Guide to FY2019 Research Funding at the Department of Defense (DOD)

Contact: James Murday, DC Office of Research Advancement
202 824 5863, Murday@usc.edu

Summary and Index

This document provides insights into the various DOD funding agency opportunities for University (with bias toward USC competencies) basic research (6.1) and for some applied research (6.2) efforts. Special attention is given to changes anticipated in FY2019. There are supplementary Mission Agency Program Summary (MAPS) charts cited in the text; they are available from Res. Adv.

DOD funds research that is relevant to its mission, predominantly drawing on engineering, computer/information science, and physical sciences, but there is also attention to social sciences.

Overview

Since DOD relies heavily on technological advantage, contributions from research, development and engineering must be marshaled to meet tomorrow's defense challenges. DOD funds research and development (R&D) that is relevant to its mission, predominantly drawing on engineering, computer/information science, and physical sciences. However, DOD also funds some social science, life science, and medical research.

The DOD has many different funding organizations that engage in Research, Development, Test and Evaluation (RDT&E), each with its own foci and idiosyncrasies. Information on the RDT&E budgets can be found in the annual DOD R-1 Document that summarizes the budget at a high level, and the R-2 documents (Research and Development Descriptive Summaries) that address each agency budget in more detail. (http://comptroller.defense.gov/budgetmaterials.aspx)

As part of its investment in R&D, DOD funds basic research (labeled 6.1, or BA1), applied research (6.2, or BA2) and advanced technology development (6.3, or BA3). Taken together, these three budget lines are referred to as the S&T investment. In 2011 the Department identified seven Science and Technology (S&T) priorities: Autonomy, Counter Weapons of Mass Destruction, Cyber Science and Technology, Data-to-Decisions, Electronic Warfare / Electronic Protection, Engineered Resilient Systems, and Human Systems.

Universities get about 60% of the 6.1, 10% of the 6.2, and 5% of the 6.3 funding. However, the 6.2 and 6.3 funding at Universities includes University Affiliated Research Centers (UARCs) and other entities that are structured to handle the greater deadline, security classification, and reporting requirements. For 6.2/6.3 projects, it is not unusual for a University professor to be a collaborator with industry, a university affiliated organization (such as the Information Sciences Institute and the Institute for Creative Technologies at USC), or a DOD laboratory/center.

Basic Research

DOD defines basic research as systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and/or observable facts without specific applications toward processes or products in mind. With very few exceptions, the results of basic research will not be classified or restricted, and are reported in the open literature.

The DOD Office of Basic Research sometimes sponsors workshops in emerging areas of science/engineering that it perceives as important to the DOD; these workshops are meant to guide research investment. The latest were in 2016. (http://basicresearch.defense.gov/future-directions/)

Funding for basic research is available from several DOD agencies, each having its own particular focus:

Agencies with >$40M basic research monies available to Universities

- Air Force Office of Scientific Research (AFOSR): www.wpafb.af.mil/afrl/afosr/
  Focus: pilot, aerospace mission (6.1 only)
- Army Research Office (ARO): www.arl.army.mil/www/default.cfm?page=29
  Focus: soldier, ground force mission (6.1 only)
- Office of Naval Research (ONR): www.onr.navy.mil/
  Focus: sailor, marine, ship/sub, ocean mission (6.1 - 6.3)
- Defense Threat Reduction Agency (DTRA): www.dtra.mil/

Focus: weapons of mass destruction – detect, protect, defeat (6.1 – 6.3)
- Defense Advanced Research Projects Agency (DARPA): www.darpa.mil/
  Focus: defense-wide technology innovation (6.1 – 6.3)
- Congressionally Directed Medical Research Program (CDMRP): cdmrp.army.mil/
  Focus: medical research topics of interest to a Congress person (6.1 only)

Other Agencies with smaller amounts of basic research monies available to Universities
- Army Research Inst. for Behavioral and Social Sciences (ARI): https://ari.altess.army.mil/
  Focus: basic research in behavioral science (6.1 - 6.3)
- Army Corps of Engineers (USACE): http://www.erdc.usace.army.mil/
  Focus: support of the Engn. Res and Development Center (ERDC) research interests (6.1 - 6.3)
- Chemical Biological Defense Program (CBDP): www.jpeocbd.osd.mil/
  Focus: chemical/biological warfare defense (6.1 - 6.3) – managed through DTRA
- Defense Medical R&D Program (DMDRP): http://cdmrp.army.mil/dmrdp/
  Focus: military specific medical research (6.1 – 6.3) – managed through CDMRP
- Office Secretary of Defense (OSD): http://www.acq.osd.mil/chieftechnologist/
  Focus: overarching Defense issues (6.1 – 6.3)
- Naval Postgraduate School (NPS); http://my.nps.edu/web/research/funding-opportunities
  Focus: support of NPS core mission in graduate education and research (6.1 - 6.3)

Single Investigator Efforts - Generic Basic Research Announcements
The majority of DOD basic research funding is invested in single investigator efforts and is advertised through relatively generic Broad Area Announcements (BAAs) from the three services. The funding for these efforts typically ranges between $100-200K/yr for three years; continuation is possible. Approximately 20% of the projects will be turned over annually. The six DARPA offices also each have a generic BAA, and can fund single investigator "seedling" efforts which tend to be $300-500K for 12-18 months. DTRA has a generic Fundamental Research to Counter Weapons of Mass Destruction BAA. NPS, USACE and ARI issue generic solicitations, but usually without significant monies devoted to them. For more information, see MAPS DOD Charts 37 to 124.

While peer review is used to differing degree by the various DOD agencies, the DOD program officers have far greater latitude than do NSF program officers. So it is <u>essential</u> to contact a program officer and explore mutual interests. The DC Office of Research Advancement can assist in identifying appropriate program officers. A white paper is <u>very</u> useful (often required). The program officers don't want to waste your time writing, nor their own time reading, an inappropriate proposal. Proposals to the long-range BAA programs may be submitted at any time, but late spring is when many tentative decisions are being made for new starts in the coming fiscal year (which starts 1 Oct). There is no standard DOD proposal format; each agency/office has its own requirements.

Young Investigators
Each of the three services, DTRA, and DARPA have special announcements for young faculty programs (except ARO where it is part of the generic BAA). The eligibility typically is within five years of Ph.D. or equivalent degree, but DARPA is unlimited years and ONR 5 years from initial tenure-track appointment. US Citizenship or "green card" status is required by the Services, but not by DARPA and DTRA. The available funding ranges from $120K/yr (Army) to $250K/yr (DARPA). Submission deadlines vary. For more information, see MAPS DOD Charts 149-155; a listing of prior awardees and their research topics is available from the DC office.

Senior Investigators – Vannevar Bush Faculty Fellowship (VBFF, was the NSSEFF)
http://www.acq.osd.mil/rd/basic_research/program_info/vbff.html
This is a special program to support outstanding faculty in topics-of-interest to DOD; it is competed intermittently as funding allows. A Vannevar Bush awardee receives ~$600K/yr for five years. Awardees are generally ~20 years past PhD, have impressive credentials, and address a science/engineering basic research topic of interest to DOD. For more information, see MAPS DOD Charts 157-158; a listing of the prior awardees and their topics is available from the DC office. In 2015 DOD created the Laboratory University Collaborative Initiative (LUCI) which funds a DOD scientist/engineer to work with a VBFF fellow.

Special Research Program Announcements
During the year, DOD agencies can announce special program opportunities about a specific topic; DARPA, DTRA and CDMRP, in particular, use this approach predominantly. These opportunities range from large, center efforts [e.g., University Affiliated Research Centers (UARCs), Collaborative Research Alliances (CRA), and Centers of Excellence (CoE)] to single investigator programs [e.g., DTRA/CDMRP topic solicitations, and ONR's Basic Research Challenges]. These announcements have specific application due dates.

The Defense Enterprise Science Initiative (DESI) pilot program was initiated with a FY18 BAA. DESI funds projects that bring together industry and university teams to look for new solutions to challenging defense and national security problems, with the aim of accelerating the impact of basic research on defense capabilities.

Multidisciplinary Efforts – Multidisciplinary University Research Initiatives (MURIs)
http://www.onr.navy.mil/en/Science-Technology/Directorates/office-research-discovery-invention/Sponsored-Research/University-Research-Initiatives/MURI.aspx
As part of DOD's University Research Initiative budget line, the multidisciplinary university research initiative (MURI) program has ~20 topics announced in the March-June time frame each year, with white papers due about 1-2 months after the announcement, and proposals about three months after the white paper. By law these require multidisciplinary teaming efforts; the funding is up to $1-2.5M/yr for five years (presuming acceptable performance). Successful proposals have typically engaged 3-5 Universities, but a single University effort can be successful. For more information, see MAPS DOD Charts 128-132; a listing of prior awardees/topics is available from the DC office.

University Centers of Excellence (COE)
Both the Army and Navy support University Affiliated Research Centers (UARCs) that, in addition to basic research, also address applied research and development (see MAPS DOD Chart 148). The Army also has University COE, Collaborative Technology Alliances (CTA), and Collaborative Research Alliances (CRA) that engage Universities (see MAPS DOD Charts 180-197). The Air Force supports University Centers of Excellence (~5yr lifetime) that are associated with specific Air Force Research Laboratory technical directorates. (see MAPS DOD Chart 176)

Human Social, Cultural, and Behavioral Modeling (HSCB)
DARPA DSO and the service OXRs have social/behavioral efforts.

MINERVA
http://minerva.defense.gov/
In addition to Service core HSCB programs, the Office of the Secretary of Defense (OSD) funds S&T projects to address understanding and modeling of human behavior in social and cultural contexts. The basic research component is entitled the Minerva Initiative. For more information, see MAPS DOD Chart 131; it is presently administered by ONR.

