&D Strategy? What is a *strategy*? An R&D strategy in the broad sense entails a rational determination of interests in technology alongside the principles that define the U.S. in relation to U.S. adversaries and U.S. objectives. Strategy in the narrow sense entails planning the use of resources and the deployment of capabilities to achieve objectives and prevail over adversaries.[2] Strategy in the broad sense comes first and is directional. Strategy in the narrow sense comes second and supports the implementation of the direction. The incoming USD(R&E) needs to develop and shepherd both aspects of the defense R&D strategy.

A directional defense R&D strategy requires a clearly stated, overarching goal for America's technology advantage (force multiplication, for example) alongside a *focused set* of technology cornerstones (such as stealth, sensors, and precision guidance, for example). In other words, compiling a list of current technology investments *does not* constitute a strategy. To arrive at the strategic essence, one must consider the threats that will need to be countered over the time horizon of the strategy, the missions needed to defeat these threats, the capabilities needed to fight these missions, the technologies needed to build these capabilities, and finally, the ways of achieving and protecting the technology advantage in these areas. One must also consider factors outside the defense enterprise, such as commercial and consumer technology vectors that are evolving alongside the defense mission but could nonetheless give rise to significant military technology advantage to the U.S. or its adversaries.

The Defense Department began addressing the R&D strategy gap with the Third Offset Strategy work, which culminated in the Long Range Research and Development Plan (LRRDP). It remains a work in progress. While there has been a clear articulation of the objectives of the defense policy under the Obama Administration, namely strong nuclear and conventional deterrence, this has not been matched with an equally crisply stated objective of the U.S. technology advantage. Is it still force multiplication or is it something else? The LRRDP exercise chose technologies vs. desired outcomes as its points of departure. The LRRDP working groups assembled and sought to prioritize some of hundreds of technologies in the space, undersea, air, and missile defense domains. But such prioritization is impossible without a clearly stated desired technological advantage to act as a reference point. As the Trump Administration begins formulating its own overarching defense policy objectives, the incoming USD(R&E) ought to revisit and define the technology advantage needed to support those objectives, drive the identification of the cornerstone technologies, and rally the defense R&D community to deliver them.

What Makes a 21st-Century R&D Strategy? An effective R&D strategy uses technology to give U.S. forces the decisive advantage. Technology is still clearly at the heart of the U.S. military capability. The range of missions the U.S. military are called upon to perform, however, has changed. Today, the United States is faced with a changed threat environment where the classic confrontation of armored forces has been replaced by a vast spectrum of threats—from failed states waging "small wars," to asymmetric threats, possibly with WMDs, to classical adversaries who can fight major theater wars, such as Russia, China, North Korea, and Iran. What has also changed is that much of the technology that the U.S. could effectively deny its opponents in the 1970s is now freely available to them either via the Internet or in a globalized technology market fueled by commercialization.

The R&D strategy of the 1970s was about conferring unprecedented force multiplication advantage to the military. If the strategy were being invented today, would it still be about force multiplication? Would it still be about the number advantage? There is widespread evidence[3] that more boots on the ground in Iraq early on in the war would have reduced casualties and accelerated counterinsurgency operations. So, force multiplication would still be very much relevant as a goal of the R&D strategy. But it may not be the only one. Can the U.S. win a war in a single year that otherwise might take 30 years to win? When the Royal Hampshires, Victoria Cole-

1. Robert O. Work, remarks by Deputy Secretary of Defense on Third R&D Strategy, Brussels, Belgium, 2016.
2. Robert A. Burgelman, *Strategy is Destiny: How Strategy-Making Shapes a Company's Future* (New York: Free Press, 2002).
3. James Dobbins et al., *America's Role in Nation-Building: From Germany to Iraq* (Santa Monica, CA: RAND Corporation, 2005).

man's late father-in-law's regiment, left Portsmouth, England, in 1918 to deploy to present-day Afghanistan, Pakistan, and India to fight their own nation-building and counterinsurgency war, they did not return home for 20 years. Are Americans willing to support deployments like that today? Maybe the 21st-century defense R&D strategy should be as much about *time compression* as it is about force multiplication.

