Statement of the Coalition for National Security Research (CNSR)
Prepared for the Subcommittee on Defense, Committee on Appropriations, U.S. Senate
Defense Basic Research and Science & Technology (S&T) Funding for Fiscal Year 2019

Chairman Shelby, Ranking Member Durbin, and distinguished Members of the subcommittee, thank you for the opportunity to submit outside witness testimony as you begin to craft the fiscal year (FY) 2019 Defense Appropriations bill. The Coalition for National Security Research (CNSR) offers the following recommendations for funding levels for the Defense Science & Technology (S&T) program and select program elements (PEs) that support innovations to ensure U.S. military technical superiority now and in the future.

CNSR is a broad-based alliance of more than 90 organizations including industry, academia, research institutes, scientific and professional organizations, and non-profits committed to a strong Defense S&T enterprise. In FY 2016, coalition members performed more than $5.2 billion in U.S. Department of Defense (DOD)-sponsored scientific research to create new technologies and capabilities for the U.S. military to counter emerging and future threats.

CNSR members provided critical research to enable military capabilities such as unmanned underwater vehicles; countermeasure anti-torpedo technologies; and magnetic sensors for detecting improvised explosive devices (IEDs); developed the mathematical theories that enabled the design of the F-35 stealth fighters; and significantly reduced costs for smart bomb technology that was incorporated into the Tomahawk cruise missile system. With support from the Defense S&T program, our members are working to develop next generation military technologies in areas such as advanced unmanned aerial vehicle maneuvering; high-energy, solid-state lasers capable of stopping rocket attacks; improved composite materials for blast protection; un-hackable computers; metamaterials to mimic cloaking; material stability at hypersonic speeds; and quantum communications, among many other areas of importance to DOD.

It is well known that industry is a vital partner for DOD as it relates to technology development. What is not as well-known is the importance of academia and non-profits in advancing DOD's technological capabilities. According to the National Science Foundation, nearly one in every three dollars DOD awards for scientific research is awarded to colleges, universities and non-profits.[1] DOD awards this large amount of funding because it has determined that the research performed by these institutions will help advance the Department's technology needs. Basic research is the type of scientific research that leads to transformational discoveries that serve as the foundation for new military capabilities. More than 57 percent of DOD-sponsored basic research is conducted by colleges, universities and non-profits, demonstrating the critical role these organizations play in performing the underlying scientific research where new military capabilities truly originate.[2]

The National Security Strategy and National Defense Strategy acknowledge that our competitive military advantage in air, land, sea, space and cyberspace has eroded. Recent Congressional testimony from DOD leaders revealed that in some cases our near-peer competitors are matching

[1] https://ncsesdata.nsf.gov/fedfunds/2015/
[2] Ibid

or exceeding our nation in game-changing capabilities.[3] It is clear that we need to take steps to address immediate threats but we should not do so at the expense of the scientific research that underpins many of the military technologies deployed today. The Defense S&T program strikes the appropriate balance of long-term basic research and short-term applied scientific research to generate disruptive advances in technology capabilities. It is vital to our national security that the United States maintains its technical superiority – investing in the Defense S&T program now will help address short and long-term challenges facing the military.

Our FY 2019 funding recommendations stem from *Innovation: An American Imperative* (Innovation Imperative), a statement signed by the CEOs of Northrop Grumman, Lockheed Martin, Boeing, and Microsoft, and endorsed by over 500 other leading organizations from industry, academia, and science and engineering. Specifically, the Innovation Imperative urges Congress to provide steady and sustained growth in funding of at least four percent for basic scientific research at numerous federal agencies, including DOD. We believe the Innovation Imperative is consistent with the National Defense Strategy's objective of establishing an unmatched twenty-first century national security innovation base. Defense S&T including basic research enables the discovery of new military capabilities utilized by the national security innovation base to provide unmatched technological superiority for the military.

Defense Basic Research PE Recommendations

The National Defense Strategy states, "We cannot expect success fighting tomorrow's conflicts with yesterday's weapons or equipment." For decades, the defense basic research programs have provided the scientific breakthroughs to give the warfighter the weapons and equipment needed to succeed in conflicts. Stealth technology, night vision, near-real-time delivery of battlefield information, GPS, communication and weather satellites, laser technology, nuclear propulsion, counter stealth technology, and precision munitions all derive from defense basic research. These capabilities have helped ensure our national security for decades. If we are to continue to succeed in future conflicts, we cannot underinvest in the long-term basic research that will provide the military with the new transformational capabilities needed to assure technical dominance over adversaries. Defense basic research is currently exploring future military capabilities in areas such as quantum materials, biologically-enhanced sensing and computing, autonomous reasoning, and adaptive materials among many other areas of interest to DOD.