Army Research Institute for Behavioral and Social Sciences (ARI)
https://ari.altess.army.mil/
ARI supports research projects that are designed to expand fundamental knowledge and discover general principles in the behavioral and social sciences, and generally focused on individual and unit performance and readiness. In addition to programmatic efforts to develop and evaluate psychological and behavioral theory, researchers are encouraged to propose novel, state-of-the-art, and multidisciplinary approaches that address difficult problems. For more information, see MAPS DOD Chart 63.

Medical
Congressionally Directed Medical Research Program (CDMRP)
http://cdmrp.army.mil.
Congress typically adds funds to the DOD budget for support of selected medical basic research topics; these total ~$1B/yr in recent years. Each year the funds are inserted by a congressperson for specific topics for that year only. Those topics are then openly competed through Congressionally Directed Medical Research Program (CDMRP) solicitations. The Army's Medical Research and Materiel Command manages the CDMRP with contractors providing the administrative functions. Since there is no certainty of continued funding, there are no program officers per se. For more information on the CDMRP, see MAPS DOD Charts 142-151 and/or visit the CDMRP website (which is very informative).

Defense Health Program
http://cdmrp.army.mil/dmrdp/
DOD budgets a relatively small extramural effort in medical basic research (<$10M). In 2010 the DOD established a joint program, the Defense Medical Research and Development Program (DMRDP) with 6.1-6.3 funding. The DMRDP is organized about six Joint Program Committees (JPC), which consist of DOD and non-DOD medical and military technical experts. Its solicitations are administered through the CDMRP process. For more information, see MAPS DOD Charts 136-141.

Agency Level Programs
The Army Medical Research and Materiel Command (USAMRMC) issues a generic BAA for basic research, but generally without much money available. In addition, USAMRMC manages the Armed Forces Institute of Regenerative Medicine (AFIRM), which funds University-based consortia (see DOD Charts 59-62). DARPA has a Basic Operational Medical Science (6.1) effort (see MAPS DOD Charts 100-102). ONR has a Warfighter Protection and Application Division with interest in selected medical topics (see MAPS DOD Chart 77). DTRA funds Medical research in support of defense against weapons of mass destruction. For more information, see MAPS DOD Charts 127-128.

Instrumentation

http://www.onr.navy.mil/en/Science-Technology/Directorates/office-research-discovery-invention/Sponsored-Research/University-Research-Initiatives/DURIP.aspx

As part of the University Research Initiative (URI) budget line, the Defense University Research Instrumentation Program (DURIP) is competed each summer. The awards range from $50K to $1.5M; matching funds are not required, but are very useful for the high priced instruments. While anyone may submit, there is a strong preference for instrumentation in support of funded DOD research efforts. For more information, see MAPS DOD Charts 130. ARO also has its own research instrumentation program (see MAPS DOD Chart 54).

Education/Training/Sabbaticals

In addition to funding research itself, there are DOD programs in support of: a) PhD education (the National Defense Science and Engineering Graduate (NDSEG) program (http://ndseg.asee.org/), and b) the National Defense Education Program (NDEP, http://www.ndep.us/) for undergraduate/graduate education (which includes the Science, Mathematics and Research for Transformation (SMART) Scholarship for Service Program (http://smart.asee.org/). Each of the Services also has a STEM education effort, generally focused on K-12.

The DOD research laboratories fund postdoctoral positions through the National Research Council (NRC, http://sites.nationalacademies.org/pga/rap/), the American Society for Engineering Education (ASEE, https://www.asee.org/fellowship-programs), and the Oak Ridge Associated Universities (ORAU, http://orau.org/science-education/internships-scholarships-fellowships/default.aspx) programs. In addition, there are many programs to support faculty working at the various DOD laboratories. For more information on these programs see MAPS DOD Charts 162-163).

Resources

Defense-wide central resource:
defenseinnovationmarketplace.mil

Office of the Secretary of Defense (OSD) Basic Research:
http://www.acq.osd.mil/rd/basic_research/

Army Research Laboratory S&T Technical Implementation Plan 2015-2019
http://www.arl.army.mil/www/pages/172/docs/ARL_Technical_Implementation_Plan.pdf

Air Force Strategic Master Plan with S&T Annex (2016)
http://www.af.mil/News/Article-Display/Article/589441/air-force-releases-strategic-master-plan/

Naval S&T Strategy (2015)
http://defenseinnovationmarketplace.mil/resources/NavalS&TStrategy2015_Final_01-26-15.pdf

Mission Agency Program Summary (MAPS)
The DC Office of Research Advancement has created the Federal Mission Agency Program Summary to:

1. connect PIs with appropriate funding agency programs/program officers
2. assist in development of white papers/charts/elevator speeches

The following resources are available on request

1. Data sheets on programs officers and their programs
2. For DHS, DHHS, DOD, DOE, DOJ, DOT, ED, EPA, INTEL, NASA, NIST, NOAA, and USDA:
   - Agency Planning Documents
   - Guides to Agency Funding for FYXX
   - Agency Research Program Charts
     - Chart numbers in the "Guides to Funding" reference the "Research Program Charts."
3. Charts from recent USC Center of Excellence in Research workshops
4. Reports / guides on writing proposals
5. URLs at which one can arrange for Agency automatic solicitation updates
6. URLs at which one can find previous agency/program officer awardees
7. Information about DC Office services

Personal Assistance in Locating Funding and Preparing Proposals

Dr. James S. Murday DC Office of Research Advancement
Tel: 202 824 5863 Email: Murday@usc.edu

Table 1: FY2015 and FY2016 DOD Research Funding ($M)
Obligations at Universities/Colleges

	2015		2016	
	Basic	Applied	Basic	Applied
Total for DOD	**2133**	**4558**	**2327**	**5005**
Total at Universities	**1056**	**507**	**1135**	**559**
Physical Sciences	**193**	**36**	**207**	**38**
Astronomy	-	-		
Chemistry	34	2		
Physics	119	23		
Other	40	12		
Environmental Sciences	**59**	**14**	**63**	**16**
Atmospheric	15	2		
Geological	2	-		
Oceanology	32	11		
Other	10	2		
Mathematics and Computer	**210**	**76**	**225**	**85**
Computer Sciences	113	73		
Mathematics	61	2		
Other	36	2		
Engineering	**249**	**205**	**261**	**223**
Aeronautical	45	26		
Astronautical	5	2		
Chemical	12	9		
Civil	14	9		
Electrical	43	56		
Mechanical	19	9		
Metal/Materials	60	16		
Other	52	84		
Life Sciences	**114**	**121**	**110**	**138**
Agriculture	7	0		
Biological	58	10		
Environmental	3	-		
Medical	35	111		
Other	11	0.1		
Psychological	**29**	**8**	**26**	**9**
Social Sciences	**10**	**-**	**16**	**-**
Other Sciences	**199**	**45**	**217**	**49**

From NSF "Federal Funds for Research and Development: FY2015-2017," April 5, 2017 next due June 2018
https://www.nsf.gov/statistics/fedfunds/
Because the entries in the report for FY2017 are Budget Request only, they are not reported here.

Basic	2015	Tables 30, 77 and 80-86
Applied Research	2015	Tables 44, 88 and 91-97
Basic	2016	Table 31 and 78
Applied Research	2016	Table 45 and 89

Table 2: Projected DOD Basic Research Funding ($M) for FY2019: From the President's Budget Request Submitted to Congress.

Discipline / Agency	Army	AF	Navy	DARPA	DTRA	CBDP	DHP	OSD
Biology / Life Sciences	6							
Human Systems			16					
Biology / Medical			20					
Chemistry	14							
Propulsion		34						
Physics	19	21						
Electronics/Photonics	7	81	48	105				
Materials	14	29	58	86				
Mechanics	7							
Mechanics Structural		42						
Mechanics Fluid		32						
Environment	0.3							
Ocean			76					
Atmosphere and Space			26					
Environmental Science								
Computer, Information Sciences, Mathematics			46	160				
Mathematics	6							
Computing Sciences	7	27						
Information Sciences		21						
Networks	13	26						
Simulation and Training	2							
Social Sciences	6							
Cyber								
Air/Ground/Sea Vehicles			58	16				
Weapons			20					
Science Addressing Hybrid Threats			24					
Science Education Career and Outreach		22	44					
International Outreach		12						
Transformative / Basic Research Challenge			22	56				
Chemical/Biological Warfare Defense						42		
Weapons of Mass Destruction Defeat					37			
Hi-Energy Laser Multidisciplinary Res Initiative		14						
Multidisciplinary Univ Research Initiatives	53	84	87					
Defense Univ Research Instrumentation Program	8	15	24					
National Defense S & E Graduate Program and ASSURE		56						
National Defense Educ Program (NDEP)								86
Social / Cultural / Human - MINERVA, HSCB	4							11
Vannevar Bush Faculty Fellowship (was NSSEFF)								30
PECASE	5		9					
Basic Operational Medical							8	

The reported Army funding by discipline reflects only the ARO budget available for University single investigator proposal submission (budget line item HR 57), not the total Army basic research funding; from a different basic research budget line the Army also funds University Centers through special competitions. For the Navy, about 25% of the reported total basic research funding is provided to the Naval Research Laboratory; for the Air Force, about 30% is provided to the Air Force Research Laboratories.

Table 1 (previous table) provides the funding parsed by academic discipline as reported by DOD to NSF. Since the academic disciplines in Table 2 (here) are different from most of the agency's program taxonomies, clear assignment of funds by academic taxonomies is not always possible from the budget submission. Table 2 should be considered a best estimate. In some cases, the amount of funding in a discipline is included under other headings and is thereby unknown from the budget submission; physics and chemistry at ONR and DARPA are good examples.