Needed: An Adaptive R&D Strategy. Having determined the goals of the renewed R&D strategy, the next question is: What are its cornerstone technologies for conferring either the number or the time offset advantage? In the 1970s it was the holy trinity of stealth, sensors, and precision guidance. What would the holy trinity be today? One may posit cyber, autonomy, hypersonics, long-distance strike, and the list goes on. The truth is that *nobody* knows. In the past two decades, the U.S. has been too preoccupied with fighting today's wars to reflect on the key technologies that can deliver the decisive advantage for tomorrow's conflicts. Much effort is focused on finding solutions to today's problems, such as countering drones or electronic warfare tactics, as in the Ukraine. These are the issues that the U.S. military should have confronted a decade ago. And, because the U.S. is still not thinking about tomorrow's conflicts, the military will predictably lack these key technologies when it needs them the most. As any good Chief Technology Officer will explain, to create disruptive innovation of the kind that the R&D strategy of the 1970s was built on, one must start early. For those who wait until the need is obvious, it will be too late, and the company will go out of business. Worse, the military will lose the war.

So the U.S. must reshape its defense R&D strategy so that it continues providing technological superiority in today's spectrum of conflicts. The U.S. must nurture the strategy so that it can adapt in response to future threats and technologies. Threats will continue to evolve, markets will continue to globalize, and technologies will continue being commercialized—so the R&D strategy must continue to evolve right alongside them. This cannot be a one-shot deal. The U.S. cannot figure it out for the current threat environment, or the emerging one as it appears today, and then rest on its laurels. The R&D strategy must be assessed and adapted in a continuous life cycle. How can this be done? First, the U.S. military leadership must identify emerging and over-the-horizon threats. Second, military leadership must consider in which ways adversaries will engage the U.S., and how the U.S. will engage them. Third, we need to identify, build, and protect the cornerstone technologies. These are the questions that must be answered as we begin to assemble an adaptive R&D strategy framework.

Recommendation. The USD(R&E) must immediately convene a task force consisting of scientists and engineers as well as military experts, analysts, and policy strategists to quickly review the existing LRRDP and adapt it to current priorities and needs, producing a strategy the Administration can call its "own," alongside a framework and process for its continued evolution. The new USD(R&E) organization must provide for the continuous evaluation and adaptation of the defense R&D strategy by creating an Assistant Secretary of Defense charged with the task.

Priority 2: Build an Efficient & Responsive Defense Technology Pipeline

Required: Start Before It Is Necessary, and Keep at It. Core technologies take a long time to conceptualize, develop, and mature. Even well-understood technologies can take anywhere from five years to 15 years to mature (if one is lucky and does not hit dead ends). It is the nature of research to fail more times than it succeeds. Once one identifies the core technology themes of the new R&D strategy, one must pursue them with energy, with passion, and with patience. Short-termism has been the scourge of core military R&D programs, and it has cost the military dearly. Speech and natural language recognition and processing are two examples. In the late 1990s, the Defense Advanced Research Projects Agency (DARPA) decided that the research area had been exhausted and dropped all funding for it. The assumption was that industry would do the rest. Sure enough, industry did develop excellent speech-recognition systems so that people could conduct stock trades at Charles Schwab. Industry did not, however, develop the capability to rapidly build speech recognition and translation capabilities for exotic languages, such as Pashto or Farsi. Why would it? In the wake of 9/11, DARPA had to scramble to restart language research. In the meantime, valuable time was lost and U.S. troops were deployed in the war theater without the necessary technology to help them in the critical mission of

stabilization and reconstruction. In an even more striking case, in the 1970s, DARPA dropped counterinsurgency research, which had been stimulated by military interests during the Vietnam conflict. Post-9/11, the U.S. military had to scramble to figure out which technologies it could deploy to counter the insurgency in Iraq. As Clayton Christensen and Michael Raynor exhort senior executives in the sequel to the seminal *Innovator's Dilemma*, step 1 in creating disruptive growth is to "Start before you need to."[4]

Aligning Innovation with Acquisition Is Essential. Identifying the cornerstone technologies for the next R&D strategy is just the beginning. The world is full of good ideas. But the idea accounts for, at most, 10 percent. The remaining 90 percent is execution, and it differentiates those who win from those who get swept away. Taking an idea from concept to deployment is a fiercely challenging process that requires *unrelenting focus*, *exquisite execution*, and *precise alignment* throughout the organization.