The FY 2019 budget request falls $1.2 billion short of the recommended funding levels from the National Academies of Sciences, Engineering and Medicine for defense basic research.[4] If enacted, the FY 2019 budget would result in a 3.2 percent or more than $73.9 million cut in defense basic research compared to FY 2018 enacted levels. We are concerned cuts of this magnitude would harm technological developments critical to maintaining our military superiority across air, land, sea, space, and cyber.

In addition, we are concerned that the FY 2019 budget does little to address the large number of unfunded proposals, due to budget limitations, under the Multidisciplinary University Research

[3] https://armedservices.house.gov/hearings/review-and-assessment-fiscal-year-2019-budget-request-department-defense
[4] https://www.nap.edu/catalog/11463/rising-above-the-gathering-storm-energizing-and-employing-america-for

Initiatives (MURI) program. Since FY 2014, on average, only 23 MURI proposals are funded. As a result, each year, on average, more than 60 MURI proposals are not funded. MURI sponsored university research has regularly produced revolutionary new military technologies. Nanotechnology, foundations for military drones, biological detection capabilities for anthrax, handheld and robotic systems for explosive detection, material foundations for military armor including force protection for tactical vehicles, and sensors able to detect stealth aircraft and unmanned aerial vehicles all stem from MURI sponsored scientific research. Given all the global challenges facing the military, we strongly believe we should be investing additional resources into the MURI program. ***As a result, we respectfully request that you increase each Services University Research Initiatives program element and require that the additional dollars be used to support the MURI program.*** We request that these increases not come at the expense of the other initiatives funded under this program element. We encourage you to direct DOD to maintain and grow funding for the MURI program in the Future Years Defense Program (FYDP).

Furthermore, we would like to highlight CNSR's strong support for the Defense University Research Instrumentation Program (DURIP), each Service's Young Investigator Programs (YIP), Vannevar Bush Faculty (VBF) Fellowships, Minerva Research Initiative, and National Defense Science & Engineering Graduate (NDSEG) Fellowships. Each of these programs plays a role in supporting the DOD innovation ecosystem. DURIP helps ensure universities have state of the art equipment needed to continue cutting edge defense research of importance to DOD. YIPs, VBF, and Minerva provide vital support to investigators to conduct the type of scientific research that overcomes complicated challenges facing the military and develops a cadre of scientists who understand national security problem sets. NDSEG supports opportunities to train the next generation scientific workforce DOD needs to support the national security innovation base.

Finally, CNSR has a variety of concerns related to the FY 2019 budget request for the Basic Research Initiatives PE (DW 601110D8Z) and National Defense Education Program PE (DW 601120D8Z). It appears in FY 2019 that DOD did not request resources to support the Proof of Concept Commercialization Pilot Program Innovation Corps @ Department of Defense (I Corps @ DoD) and the Defense Enterprise Scientific Initiative (DESI), which are funded under the Basic Research Initiatives PE, and the Manufacturing Engineering Education Program (MEEP), which is funded within the National Defense Education Program PE. Both the I Corps @ DoD and DESI initiatives are innovative approaches by DOD to help speed the transition from research to new military capability either through commercialization activities or university-industry collaborations. At a time when the focus is to transition scientific research to a deployable capability, it seems counterproductive not to fund these important initiatives. Moreover, the purpose of the MEEP is to provide support to better position the current and next-generation manufacturing workforce to produce military systems and components that assure technological superiority for DOD. The ability of the national security innovation base to support DOD will largely depend on the quality of the workforce. MEEP seeks to ensure that we have the highest quality workforce. ***We urge Congress to continue to support the I Corps @ DoD, DESI and MEEP initiatives.***

We offer the following recommendations for the key defense basic research PEs that create game-changing military capabilities:

PE Number	Agency/Account	Program Element (PE) *($ in Thousands)*	FY18 Enacted	FY19 PBR	FY19 CNSR Request
601102A	Army RDT&E	Defense Research Sciences	$273,590	$276,912	$287,988
601103A	Army RDT&E	University Research Initiatives	$77,027	$65,283	$80,108
601104A	Army RDT&E	University and Industry Research Centers	$107,395	$92,115	$111,691
601103N	Navy RDT&E	University Research Initiatives	$144,130	$119,433	$149,895
601153N	Navy RDT&E	Defense Research Sciences	$458,333	$458,708	$477,056
601102F	Air Force RDT&E	Defense Research Sciences	$342,919	$348,322	$362,255
601103F	Air Force RDT&E	University Research Initiatives	$162,923	$154,991	$169,440
601108F	Air Force RDT&E	High Energy Laser Research Initiatives	$14,417	$14,506	$15,086
6010000BR	Defense-Wide RDT&E	DTRA Basic Research Initiatives	$37,201	$37,023	$38,689
601110D8Z	Defense-Wide RDT&E	Basic Research Initiatives	$40,612	$42,702	$44,410
601120D8Z	Defense-Wide RDT&E	National Defense Education Program	$103,298	$85,919	$107,430

Defense Applied Research PE Recommendations

Fundamental scientific research is just the first step in creating new military technologies. Researchers and scientists must apply the fundamental knowledge learned from basic research in order to solve military problems and develop the systems and components for potential solutions. Even at this stage of innovation, the private sector is unable to assume the risk of applying fundamental knowledge to field the military technologies of tomorrow, which is why supporting funding for defense applied research is so vital to developing new military capabilities.

We would like to highlight the success of the Defense-Wide Manufacturing Science and Technology PE. This PE provides resources for DOD's contribution to the Manufacturing USA Network. The public-private partnerships established through the Network are helping move discoveries in the nation's universities and research laboratories to the defense industrial base, and focusing resources on developing the skilled workforce required to support a revitalized and modern U.S. manufacturing sector. For example, Manufacturing USA is creating technologies and solutions for reducing production time for certain types of metal powder additive manufacturing, developing innovative modeling and simulation software to reduce the cost and weight of additive manufactured structural parts, and creating methods to reduce setup time for machining large casting. Furthermore, Manufacturing USA initiatives are improving various manufacturing technologies and methods to domestically manufacture the world's most respected and capable weapons, such as the F-35 fighter jet, the M1-A2 tank, and the Ohio Class submarine, while also securing our economic prosperity. The National Security Strategy says, "Support for a vibrant domestic manufacturing sector, a solid defense industrial base, and resilient supply chains is a national priority." Manufacturing USA is an example of a program consistent with the National Security Strategy in supporting domestic manufacturing and the defense industrial base.

In order to ensure that discoveries made through fundamental research are translated into practical military applications, we offer the following recommendations for our priority applied research PEs:

PE Number	Agency/Account	Program Element (PE) *($ in Thousands)*	FY18 Enacted	FY19 PBR	FY19 CNSR Request
602105A	Army RDT&E	Materials Technology	$81,640	$28,600	General Support
602120A	Army RDT&E	Sensors and Electronic Survivability	$81,230	$32,366	General Support
602307A	Army RDT&E	Advanced Weapons Technology	$37,785	$29,502	General Support
602308A	Army RDT&E	Advanced Concepts and Simulation	$28,650	$28,500	General Support
602716A	Army RDT&E	Human Factors Engineering Technology	$24,127	$24,131	General Support
602783A	Army RDT&E	Computer and Software Technology	$14,041	$14,958	General Support
603461A	Army RDT&E	High Performance Computing Modernization	$221,331	$183,322	General Support
602131M	Navy RDT&E	Marine Corps Land Force Technology	$55,936	$59,607	General Support
602235N	Navy RDT&E	Common Picture Applied Research	$36,450	$36,348	General Support
602236	Navy RDT&E	Warfighter Sustainment Applied Research	$48,649	$56,197	General Support
602271N	Navy RDT&E	Electromagnetic Systems Applied Research	$85,598	$83,800	General Support
602435N	Navy RDT&E	Ocean Warfighting Environmental Applied Research	$74,911	$42,998	General Support
602750N	Navy RDT&E	Future Naval Capabilities Applied Research	$149,836	$147,771	General Support
603680N	Navy RDT&E	Manufacturing Technology Program	$67,797	$58,657	General Support
0604536N	Navy RDT&E	Advanced Undersea Prototyping	$66,543	$87,669	General Support
602102F	Air Force RDT&E	Materials	$149,264	$125,373	General Support
602202F	Air Force RDT&E	Human Effectiveness Applied Research	$133,284	$112,518	General Support
602204F	Air Force RDT&E	Aerospace Sensors	$159,282	$166,534	General Support
602605F	Air Force RDT&E	Directed Energy Technology	$132,993	$141,898	General Support
602788F	Air Force RDT&E	Dominant Information Sciences and Methods	$194,318	$162,420	General Support
602890F	Air Force RDT&E	High Energy Laser Research	$43,049	$43,359	General Support
602668D8Z	Defense-Wide RDT&E	Cyber Security Research	$14,775	$14,969	General Support
603680D8z	Defense-Wide RDT&E	Defense-Wide Manufacturing S&T Program	$186,159	$114,637	$193,605
603833D8Z	Defense-Wide RDT&E	Engineering Science and Technology	$25,395	$19,415	General Support