Table 3: Summary of Basic Research Funding
(From the President's Budget Request Submitted to Congress)

Service		Actual* FY 17	Estimate* FY18	PBR FY18	Approp FY18	PBR FY19	% inc PRB FY19-18
Air Force	Basic Research	522	505	505	505	518	
	Defense Res Sciences	371	343	343	343	348	1
Army	Basic Research	473	430	430	435	446	
	Defense Res Sciences	286	263	264	264	264	0
	ARO (H57)	91	107	96		101	5.2
	ICT (J08)	5.9	6.0	6.3		6.4	
Navy	Basic Research	549	595	596	606	597	
	Defense Res Sciences	414	458	458	458	459	0
DARPA	Basic Research (DRS)	336	432	432	432	422	-2.6
	Basic Operational Medical Res Science	42	43	43	43	49	14
DTRA	Basic Research	38	35	37	37	37	0
CBDP	Basic Research	47	45	44	44	43	0
OSD	NDEP	53	69	74	88	74	0
	MINERVA (0601110D8Z)	9.2	9.4	9.5		9.5	0
DHP	GDF-Basic Operational Med Res Sciences (0601117HP – 371A)	9	6.4	6.9		6.9	0

* The FY17-18 numbers may include Congressional changes and Congressional adds (CA, sometimes labeled Congressional Special Interest, CSI) which do not appear in the President's Budget Request (PBR).

Other reports on budget changes might show different percentages than those in Table 3. For instance, a AAAS estimate for change to DOD basic research compared the FY17 PBR to the Estimated FY16. Congress sometimes adds funds into the basic research accounts. So, for instance, the AAAS cited percentages, when Congress has augmented the PBR funding, are lower than those as shown in Table 3.

Each of the Services has a strategic S&T plan which provides guidance into priorities; these can found in the USC DOD MAPS. In addition to any funding growth identified in Appendix 1 of this document, approximately 20% of projects in a DOD basic research program are turned over each year. So there are opportunities in most programs even in the absence of budget growth or modest decline.

Applied Research and Advanced Technology Development

http://www.acq.osd.mil/chieftechnologist/index.html

DOD defines applied research (6.2 or BA2) as systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met. Advanced technology development (6.3 or BA3) includes all efforts that have moved into the development and integration of hardware for field experiments and tests. The S&T investment is led by a DOD executive committee comprised of the major departmental S&T organizations. Underpinning that leadership, there are 16 Communities of Interest (COIs, see Table 5) that encourage multi-agency coordination and collaboration. Each COI identifies appropriate thrust areas, gaps and opportunities, investment profiles and engagement opportunities for its topics.

Since not much 6.3 funding goes to Universities, only the Applied Research Budget lines are provided in Table 4. Applied funding opportunities are distributed among many DOD agencies, each having its own particular focus:

<u>DOD S&T Funding Agencies managing a 6.1-6.3 investment portfolio</u>

- Office of Naval Research (ONR, Naval includes the Navy and Marine Corps)
  http://www.onr.navy.mil/Science-Technology/Directorates/Transition/
  Focus: develop/transition cutting-edge technology products to Naval acquisition managers
- Defense Advanced Research Projects Agency (DARPA)
  www.darpa.mil
  Focus: defense-wide technology innovation
- Defense Threat Reduction Agency (DTRA)
  http://www.dtra.mil/Research.aspx
  Focus: countering weapons of mass destruction – chem, bio, radiological, nuclear, explosive

<u>Other DOD S&T Funding Agencies (w/o basic research)</u>

- Defense Forensics and Biometrics Agency (DFBA)
  http://www.dfba.mil/
  Focus: forensics and biometrics activities and operations in support of identity operations
- Defense Logistics Agency (DLA)
  http://www.dla.mil/
  Focus: support the weapon system sustainment program
- Missile Defense Agency (MDA)
  https://mda.mil/
  Focus: system to defend against ballistic missile attacks
- Special Operations Command (SOCOM)
  http://www.socom.mil/
  Focus: development, acquisition, and fielding of critical items to enable the SOF Warfighter
- Strategic Environmental Research and Development Program (SERDP)
  Environmental Security Technology Certification Program (ESTCP)
  https://www.serdp-estcp.org/
  Focus: develop and demonstrate innovative, cost-effective, and sustainable solutions

In addition, there are funding opportunities emanating from the Service laboratories/centers/institutes, especially with the Air Force Research Laboratory.

Office of Naval Research (ONR)

http://www.onr.navy.mil/Science-Technology/Directorates/Transition/Future-Naval-Capabilities-FNC.aspx

In addition to its Discovery and Invention program (most of the 6.1 and about half of the 6.2), ONR has a Future Naval Capabilities (FNC) program that invests about half of the Naval 6.2 and most of the 6.3 monies in the following pillars. FNC products start at a technology readiness level (TRL) of three and conclude at a TRL of six. Emerging Capabilities (ECs) represent ongoing products efforts under the pillars:

- Air Warfare (AW) Anti-Air Warfare (AAW); Anti-Surface Warfare (ASuW); Anti-Submarine Warfare (ASW); Aircraft, Power Projection; Cyber
- Information Warfare (IW) Sensors; Cyber; Space; Electromagnetic Maneuver Warfare; Military Deception; Command and Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR); Positioning, Navigation and Timing; Meteorology; Oceanography; Hydrography; Man-Machine Teaming in support of Information Warfare
- Expeditionary Maneuver Warfare (EMW) Special Operations Forces; Amphibious Warfare; Mine Counter-Measures; Mine Warfare; Humanitarian Assistance/Disaster Relief; Anti-Terrorism Force Protection; Explosive Ordinance Disposal; C4ISR; Cyber
- Surface Warfare (SW) Anti-Air Warfare (AAW); ASW; ASuW; Defensive Submarine Warfare (SUW); Theater Air and Missile Defense; Power Projection; Cyber; HM&E
- Undersea Warfare (UW) ASW; Power Projection; Strategic Deterrence; Cyber
- Capable Manpower (CMP) Manpower, Personnel, Training and Education
- Energy, Logistics and Platform Enablers (ELP) Ashore energy; logistics; maintainability; sustainability; efficiency improvements
- Force Health Protection (FHP) Medical Equipment and Supplies; Health Care and Protection; Reduction of Morbidity/Mortality

ONR also has an Innovative Naval Prototypes program (INP) that explores high 6.2 and 6.3 technologies that can dramatically change the way naval forces fight. Programs in this category may be disruptive technologies, which for reasons of high risk or radical departure from established requirements and concepts of operation, are unlikely to survive without top leadership endorsement, and, unlike Future Naval Capabilities, are initially too high risk for a firm transition commitment from the acquisition community. For more information, see MAPS DOD Charts 199-201.

Defense Advanced Research Projects Agency (DARPA)

http://www.darpa.mil/default.aspx

DARPA invests 6.1-6.3 monies through six offices: Defense Sciences (DSO), Biological Technologies(BTO), Information Innovation (I2O), Microsystems Technology (MTO), Strategic Technologies (STO), and Tactical Technologies (TTO). While all of the offices have this range of funding, DSO has the most emphasis on basic research and STO / TTO the most emphasis on advanced technology development. DARPA typically issues solicitations for larger scale, multi-participant efforts that are held to milestones and must deliver a prototype in a three-year time frame. The solicitations are frequently preceded by: a) a proposer day where interested parties can gain more information on the effort and meet potential team partners, b) a workshop, and/or c) a Request for Information (RFI) that is used to shape a pending solicitation. For more information, see MAPS DOD Charts 215-221.

Defense Threat Reduction Agency (DTRA)

http://www.dtra.mil/Research.aspx

DTRA is the combat support agency for countering weapons of mass destruction. It addresses the

entire spectrum of chemical, biological, radiological, nuclear and high yield explosive threats. DTRA's programs include research and development, operational support to US warfighters on the front line, and an in-house weapons-of-mass-destruction think tank that aims to anticipate and mitigate future threats. For more information, see MAPS DOD Charts 216-223.

Defense Forensics and Biometrics Agency (DFBA)
http://www.dfba.mil/
Biometrics and forensics are critical to identifying known and unknown individuals by matching them with automated records (such as for access control) or with anonymous samples (such as crime scene investigations). DFBA is responsible for applying biometrics and forensics capabilities through various tactics, techniques and processes. It has a generic BAA for research addressing its needs. For more information see MAPS DOD Chart 227.

Defense Logistics Agency (DLA)
http://www.dla.mil/
The Defense Logistics Agency (DLA) Logistics Research & Development (R&D) Branch is charged with conducting research and development in all areas relevant to its mission and across all its supply chains. White papers submitted to DLA may address: fundamental R&D; concept formulation; assessment of system and subsystem requirements and processes; development, analysis and evaluation of concepts, systems and subsystems; development of associated industrial capabilities support techniques and processes; development of associated manufacturing techniques and processes; modeling and simulation; simulation-based acquisition; integrated data environments and product data managers; and development of operational systems. For more information, see MAPS DOD Charts 228 - 229.

Missile Defense Agency (MDA)
http://www.mda.mil/business/advanced_research.html
The Ballistic Missile Defense System (BMDS) includes operational elements for sensing, monitoring, and intercepting ballistic missiles during all three phases of flight: boost, mid-course, and terminal. BMDS elements include a network of space, ground, and sea based sensors for detecting and tracking threat missiles; interceptor missiles launched from silos, trucks and ships; and tools for command and control. The MDA has a University Research Program for advancing and solving complex technological problems, ultimately contributing to enhancing a more robust Ballistic Missile Defense System; these efforts are applied research and development. For more information, see MAPS DOD Chart 230.