One might imagine a company that has built its business on selling hardware components. One day, the company decides to diversify in an adjacent, but more profitable, software services business. A senior executive must be named who will be accountable for the success or failure of the initiative to move into services. This champion should be empowered to create the business vision and execute it within agreed parameters with the senior leadership (up to and including the Secretary of Defense in the case of the military). He or she must be, in the phrase of Steve Jobs, the "directly responsible individual" (DRI)[5] who succeeds or fails alongside the initiative. Without this kind of high-level support and focus, virtually all innovation initiatives will eventually fail.

Now, with the help of the DRI, the engineering department—which has so far been building hardware components—retools with software experts to build the new service products. Assembling a workforce with the right mix of skills is only the first challenge. Ensuring that they are enabled by a tool chain that supports software instead of hardware development is next. Acquiring the necessary experience to build software products cost-effectively and with accuracy and speed is not easy as the imaginary company will soon discover. Execution is paramount.

The engineering department might very well succeed in building the new software products, but the sales force will still only know how to sell hardware components. They will lack the contacts and the expertise to sell the new products. Unless they are retrained, the innovation might as well not have happened. Innovation needs to be executable by the entire organization.

These hypothetical examples are not at all far from the challenges faced by the Defense Department. Software acquisition is an example. Commercial software is developed using agile[6] methodologies and lean start-up principles,[7] while the Defense Department still often attempts to acquire software using outdated waterfall methods. The military may be able to develop defense systems software in an agile way, but unless it can also buy it in agile fashion, it will be imposing ineffective development practices on the vendor community. There is a lesson here for the new USD(R&E) and his or her USD(A&S) counterpart: Innovation without alignment with acquisition defeats the purpose. It may create interesting artifacts but will not translate into tangible technology advantage for the warfighter.

Recommendation. The USD(R&E) must work in unison with the USD(A&S) to create and maintain an efficient and responsive innovation pipeline all the way from ideation to deployment. They must do so by internalizing and learning from best commercial practices.

Priority 3: Embrace Open Innovation

In the decades after the Sputnik experiment in the 1950s, and right up to the Cold War, technology innovation was driven by defense investments, and priorities were executed by a broad and vibrant

4. Clayton M. Christensen and Michael E. Raynor, "The Role of Senior Executives," in *The Innovator's Solution: Creating and Sustaining Successful Growth* (Cambridge, MA: Harvard Business School Press, 2003), chapter 10.
5. Adam Lashinsky, "How Apple Works: Inside the World's Biggest Startup," *Fortune*, May 9, 2011.
6. Kent Beck et al., *Manifesto for Agile Software Development*, Agile Alliance, 2001.
7. Eric Ries, *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses* (New York: Crown Business, 2011).

defense R&D industry. With the end of the Cold War, as the U.S. started drawing on the peace dividend and U.S. defense investments began to shrink, commercial technology innovation and globalization took over. Often fueled by Defense Department investments, such as the Arpanet and microelectronics, information technology companies like Intel, Microsoft, IBM, Hewlett-Packard, and others begun to dominate the technology landscape that defined the ecosystem from where the Defense Department drew many core technologies essential to its mission.

In the past 15 years or so, as these technologies spread beyond enterprise uses, the world witnessed the ascendancy of consumer technology. The technology landscape today is not defined by the traditional powerhouses of the 1980s and 1990s, but by companies that bring these technologies to consumers. A phone maker—Apple—who put a computer in everyone's pocket; a retailer—Amazon—who invented cloud computing; an advertising company—Google—that made searching the Web child's play; and a company that acts as a personal address book—Facebook—that built social media as we know it. Armed with commercial satellite imagery, GPS, and a Facebook account, an adversary can track highly sensitive military operations not only with accuracy, but also with zero technology investment.

The companies that came to define the technology context within which the military has to defend the nation today all hail from the West Coast, as do many other disruptors, such as Uber, Tesla, and SpaceX. It is no wonder then that Silicon Valley is teeming with company outposts from all over the world. Consumer electronics giants, silicon manufacturers, aircraft manufacturers, and automakers are all there, and with sales offices and R&D centers, Open Innovation Centers abound. Their purpose: to gain visibility into talent and technologies they can acquire to further their interests. Open innovation is about building a presence in and bridges with innovation hubs, such as Silicon Valley and the Boston Corridor. Incomprehensibly, the Defense Research Enterprise (consisting loosely of DARPA and the defense laboratories) is mostly absent from these hotspots. The cost to their mission in support of the warfighter is serious and material. While efforts at innovation, such as the Defense Innovation Unit Experimental (DIUx), are building links with some non-traditional defense vendors, they are, as their name denotes, merely experiments. These proof-of-concept efforts do not scale, they mask the extent of the disconnect between the defense and commercial technology sectors, and leave the bulk of the Defense R&D enterprise untouched. The innovation muscle of the Defense Department lies in the defense vendor base—the defense laboratories, DARPA, and the various other defense R&D agencies.