Defense Advanced Research Projects Agency (DARPA) Recommendation

DARPA's ability to create truly revolutionary new capabilities is well documented. The Internet, stealth technology, nearly all the technologies found in mobile phones, and more recently, an upper-limb prosthesis for military amputees inspired by the limb that Luke Skywalker wore in the *Star Wars* films. DARPA is currently spearheading scientific research in important areas such as artificial intelligence, hypersonics, detecting radiological threats, microelectronics, and long-range anti-ship capabilities.

The U.S. needs organizations like DARPA that specialize in undertaking high-risk, high-reward research and development to create game-changing technologies. DARPA's unique research model helps ensure that we remain ahead of our adversaries. As a result, CNSR supports the FY 2019 budget request for DARPA.

Defense Medical Research Recommendations

In order to maintain a strong military, the U.S. must have healthy families and soldiers. It is imperative for DOD to contribute to curing diseases that affect not only men and women in the

military, but also the public since we have an all-volunteer force. Defense medical research programs help ensure the United States has the medical technologies necessary to enable military readiness and serve those who have been wounded on the battlefield. Developments in battlefield medicine also contribute to significant advances which benefit civilian trauma-related medical practice, such as regenerative medicines, vaccine developments, battlefield dressings, and one-handed tourniquets. We offer the following recommendations for CNSR priority Defense medical research PEs:

PE Number	Agency/Account	Program Element (PE) *($ in Thousands)*	FY18 Enacted	FY19 PBR	FY19 CNSR Request
602787A	Army RDT&E	Medical Technology	$89,434	$90,075	General Support
603002A	Army RDT&E	Medical Advanced Technology	$106,780	$62,496	General Support
603807A	Army RDT&E	Medical Systems Advanced Development	$33,491	$34,284	General Support
	DHP RDT&E	Research, Development, Test and Evaluation Research	$9,796	N/A	General Support
	DHP RDT&E	Exploratory Development	$64,881	N/A	General Support
	DHP RDT&E	Undistributed Medical Research/Peer-Reviewed/CDMRPs	$1,386,100	$0	$1,441,544

Overall Defense S&T Program

If enacted, the FY 2019 PBR would result in a more than 8 percent cut to the Defense S&T program. The cuts would disproportionally impact the Services. Army S&T funding would decline by more than 27 percent, Navy S&T funding by 7.9 percent and Air Force S&T funding by 6.3 percent. This would continue the trend of fewer resources being devoted to support the Defense S&T program. According to the Congressional Research Services (CRS), in FY 2017 constant dollars, Defense S&T funding has declined by $2.8 billion from FY 2005 to FY 2017.[5]

If trends such as declining Defense S&T funding continue, the National Science Board expects China to surpass the United States in research and development investments by the end of this year.[6] The military implications of having China become the top nation in world supporting innovation are concerning. DOD, through the Defense S&T program, plays a vital role in supporting the nation's innovation ecosystem. Having China lead in research and development investments will be harmful for our national and economic security. Additionally, the National Security Strategy states China and Russia are now our primary strategic competitors. To be successful, we need new military capabilities to counter threats from nation states like quantum, artificial intelligence and human-machine teaming rather than focusing solely on countering threats from terrorist groups. With ubiquitous support for the Defense S&T program, we can develop those new military capabilities.

The National Academies of Sciences, Engineering and Medicine recommended that Defense S&T funding equal 3 percent of the total defense budget.[7] Based on the FY 2019 budget, in order to meet the National Academies recommendations, Defense S&T funding would have to grow by nearly $4 billion. We urge the subcommittee to provide robust funding for the PEs that comprise

[5] U.S. Congressional Research Service. Defense Science and Technology Funding (R45110, February 21, 2018) by John F. Sargent Jr., Specialist in Science and Technology Policy.
[6] https://nsf.gov/nsb/news/news_summ.jsp?cntn_id=244465
[7] https://www.nap.edu/catalog/11463/rising-above-the-gathering-storm-energizing-and-employing-america-for

the Defense S&T program in an attempt to meet the recommendations from the National Academies and help sustain U.S. leadership in research and development investments.