Special Operations Command (SOCOM)
http://www.socom.mil/Sordac/Pages/Default.aspx
SOCOM has a long-term goal to develop technologies to meet Special Operations Forces (SOF) mission requirements. The intent is to accelerate the delivery of these innovative capabilities to the SOF warfighter. Prior studies and analyses have determined the technical challenges to be:
1) trade space between weight, protection, power, and mobility; 2) cost; and 3) system component integration. SOCOM is interested in receiving white papers from all responsible sources from industry, academia, individuals, and Government laboratories capable of providing experiments and tests, feasibility studies, modeling and simulation, design, construction, and testing of SOF-related technologies. For more information, see MAPS DOD Chart 231.

SERPD and ESTCP - Environmental Protection

https://www.serdp-estcp.org/

The DOD provides support for environmental efforts through the Strategic Environmental Research and Development Program (SERDP). It is a 6.3 (advanced development) budget line, but does fund 6.1 or 6.2 work, if the circumstances are right. In addition the DOD has the Environmental Security Technology Certification Program (ESTCP) that identifies and demonstrates the most promising innovative and cost-effective technologies and methods that address DOD's high-priority environmental requirements. For more information, see MAPS DOD Charts 233 - 235.

DOD Laboratories, Centers, Institutes and Schools

The DOD has an extensive intramural research program distributed among various laboratories, institutes and centers (see Table 6). Those entities do have opportunities to fund University-based efforts, usually (but not always) involving applied research. There are also opportunities for collaboration. In particular, relative to Universities, most DOD laboratories are far better equipped and manpower limited. Generic BAAs are published to announce the areas of potential interest, but contacting the institution prior to submitting a white paper / proposal is a good idea since there may be no interest in your ideas or no funding available.

Air Force Research Laboratory (AFRL)

http://www.wpafb.af.mil/afrl/

Of the three service laboratories, AFRL issues the largest number of solicitations for extramural research. AFRL also has University Centers of Excellence in support of specific AFRL interests. For more information, see MAPS DOD charts 173 - 179.

Air Force Academy (USAFA)

The Air Force Academy has a number of solicitations looking for fundamental research in support of select projects such as: a) a Project on Advanced Systems and Concepts for Countering Weapons of Mass Destruction (PASCC) and b) the Center for Aircraft Structural Life Extension.

Army Research Laboratory (ARL)

http://www.arl.army.mil/www/default.cfm

ARL has a generic solicitation identifying basic and applied research extramural opportunities, but, beyond ARO, ARL is more interested in collaborations than funding efforts. ARL has instituted an Open Campus policy (http://www.arl.army.mil/www/default.cfm?page=2357). The Open Campus is not a funding opportunity. Through the Open Campus framework, ARL scientists and engineers (S&Es) will work collaboratively and side-by-side with visiting scientists in ARL's facilities, and as visiting researchers at collaborators' institutions. Central to the research collaborations is mutual scientific interest and investment by all partners. For more information, see MAPS DOD Charts 180 - 197.

US Army Corps of Engineers Engineering Research and Development Center (ERDC)

http://www.erdc.usace.army.mil/About/MissionandVision.aspx

The US Army Corps of Engineers' (USACE) Engineer Research and Development Center (ERDC) helps solve our Nation's most challenging problems in civil and military engineering, geospatial sciences, water resources, and environmental sciences. ERDC has a generic solicitation.
For more information, see MAPS DOD Chart 198.

Naval Postgraduate School (NPS)
http://www.nps.edu/
The Naval Postgraduate School (NPS) is interested in receiving proposals for research initiatives that offer potential for advancement and improvement in the NPS core mission of graduate education and research. Also, the Naval Postgraduate School Center for Multi-INT Studies (CMIS) supports innovative, independent research to vastly improve the current state of the art in intelligence, surveillance and reconnaissance (ISR). For more information, see MAPS DOD Charts 78 - 81.

Advanced Manufacturing

Small Business Innovative Research (SBIR and STTR)
http://www.acq.osd.mil/osbp/sbir/about/
The SBIR/STTR Programs are structured in three phases. Phase I (project feasibility) determines the scientific, technical and commercial merit and feasibility of the ideas submitted. Phase II (project development to prototype) is the major research and development effort, funding the prototyping and demonstration of the most promising Phase I projects. Phase III (commercialization) is the ultimate goal of each SBIR/STTR effort and statute requires that Phase III work be funded by sources outside the SBIR/STTR Program. For more information, see MAPS DOD Charts 237 - 242.

Rapid Innovation Fund (RIF)
http://www.acq.osd.mil/osbp/sb/opportunities.shtml
The Rapid Innovation Fund provides a collaborative mechanism for small businesses to provide DOD with innovative technologies that can be rapidly inserted into acquisition programs that meet specific defense needs. The RIF is administered by the Office of the Secretary of Defense (OSD) Assistant Secretary of Defense for Research and Engineering (ASD R&E) and Office of Small Business Programs (OSBP). The RIF can be a source of the SBIR/STTR Phase III funding. For more information, see MAPS DOD Chart 243.

Mantech
https://www.dodmantech.com/
All ManTech projects and initiatives are selected and executed through the Service and Agency ManTech Programs. The Army executes primarily through Army Research, Development and Engineering Centers and Army Laboratories; the Navy ManTech Program relies almost exclusively on Centers of Excellence; the Air Force partners with industry, other government agencies, and academia; DLA uses multi-contractor, 5 year competitive contracts; and the OSD's Defense Manufacturing S&T Program is executed through the Air Force primarily using Broad Area Announcements. For more information, see MAPS DOD Chart 244.

Manufacturing USA
https://www.manufacturingusa.com/
Manufacturing USA (formerly the National Network for Manufacturing Innovation) consists of linked Manufacturing Innovation Institutes (MIIs) with common goals, but unique concentrations. In an MII, industry, academia, and government partners leverage existing resources, collaborate, and co-invest to nurture manufacturing innovation and accelerate commercialization. Typically, an MII has ~$70-100M Federal monies over five years, with a requirement of at least an equivalent amount of matching funds. The MIIs have some limited funds available for University research. For more information, see MAPS DOD Charts 245 - 246.

Table 4: Summary of Applied (6.2) Research Funding (Taken from the President's Budget Requests to Congress)

Service		Actual* FY 17	Estimate* FY18	PBR FY18	PBR FY19	% inc PRB FY18-17
Air Force		1314	1260	1284	1312	2
Army		1196	889	889	920	3
Navy		955	886	886	891	0.5
DARPA		1143	1379		1431	
	Biomedical	96	109	108	101	-7
	Information & Comms	342	393	393	395	0.5
	Bio Warfare Defense	20	13	13	39	300
	Tactical	285	344	344	335	-3
	Materials and BioTech	209	224	224	227	1
	Electronics Tech	191	295	295	334	13
DTRA		151	158	158	161	2
CBDP		186	201	201	193	-4
OSD	Cyber Security	12	15	15	15	0
DHP	Applied Biomedical	86		64	74	16

* The FY17-18 numbers may include Congressional changes and Congressional special adds (CA, sometimes labeled Congressional Special Interest, CSI) which do not appear in the President's Budget Request (PBR).

Table 5: DOD S&T Communities of Interest

COIs were established in 2009 as a mechanism to encourage multi-agency coordination and collaboration in cross-cutting technology focus areas with broad multiple-component investment. COIs provide a forum for coordinating S&T strategies across the Department, sharing new ideas, technical directions and technology opportunities, jointly planning programs, measuring technical progress, and reporting on the general state of health for specific technology areas.

Communities of Interest Tier-1 Taxonomy
http://www.acq.osd.mil/chieftechnologist/COIs.html

- Advanced Electronics
- Air Platforms
- Autonomy
- Biomedical (ASBREM)
- Command, Control, Communication, Computers, and Intelligence (C4I)
- Counter IED
- Counter WMD
- Cyber
- Electronic Warfare
- Energy & Power Technologies
- Ground & Sea Platforms
- Human Systems
- Materials & Manufacturing Processes
- Sensors
- Space
- Weapons Technologies

The collection of COIs serves as an enduring structure to integrate technology efforts throughout the DoD S&T enterprise. While they cover the majority of the DoD's S&T investment, some Service specific investments are not included in these groups. (A former COI on Engineered Resilient Systems is listed as alumni).