The lack of a physical, substantial, and enduring presence of DARPA and the laboratories in Silicon Valley and the other national innovation hotspots means that they are not able to act as the eyes and ears of the Defense Department when it comes to emerging technologies and talent in these areas. It also sends a message to the defense vendor community that harvesting commercial innovation on behalf of the department is a good-to-have vs. an essential core competency. The consequence is a chronic isolation of the defense technology establishment from the very commercial innovation that U.S. competitors and adversaries exploit to build asymmetric technology advantage against this country.

It does not have to be this way. The Army Research Laboratory (ARL) Open Campus initiative is a commendable example of open innovation that can serve as a role model to the broader defense research enterprise. Open Campus is a collaborative endeavor, with the goal of building an R&D ecosystem to encourage groundbreaking advances in basic and applied research in areas of relevance to the Army. Through the Open Campus framework, ARL scientists and engineers work collaboratively and side by side with visiting scientists in the lab facilities, and as visiting researchers at collaborators' institutions. Central to the research collaborations is mutual scientific interest and investment by all partners.

The global academic community, industry, small businesses, and other government laboratories benefit from this engagement through collaboration with the ARL's specialized research staff and unique technical facilities. The collaborations build research networks, explore complex and singular problems, and enable self-forming expertise-driven team building. These collaborative efforts are well-positioned for competitive research opportunities and expose scientists and engineers, including professors and students, to realistic research applications and perspectives. Initiatives such as the Open Campus initiative are critical for ensuring the timely acquisition of emerging technology and talent out-

side the pool of traditional defense contractors for the benefit of the warfighter.

Recommendation. In embracing Open Innovation, the USD(R&E) should act expeditiously to ensure that DARPA and the defense laboratories establish a robust presence in the nation's innovation hubs, including hiring and placing researchers and engineers locally to take advantage of the technology-transition opportunities as well as local talent pools.

The United States Must Act with Urgency and Focus

Today, there is no systematic or continuous effort to identify over-the-horizon threats, to identify the missions needed to defeat them, or the cornerstone technologies that will give the U.S. military the decisive technological advantage in conflicts to come. Congress has created a golden opportunity to address this critical gap with the creation of the USD(R&E) and the consequent reorganization of the Office of the Secretary of Defense (OSD). Secretary Jim Mattis must act with urgency and with focus to establish the context within which the defense R&D strategy can be reprised and executed. In doing so, he must ensure that the two new Under Secretaries work collaboratively to establish a responsive and efficient technology pipeline that translates ideas to actionable technology advantage for the warfighter, and does so with speed, efficiency, and quality. Open innovation is at the heart of the ability to absorb and internalize technology advances outside the defense industrial base. Secretary Mattis must act with haste to establish a meaningful and robust presence of the Defense Research Enterprise, including DARPA and the Defense Department laboratories in the national innovation hubs, starting with the Silicon Valley.

Finally, he must ensure that he sets out the goals for the new OSD technology organization as envisioned by Congress, and tailor the organizational structure to maximize the ability to deliver on these goals. Neglecting to do so runs a great risk of creating an inferior technology product that reflects the organizational structure of OSD vs. an OSD organizational structure that is optimized to deliver a good-quality product to the warfighter.

Recommendations.

- **The USD(R&E) must immediately convene a task force** consisting of scientists and engineers as well as military experts, analysts, and policy strategists to quickly review the existing LRRDP and adapt it to current priorities and needs alongside a framework and process for its continued evolution.

- **The USD(R&E) must work in unison with the USD(A&S) to create and maintain an efficient and responsive innovation pipeline** all the way from ideation to deployment. They must do so by internalizing and learning from best commercial practices.

- **The USD(R&E) should act expeditiously to ensure that DARPA and the Defense Department labs establish a robust presence in the nation's innovation hubs**, including hiring and placing researchers and engineers locally to take advantage of the technology-transition opportunities as well as local talent pools.

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