Table 6: Service Research Laboratories/Centers/Institutes (mostly in-house efforts)

Army

- Army Research Laboratory (ARL, mostly 6.1 and 6.2)
  http://www.arl.army.mil/www/default.cfm?page=8
  Focus:
    - Computational and Information Sciences
    - Human Research and Engineering
    - Sensors and Electron Devices
    - Survivability/Lethality Analysis
    - Vehicle Technology
    - Weapons and Materials Research
- Army Research and Development Commands (RDECOM, mostly 6.2 - 6.4)
  http://www.army.mil/info/organization/unitsandcommands/commandstructure/rdecom/
  Focus:
    - Edgewood Chemical Biological Center (ECBC)
    - Soldier Research Development and Engineering Center (NSRDEC)
    - Communication-Electronics RDE Center (CERDEC)
    - Aviation & Missile RDE Center (AMRDEC)
    - Tank-Automotive RDE Center (TARDEC)
    - Armament RDE Center (ARDEC)
- Army Corps of Engineers, Engineering Research and Development Center (ERDC)
  http://www.usace.army.mil/Missions/ResearchandDevelopment.aspx
  Focus: solve nation's problems in geospatial sciences, water resources, and environmental
- Army Medical Research and Materiel Command (AMRMC)
  https://mrmc.amedd.army.mil/
  Focus: medical research, development, and acquisition and medical logistics management
- Army Research Institute for Behavioral and Social Sciences
  https://ari.altess.army.mil/
  Focus: research in behavioral science (6.1 - 6.3)

Air Force

- Air Force Research Laboratories (AFRL)
  http://www.wpafb.af.mil/afrl
  Focus:
    - Aerospace Systems (RQ)
    - Sensors (RY)
    - Materials and Manufacturing (RX)
    - Munitions (RW)
    - Directed Energy (RD)
    - Space Vehicles (RV)
    - Information (RI)
    - Human Effectiveness (711 HPC)

Navy and Marine Corps

- Naval Research Laboratory
  http://www.nrl.navy.mil/
  Focus: S&T in support of the Navy and Marine Corps
- Naval Warfare Centers

- Naval Surface Warfare Centers (NSWC) www.navsea.navy.mil/nswc/default.aspx
  - Warfare Systems – Dahlgren
  - Ship Technology – Carderock
  - Maintenance - Port Hueneme
  - Technology Life Support - Crane
  - Logistics/Foundry - Philadelphia
  - Explosive/Ordnance - Indian Head
- Naval Air Warfare Centers (NAWC)
  - Weapons – China Lake www.navair.navy.mil/nawcwd
  - Aircraft - Pax River www.navair.navy.mil/NAWCAD
  - Training Systems - Orlando www.navair.navy.mil/nawctsd
- Naval Undersea Warfare Centers (NUSC) www.navsea.navy.mil/nuwc/default.aspx
- Space & Naval Warfare Sys Ctr (SPAWAR) www.public.navy.mil/spawar/Pages/default.aspx

- Navy Medical Research Center www.med.navy.mil/sites/nmrc/Pages/ott_main.htm
  Focus: battlefield medical problems and naturally occurring infectious diseases
- Naval Postgraduate School (NPS) www.nps.edu/Research/rspa.html
  Focus: research and unique research laboratory facilities to support Fleet and OPNAV needs.

For more information on these activities, see MAPS DOD Charts 173-210.

Appendix 1: FY2019 Basic (6.1) Research Program Significant Changes

$M from 2018 to 2019
Derived from the RDDS (R-2s) in the DOD President's Budget Submission

AFOSR

No changes of significance

Army Research Office (ARO) (H57)

Physics **17.9 to 19.3**

Will modify graphene to induce an optical nonlinearity (e.g., emitting light at a different frequency than was introduced); will create theoretical models of the quantum phases and dynamics of periodically driven ultra-cold atomic gases; will explore the quantum limits of spectroscopy and control of single molecular ions using atomic ions as qubit probes.

Life Sciences **5.6 to 6.1**

Funding levels increased to enable pursuit of novel bio-derived materials.

Network Sciences **11.6 to 12.8**

Funding increase enables pursuit of novel networking protocols, components, and theoretical networking understanding.

Social Sciences **4.0 to 5.7**

Funding increase enables pursuit of novel social scientific understanding, including genetics, group processes, and impacts of social institutions.

Army University and Industry Research Centers

J08 Institute for Creative Technologies

Immersive Environments **2.4 to 2.6**

Will examine characteristics of virtual humans that promote trust in domains such as persuasion tasks, social dilemmas and interviews (with sensitive questions) and will examine differences between normative influence (emphasizing social norms) and informational influence (e.g. conveying expert information); these areas have potential applications for not only virtual humans but also robotics.

Graphics and Animation **1.5 to 1.3**

Will research virtual reality and augmented reality-driven teleportation system that will use detailed 3D models created in prior research to in-person, photo-realistic communication for remote participants; Will research techniques for rapidly capturing movement and speech animations that are specific to individuals. Funding levels decreased due to reduced emphasis on creating detailed 3D models as a result of prior year progress.

Techniques and Human-Virtual Human Interaction **2.5 to 2.6**

Will study how extended interaction occurs in groups larger than a dyad, investigate how information can span multiple conversations, and research how to endow virtual humans with these capabilities. Will develop techniques that will allow virtual humans to automatically identify strategic emotional manipulation and defend against it. Will leverage Sigma cognitive architecture's combined neural and symbolic representations to create a model of question answering. Funding

levels increased to enable improved knowledge to support Soldier Lethality for enhanced human performance.

Office of Naval Research

Air Ground and Sea Vehicles **57.2 to 57.8**
Expand research related to naval sea platform engineering and platform design, including Ohio Replacement Program efforts, and centers for innovative naval technology.

Human Systems **15.5 to 16.5**
Increased effort within Social Network Analysis, including research on computational social science models for course of action and forecast in support of information environment maneuvers for strategic communication.

Medical and Biosciences **19.1 to 19.6**
Research improved hemorrhage resuscitation with enhanced endothelial treatments. Synthetic biology for bioelectronics devices, materials and information processing.

Ocean Sciences **75.2 to 76.1**
Initiate studies of prediction and observations of 3-D Lagrangian studies and abilities to predict the vertical pathways in the ocean. Initiate studies of the input and fate of near-initial shear and energy in the ocean via observational and predictive studies in the GIUK (Greenland, Iceland, and the United Kingdom) regions.

Weapons **18.9 to 20.3**
Increased research initiatives in the areas of Directed Energy and Hypersonics.

Basic Research Challenges **21.4 to 22.2**
This increase funds topics that foster leading edge science and attract new principal investigators and organizations. Areas of increased investment include randomized numerical computation for large datasets, levitated optomechanics, multi-principal alloys for high-temperature applications, and multibody control systems for flight dynamics.

DARPA

CCS-02 Math and Computer Sciences

Machine Common Sense (MCS) **0 to 6.2**
The program will create more human-like knowledge representations, for example, perceptually-grounded representations, to enable commonsense reasoning by machines about the physical world and spatio-temporal phenomena.

Short Range Independent Microrobotics Program (SHRIMP) **0 to 8.2**
Develop microrobots with the ability to clandestinely enter tactical environments and perform close-proximity (within 10cm) functions. These ant-sized microrobots could obtain local sensing data, such as visual, audio, or chemical trace data, whereas similar capabilities today would require hand-placed sensors or not be performed at all. SHRIMP microrobots should be able to self-navigate to an objective location and operate indefinitely from harvested energy. The primary technical developments needed are in the efficiency, robustness, and control of millimeter-scale actuators, which allow the robots to move using new materials, processing, and sensor integration techniques.

Appendix 2: FY2019 Selected Appl Research (6.2) Program Significant Changes

$M from 2018 to 2019
Derived from RDDS (R-2) in the President's Budget Submission

Air Force

Aerospace Vehicle Technologies

Structures **8.0 to 8.1**

Initiate development of innovative structural design methods to dramatically reduce weight and complexity of aircraft structures. Initiate the development of fail-safe technologies for bonded unitized composite structures applicable to Mobility aircraft.

Aerospace Vehicle Technologies – Aeromechanics and Integration **7.8 to 8.2**

Initiate the development of a high fidelity aerodynamic analysis tool for the design of lasers turrets applicable to Air Superiority 2030 requirements.

Aerospace Vehicle Technologies – High Speed Systems **12.8 to 14.4**

Initiate development on novel designs and demonstration of integrated hot structures for hypersonic reusable air platforms.

Human Effectiveness

Bioeffects **11.7 to 14.2**

Incorporate glare vision effect models in national and DoD standards for definition of protective requirements and glare device effectiveness.

Aerospace Sensors

Electronic Component Technology **5.5 to 9.3**

Initiate demonstration of high pulse power midwave IR laser source.

Trusted Electronics **6.2 to 9.8**

Initiate reliability assessments of advanced heterogeneously integrated microsystems.

EO Sensors and Countermeasures **8.2 to 13.7**

Develop an enhanced midwave infrared imaging upgrade to a fielded reconnaissance sensor. Fabricate and test in a laboratory environment, an electro-optical sensor fore-optic based on novel concepts in optical engineering. Develop and implement the necessary optical metrology capability to support laboratory testing of the novel optics.

Conventional Munitions

Aerodynamics, Navigation, and Control Technologies **28.2 to 28.7**

Initiate demonstration, via flight test, cooperation, and collaboration of a swarm of small cruise missiles flying into an operationally relevant threat environment having the ability to find, locate, and overwhelm targets. Initiate flight test of a multi vehicle mapping without Global Positioning System and saturation approach of the entrance of a hardened deeply buried facility or tunnel target, design the ingress method to include packaging multi rotor aircraft into common launch tubes. Initiate the development of defensive cyber algorithms for autopilot and navigation functions, including swarms.

Dominant Information Sciences and Methods

Campaign Planning Technologies **5.4 to 9.9**

Develop algorithms for data-efficient leaning and integrate with a machine learning framework. Develop algorithms that will dynamically adapt to varying situations based on situational awareness.

Processing Technologies (Quantum) **6.9 to 8.9**

Test the ability to teleport quantum information between network nodes, and to establish two-way quantum communication between two memory nodes. Conduct an analysis of conventional/quantum channel interface for long-distance communication.

Army

Materials Technology

Materials **0 to 3.2**

Will conduct rapid design, selection and production of peptide reagents for potential applications such as the improvement of sensor devices, and logistics and sustainment; and will design and develop specialty materials via synthetic biology for potential applications that will improve safety, cost, logistics, robustness, and create new abilities to adapt existing materiel.

Agile Expedient Manufacturing **0 to 4.5**

Will quantify processing-structure-property relationships in additively manufactured steel alloys; validate continuum scale finite element-based model of laser-metal powder bed additive manufacturing process and mesoscale phase field model of microstructure prediction.

Aviation Technology

Mission Systems **0 to 11.9**

Will investigate adaptive Infrared (IR) engine suppression systems for future Army aircraft in an engine test cell to evaluate engine and IR suppression performance. Will continue maturation of signature management technologies for Future Vertical Lift. Will develop modeling and simulation tools to support survivability analysis against advanced threat systems. Will define, develop and assess advanced engagement concepts for exploitation of organically launch systems off of Army aviation platforms. Will investigate platform integration, mission systems, and survivability requirements to enable organically launch system engagements from Army aviation platforms.

Unmanned and Optionally Manned Technologies **6.4 to 18.9**

Will investigate and evaluate human/machine interface technologies that enable reduced workloads, increased situational understating, and maximize human/machine performance in an aviation environment. Will evaluate technologies to support the following capabilities; resupply, reconnaissance, surveillance, electronic warfare, protection, medical evacuation and attack.

Electronic Warfare Technology

Data Analytics for Situational Awareness **0 to 2.9**

Will identify relevant tactical receiver data and emerging Internet of Things data sources, to include publicly available information, enriching the existing cyber terrain and electromagnetic operations environment; will investigate potential correlation points with non-traditional datasets to identify cyber events; and will explore new data analytics, fusion algorithms and semi-automated analytical methods to process and exploit the extended datasets to support cyber situational understanding.

Offensive Information Operations Technologies **0 to 5.4**
Will investigate utilizing Machine Learning for threat assessment, decision aid, and mission choreography; will determine algorithm design needs for recognition and Battle Damage Assessment for the purposes of survey, network topology understanding, and effect assessment; will refine Cyber Electromagnetic Activities (CEMA) interface definitions to include a mechanism for service/capability discovery to address solidifying mission management across Unified Land Operations platforms.

Missile Technology
Cooperative Engagement Lethality Technology **0 to 3.4**
Will develop optimized missile design with multi-effects lethal mechanism, man-in-the-loop and loiter capability for situational awareness, targeting, and lethal effects against hard and soft targets. Will develop application-based fire control unit software hosted on a commercial end user device, extended range datalink enablers, and GPS/comms denied navigation/targeting technologies.

Advanced Concepts and Simulation
Mixed Reality Research **0 to 4.1**
Will examine how interfaces for virtual training systems affect user interactions with those systems and thereby impact training and performance outcomes; will examine how different interfaces for virtual training systems can be used to more seamlessly integrate live and virtual training to improve training transfer from virtual to live; will investigate and design the synthetic framework, architecture, and technologies to enable a manned/unmanned teaming training and rehearsal simulation environment.

Cyber for Training Simulations **0 to 3.8**
Will investigate analytical capabilities and methodologies for generating models from empirical data and social and psychological theory to describe CEMA-related human attributes (e.g., intent, posture, and capability); and will design initial simulation environment integrating new human models with existing and developing CEMA representations.

Artificial Intelligence **0 to 1.5**
Will investigate capabilities for data mining to better predict individualized degradation in task performance after completion of training; and design initial capabilities for identifying appropriate training resources to mitigate this degradation using individualized intelligent training technologies.

Synthetic Training Environment Acceleration **0 to 3.7**
Will mature AI representation of simulated forces to model relevant aspects of the Multi Domain Battle, increase simulated entity scalability and increase concurrent role-players to enable synthetic collective training; investigate the automated generation of high fidelity synthetic natural environment data in support of the Army' s future synthetic training environment global terrain requirement; determine techniques to automate the attribution of terrain, procedurally extract building extents and apply surface features utilizing point cloud, texture, crowd-sourced and other emerging sources of data; design and develop terrain resolution algorithms which encompass the ability to embed Human Terrain (cultural attributes, infrastructure, social media) in the synthetic environment.

Combat Vehicle and Automotive Technology 0 to 10.6
Will investigate vehicle behaviors to enable teamed robotic and autonomous systems to support specific capabilities supporting Army combat formations. Will research and design common user interfaces for remote lethality with limited targeting assist. Will research automation software and algorithms, increased robotic reliability and function, and determine certified safety procedures for soldier-operated armed UGVs. Will conduct experiments using various commercial network solutions.

Electronics and Electronic Devices

Advanced Distributed Power for Autonomous Platforms 0 to 1.5
Will investigate power control topologies that provide low speed high torque motor operation; will explore power distribution and conversion methods for power generation that enhance fault tolerance and provide graceful degradation; will investigate high voltage switching and power packaging for application in conversion and distribution for autonomous platform mobility and power generation; and will perform research in compact power switching, conversion and distribution technologies to produce fast, high energy electrical discharge to provide unique mobility enhancements through application of high voltage phenomenology.

Vulnerability Analysis Methodology for CEMA threats 0 to 2.0
Will design and develop a vulnerability analysis and susceptibility profile methodology based on current simulation and experimental methods for cyber and electromagnetic threats. Will investigate and validate methodology to improve Protect, Detect, React, and Restore assessments through automation and advanced analytics.

Optimized Energy for C4ISR Platforms 0 to 4.7
Will investigate power requirements for emerging C4ISR capabilities to include directed energy, lasers, high power sensors, and electromagnetic weapons; conduct analysis of size, weight and power requirements necessary to support these capabilities with unique very high density power sources and energy storage for high rate pulsed power; identify interface requirements and constraints for power system; investigate architectures and intelligent controls necessary to manage these loads; investigate and perform high resolution characterization of cyclical, step and high power load profiles likely to result from use of lasers or other high power, short duration burst technology; examine thermal implications and waste heat generated from inefficiencies in power conversation; explore hybrid energy storage technologies to support cyclical loads such as hybrid batteries or ultra-capacitor technology; determine duel use potential of microwave or laser power transmission technologies with other developmental operational uses; conduct experiments on wireless power transmission capabilities for laser power transmission; explore the use of intelligent control strategies for platform integrated power systems.

Quantum for Assured PNT in Zero-GPS Environments Acceleration 0 to 3.2
Designing of integrated triaxial microelectromechanical systems Inertial measurement units (IMUs) with 3 orders of magnitude improvement in accuracy (goal TRL4 in FY21), develop approach/design for integrated photonics and quantum timing circuit that meets PNT timing requirements while meeting on Soldier SWAP-C goals, and to build optical time synchronization demonstration for FY20/TRL3 demonstration.

Night Vision Technology

Embedded Processing for Autonomous Sensors **0 to 4.8**

Will conduct market research on signal and image processing algorithms for autonomous applications; will investigate novel techniques for improving signal and image processing algorithms to perform functions such as scene labeling, and data association to enable autonomous functions; will research innovative approaches for data management and fusion which reduce information processing time.

Human Factors Engineering Technology

Tools for Assessing Human/Intelligent Team Performance **0 to 1.0**

Will develop portable, 'plug and play' analysis toolkit that enables individualized assessment of a single human interacting with an intelligent agent in pseudo-controlled environments.

Intelligence Underlying Efficient Integration of Cognitive Assist Agents **0 to 2.1**

Will develop novel machine learning approaches for learning the optimal allocation of tasks across hybrid teams of humans and artificial intelligent agents; develop novel approaches to deep neural networks based on the underlying geometry of the data.

Soldier Focused Neurotechnologies **0 to 2.3**

Will determine and develop efficacy of novel materials for use in advanced validation tools for mobile brain-recording hardware; develop a framework describing the relationship between computational neural data features and the performance of corresponding neural state classifiers within non-ideal, noisy environments.

Exoskeleton **0 to 1.6**

Will identify and validate initial surrogate tasks and associated performance metrics against an anticipated urban terrain scenario; identify key quantitative measures and model their relationship to performance outcomes; characterize human movement variability in performance of and transitions between component tasks and responses to perturbations within movement through complex urban environment scenario.

Environment Quality Technology

Intelligent Environmental Battlefield Awareness **0 to 2.1**

Will investigate environmental forensic methodologies to provide geo-chemical resources to mission planners. Will quantify contaminant microbial degradation/transformation activity in arctic and subarctic climates as a function of soil geochemistry and environmental flux to model contaminate fate and transport prediction for intelligence preparation on the battlefield.

Understanding the Environment as a Threat **0 to 1.8**

Will develop predictive models of environmental impact to inform environmental situational awareness and source analysis by investigating microbial products of synthetic biology and acquire a diverse variety of synthetic constructs to conduct lab-scale microcosm experiments with known microbes to assess potential for spread/transfer of synthetic component.

Command, Control, Communications Technology

Defensive Cyber Operations **0 to 6.6**

Will research and validate cyber security technologies to improve the depiction, perception, and understanding of cyber space as it pertains to a commander?s operational environment to speed actionable decisions; will research cyber hardening methodologies for software, hardware,

identities, and information to create trusted architectures and measures of provable identity, pedigree, and provenance; will investigate robust built-in techniques that enable systems and networks to absorb, fight through, and adapt to adversary attacks; will research and design autonomic techniques, models and algorithms to support convergence of defensive cyber, offensive cyber, EW, and network/spectrum management information to improve decision response; will research and validate block-chaining methodologies to trace and validate pedigree of tactical information as it traverses the network; will research and validate robust non-intrusive identity authentication techniques that supports tactical access control; and will research models and algorithms that can provably determine a confidence factor associated with software vulnerability prioritization.

Communications, Robust Tactical Systems **0 to 15.6**
This effort designs and matures components, software and algorithms that enable Army tactical wireless networks to provide assured uninterrupted access to critical communications and information links so that they operate more robustly in congested, contested and competitive electromagnetic environments.

Modular Radio Frequency (RF) **0 to 4.8**
This effort enables connectivity in contested & congested environments by applying automated networking techniques to modular radio frequency (RF) technology & networking techniques to adapt and continue operation under interference signals.

Computer and Software Technology
Machine Learning with Constrained Resources **0 to 4.1**
Will develop methods for system-self-awareness of space, time and power characteristics and their relation to requirements of active/pending system missions, with additional ability to degrade or self-destruct gracefully; will design approaches that balance the trade-off between accuracy of computation required to answer queries of users, security concerns and mission criticality/ relevance; will investigate the use of reinforcement learning to develop resilient behaviors and learn effective strategies for accomplishing Soldier relevant mission tasks in complex environments; and will develop approaches that learn from human input develop a scalable technique for performing machine learning online, in complex Army environments, and at operational tempo.

Military Engineering Technology
Geo-enable Computing Environments **0 to 4**
Will investigate a compatible framework for sharing a relevant and focused geospatially enabled visualization of the operational environment within the command post computing environment; investigation will focus on geospatial-enabled collaborative mission planning capabilities providing services, data, and information to the Army planners, staffs, and leadership.

Robotics for Engineer Operations **0 to 6.0**
Will develop robotic construction equipment capabilities allowing Engineers to conduct autonomous and semi-autonomous mobility, countermobility and construction missions. Design proof of concept for a prototype robotic obstacle-removal platform, and develop advanced construction methods for deployed forces.

Tactical Augmented Reality for Operational Technologies - 3D Terrain 0 to 1.0
Will develop advanced algorithms for the detection and delineation of edges, sides, and corners of built infrastructure within collected 3D urban data, and export results as light-weight wireframe or mesh to augment the Soldier's situational awareness in dense and congested urban and complex terrain.

Geospatial Analytics for High Resolution Enriched Terrain 0 to 3.0
Will investigate emerging man/machine learning algorithms to automate production processes, to enable change detection, and to support learning by manned and autonomous systems with the capability to collect and/or complete 3D high-resolution common operating picture of complex and urban terrain.

Geospatial Representation of Dynamic Phenomena 0 to 1.1
Will investigate new methods to identify, characterize, track and visualize battlespace objects that change with time (examples include rubble, bridge damage, vehicles, street markets, flooding and other weather induced effects) impacting Soldier and unmanned systems movement and maneuver in complex terrain.

Warfighter Technology

Soldier Situational Awareness Technologies 0 to 2.5
Will investigate and mature advanced algorithms and sensors for micro and nano robotic systems to enhance autonomy and provide collision avoidance, environmental sensing, and global positioning system denied navigation capabilities; will investigate novel Soldier-robotic interfaces and interaction modalities to enhance human-machine teaming; will investigate micro and nano sensors and robotic platforms, payloads, and architectures to enable Manned-Unmanned Teaming of autonomous systems with dismounted Soldiers.

Aerial Delivery 0 to 3.8
Will study, design, and conduct experiments with precision aerial delivery software and hardware components to enhance precision aerial delivery capabilities and assure re-supply via manned and unmanned systems in A2/AD environments; conduct research in the area of maneuver assistance in personnel airdrop systems to accelerate the certification of airborne jumpers from novice to master jumper.

Expeditionary Maneuver 0 to 1.5
Will study, design, and conduct experiments that investigate autonomous deployment methodologies, additive manufacturing of components used in expeditionary maneuver platforms that support expeditionary operations in all environments, and concepts for rapidly-deployable platforms that allows for integration of technologies that will improve protection and minimize resource consumption.

Medical Technology

Prolonged Field Care 0 to 1.4
This effort performs applied research to study the physiological implications of delayed medical evacuation and limited access to definitive surgical care in severely injured casualties

Autonomous and Unmanned Medical Capability 0 to 1.7
Will utilize invasive and non-invasive sensor systems to define new models for human physiologic responses to injury. Data from these models will be used to define new algorithms that drive

resuscitation and critical care procedures in animal models. Algorithms will be defined for implementation across a full spectrum of automation capabilities. Will define the physiological process associated with injury in trauma simulations that would be amenable to automated therapeutics with autonomous medical systems. Will explore feasibility of integrating medical capabilities and information systems with Army unmanned systems (UMS) Programs of Record in order to leverage multipurpose robotic platforms for medical capabilities. Will research standardization of medical device interfaces for use in an autonomous platform. Will research feasibility of Unmanned Aerial Systems (UAS) to support remote patient monitoring research prototypes, closed-loop patient support systems, and prototype automated diagnostic and therapeutic en route care capabilities.

Medical Aspects of Man-Machine Teaming/Medical Robotics **0 to 2.0**
Will research the design of robotic systems, including physical interfaces and hardware configurations, to effectively implement and control resuscitation and critical care procedures driven by algorithms defined by complementary research described in the Autonomous and Unmanned Medical Capability Task Area. Will research and design a proof of concept field robotic fold-up litter to show the feasibility of deploying soft robotics sensors and also show the capability to apply pressure using a soft robotics manipulator. Will model and characterize the problems caused by signal latency and constrained bandwidth on complex telerobotic surgical tasks. Will research and prioritize procedures amenable to full automation of tele-robotic operations. Will research and explore the feasibility of using robotic perception systems to detect casualties from a standoff distance and at closer ranges using both conventional computer vision approaches and recent advancements in deep learning techniques.

Navy

Directed Energy **4.6 to 6.5**
Increased investment in laser component technologies.

Human Performance and Training **3.2 to 3.7**
Increased investment in research associated with training tools for operation in EW and Cyber contested environments.

Maneuver **7.8 to 10.5**
Accelerated development of novel approaches to swarming small, low cost autonomous amphibians across open water, surf zone, and land environments.

Solid State Electronics **11.0 to 15.5**
Ramp up in funding towards the Anti-Tamper Program - develop an undetectable, robust, low/no power, low cost set of technologies that can be deployed in many different systems from many different vendors for the purpose of protecting critical technology and critical program information contained in U.S. military systems from tampering and reverse engineering.

Anti-submarine Warfare Surveillance **21.6 to 23.0**
Increased investment and research associated with new sensor concepts to provide improved performance in smaller packages; automated passive acoustic & nonacoustic detection and classification algorithms to eliminate the dependence on traditional Anti-Submarine Warfare platforms; undersea communications; secure and robust networking of autonomous sensors; and knowledge and exploitation of complex operational environment.

Restructured FNC program

EMW and Combating Terrorism, FNC **0 to 7.2**

Develop and mature technologies in asymmetric and irregular warfare, distributed operations, information dominance, survivability and self-defense to a point where they can be proposed and continued as Future Naval Capabilities in PE 0603673N, Future Naval Capabilities Advanced Tech Div.

C4ISR and Special Projects, FNC **0 to 71.9**

Develop and mature technologies in data science, mathematical optimization, computational and information sciences, quantum information sciences, electronics, command and control and combat systems, communications, cyber security, cyber operations, electronic warfare, sensing and surveillance, and precision timing and navigation, as well as technologies for surface and airborne vehicles, low observable (LO) technology, weapons system counter low observable (CLO) technology, and cruise missile defense weapons to a point where they can be proposed and continued as Future Naval Capabilities in PE 0603673N, Future Naval Capabilities Advanced Tech Div

Ocean Battlespace Sensing, FNC **0 to 21.9**

Develop and mature technologies in the areas of oceanographic and meteorological observations, modeling and prediction in the battlespace environment; submarine detection and classification, and mine warfare to a point where they can be proposed and continued as Future Naval Capabilities in PE 0603673N, Future Naval Capabilities Advanced Tech Div.

Sea Warfare And Weapons, FNC **0 to 18.1**

Develop and mature technologies that enable superior warfighting capabilities for surface and sub-surface naval platforms and undersea weaponry to a point where they can be proposed and continued as Future Naval Capabilities in PE 0603673N, Future Naval Capabilities Advanced Tech Div.

Warfighter Performance, FNC **0 to 8.8**

Develop and mature technologies that enhance warfighter effectiveness and efficiency through bioengineered and bio-robotic systems, medical technologies, improved manpower, personnel, training systems design to a point where they can be proposed and continued as Future Naval Capabilities in PE 0603673N, Future Naval Capabilities Advanced Tech Div.

Naval Air Warfare and Weapons, FNC **0 to 20.0**

Description: The objective of this activity, new for FY19, is to develop and mature technologies in directed energy, energetic materials, autonomy, electromagnetic launch, and high speed conventional air and surface weapons to a point where they can be proposed and continued as Future Naval Capabilities in PE 0603673N, Future Naval Capabilities Advanced Tech Div.

Cyber, INP **24.9 to 29.1**

Increase in funding applied to the development of capabilities to provide cyber protection for two of the program's eight identified common layers of cyber platform functionality, in an effort to improve overall naval platform cyber resiliency and warfighting effectiveness.

Unmanned and Autonomous Systems. INP **48.4 to 60.1**

Ramp up of funding in the second year of two FY18 new start INPs and an increase in funding for autonomy maturation efforts in support of unmanned surface craft operations, countered by a reduction of funding levels associated with the completion of three unmanned and autonomous systems technology development projects.

Mine Technology **3.8 to 8.3**

Additional investment and effort associated with technologies supporting applied research in modeling and applying novel mine sensing modalities and modeling and development of advanced minefield effects.

Defense Advanced Research Projects Agency

IT-02

Adversarial AI for RF **0 to 9**

Develop artificial intelligence (AI) capabilities with applications for national security, particularly in areas such as electronic warfare. Adversarial AI will develop methodologies for protecting AI-enabled DoD systems from adversary attempts to elicit an erroneous response (spoofing) and for significantly increasing AI system reliability and safety.

IT-03

Protecting C3 Networks **0 to 6.6**

Develop technologies to make military command, control, and communications (C3) networks more resilient against adversary attempts to disrupt, deny, degrade, or destroy mission-critical information, hosts, network elements, or services.

IT-04

Human-Machine Symbiosis (HMS) **0 to 5.1**

Develop technologies to enable machines to collaborate with humans as colleagues, partners, and teammates. The world is moving faster than humans can assimilate, understand, and act. Rather, HMS enabled machines will understand speech; extract information contained in diverse media; learn, reason and apply knowledge gained through experience; identify and work to fill knowledge gaps; extrapolate causal phenomena to anticipate predictable developments; respond intelligently to new and unforeseen events; and exhibit behaviors that are typically believed to require common sense.

TT-03

Lobster **0 to 12.0**

Improve U.S. operations by enabling underwater robotic systems significantly ahead of the state of the art. These robotic systems would be able to execute inspection, characterization, repair, manipulation, recharging, data exfiltration, re-tasking and other high value services without the need for continuous human control and high risk surface ship launch and recovery. Key Lobster technical challenges include scene recognition through visual and acoustic modalities, autonomous behaviors, environmental robustness, vehicle endurance, universality for all unmanned underwater systems, energy storage and interaction with the maritime domain.

MBT-02

Persistent Aquatic Living Sensors **0 to 12.0**

Develop novel capabilities to sense and surveil submersibles (e.g., submarines, unmanned underwater vehicles) and divers in littoral waters using living organisms present in the

environment. This effort will focus on characterizing marine biological behavior in response to targets of interest and developing the hardware, software, and algorithms that will translate organism behavior into DoD actionable information.

ELT-02

Ensured Communication Link for Identification Friend or Foe (ECLIFF) 0 to 9.2

Provide communication links for Identification Friend or Foe (IFF) capabilities with a reduced radio frequency (RF) signature, improved performance against jamming and interference, and a compact form factor. ECLIFF will address the challenge of identifying friendly assets and personnel in congested electromagnetic environments and in environments where there is a strong penalty for stray radio emissions. ECLIFF will explore alternative technologies to enable ~25 times greater compared to current IFF systems. These technologies should also enable IFF systems to use alternate channels at higher frequency bands.

ELT-02

Digital RF Battlespace Emulator (DRBE) 0 to 8.0

Develop a large-scale, interactive, emulated radiofrequency (RF) environment, providing DoD with the much needed capability to cost-effectively evaluate adaptive, intelligent, and spatially distributed next-generation RF systems. DRBE will leverage advances in massively multi-core computing hardware and high-bandwidth digital cross connects to emulate realistic RF environments that account for RF platform movement, signal propagation effects and delays, signal interference, and interactions between RF systems. DRBE will pursue three technical thrust areas: architecture, massively multi-core computing, and scenario modeling.

Chemical Biological Defense Program

No significant change

Appendix 3: Abbreviated illustration of a Program Officer Datasheet

Dr. David M. Stepp
ARO, Chief, Materials Sciences Division
(919) 549-4329
david.m.stepp@us.army.mil

Biosketch:
Dr. David Stepp serves as the Chief of the Materials Science Division of the U.S. Army Research Office. Also, he is Adjunct Assistant Professor in the Department of Mechanical Engineering & Materials Science, Pratt School of Engineering, Duke University.

Education
PhD in Mechanical Engineering and Materials Science from Duke University in 1998
MS in Mechanical Engineering and Materials Science from Duke University in 1995
BS in Engineering from Harvey Mudd College in 1993

Program: Mechanical Behavior of Materials
http://www.arl.army.mil/www/default.cfm?page=183
The Mechanical Behavior of Materials program seeks to establish the fundamental relationships between the structure of materials and their mechanical properties as influenced by composition, processing, environment, and loading conditions. The program emphasizes research to develop innovative new materials with unprecedented mechanical, and other complementary, properties.

Recent MURI Topics:
FY11 Flex-Activated Materials
FY10 Ion Transport in Complex Heterogeneous Organic Materials
FY09 Tailored Stress-Wave Mitigation
FY09 Disruptive Fibers for Flexible Armor

Illustrative Papers Reflecting Personal Research Interests:
A theory of amorphous viscoelastic solids undergoing finite deformations with application to hydrogels
Korchagin Vladimir; Dolbow John; Stepp David
International Journal of Solids and Structures 44(11-12), 3973-3997 JUN 1 2007

Damage mitigation in ceramics: Historical developments and future directions in army research
Stepp DM
Ceramic Transactions 134, 421-428 2002

High-resolution study of water trees grown in silver nitrate solution
Stepp, D.,King, J.A., Worrall, J., Thompson, A., and Cooper, D.E.
IEEE Transactions on Dielectrics and Electrical Insulation, 3(3), 392 - 398 1996

Appendix 4: Acronym and Abbreviation Glossary

Agency Specific

A2/AD	Anti Access, Areal Denial
AFIRM	Armed Forces Institute for Regenerative Medicine
AFOSR	Air Force Office of Scientific Research
AFRL	Air Force Research Laboratories
AMRDEC	Aviation and Missile Research and Development Center (Army)
AMRMC	Army Medical Research and Materiel Command
ARDEC	Armament Research and Development Center (Army)
ARI	Army Research Institute for Behavioral and Social Sciences
ARL	Army Research Laboratories
ARO	Army Research Office
ASBREM	Armed Services Biomedical Research and Evaluation and Management
ASSURE	Awards to Stimulate and Support Undergraduate Research Experiences
BA	Budget Activity (new designation for the R&D accounts)
BMDS	Ballistic Missile Defense System
BSV	Bio Surveillance
BTO	Biological Technologies Office (DARPA)
C2	Command and Control
C2ISR	Command, Control, Intelligence, Surveillance and Reconnaissance
C4ISR	Command, Control, Communications, Computers,…
CBDP	Chemical/Biological Defense Program
CBRNE	Chemical, Biological, Radiological, Nuclear and High Explosive
CBWD	Chemical/Biological Warfare Defense
CCRI	Cross-cut Research Initiative
CDMRP	Congressionally Directed Medical Research Program
CEMA	Cyber Electromagnetic Activities
CERDEC	Communication-Electronics Research and Development Center
CM	Counter Measures
CNA	Computer Network Attack
CoE	Center of Excellence
CONOPS	Concepts of Operation
COTS	Commercial Off-the-Shelf (products)
CSI	Congressional Special Interest (also known as budget “adds”)
CTA	Collaborative Technology Alliance
CWMD	Combating Weapons of Mass Destruction
D2D	Data to Decisions
DARPA	Defense Advanced Research Projects Agency
DDR&E	Director, Defense Research and Engineering
DESI	Defense Enterprise Science Initiative
DFBA	Defense Forensics and Biometrics Agency
DHP	Defense Health Program
DLA	Defense Logistics Agency
DMDI	Digital Manufacturing and Design Innovation (an IMI)
DMRDP	Defense Medical Research and Development Program
DMS&T	Defense Manufacturing Science and Technology
DTIC	Defense Technical Information Center
DTRA	Defense Threat Reduction Agency
DURIP	Defense University Research Instrumentation Program
EC	Enabling Technologies (at ONR)
ECBC	Edgewood Chemical and Biological Center
EM	Electromagnetic

EMW	Electromagnetic Warfare
EO	Electrooptic
ERDC	Engineering Research and Development Center, Army Corp of Engineers
ERS	Engineered Resilient Systems
ESTCP	Environmental Security Technology Certification Program
EW	Electronic Warfare
FDW	Federal District of Washington (DOD)
FNC	Future Naval Capabilities
FPA	Focal Plane Array
GDF	Guidance for the Development of the Force
GPS	Global Positioning System
HEL	High Energy Laser
HSCB	Human Social Cultural and Behavior Modeling
IED	Improvised Explosive Devices
IMI	Institute for Manufacturing Innovation
INP	Innovative Naval Prototypes
ISR	Intelligence, Surveillance and Reconnaissance
LM3I	Modern Metals Manufacturing Innovation (an IMI)
LUCI	Laboratory University Collaboration Initiative
LVC	Live, Virtual and Constructive (environments)
MDA	Missile Defense Agency
Minerva	Name of DOD program engaging the social science community
MOVINT	The ability to track moving things on land and sea (Movement Intelligence)
MTO	Microsystems Technology Office (DARPA)
MURI	Multidisciplinary University Research Initiative
NAMII	National Additive Manufacturing Innovation Institute (an IMI)
NAWC	Naval Air Warfare Centers (Patuxent River-Aircraft Div, China Lake–Weapons Div)
NDEP	National Defense Education Program
NDSEG	National Defense Science and Engineering Graduate Fellowships
NMRC	Naval Medical Research Center
NPGS or NPS	Naval Postgraduate School
NRL	Naval Research Laboratory
NSRDEC	Natick Soldier Research and Development Command
NSSEFF	National Security Science and Engineering Faculty Fellowship
NSWC	Naval Surface Warfare Center (Dahlgren and Carderock Divisions)
NUWC	Naval Undersea Warfare Center
ONR	Office of Naval Research
OSD	Office of the Secretary of Defense
PACOM	DOD U.S. Pacific Command
PE	Program Element – term from DOD budgeting
PM	Program Manager (same as PO)
PNT	Positioning, Navigation and Timing
PO	Program Officer (same as PM)
QIS	Quantum Information Science
R&E	Research and Engineering Enterprise (DOD Assistant Secretary)
R-1	RDT&E Program Budget Summary Document
RDDS	Research and Development Descriptive Summary (R-2 Budget Document)
RDECOM	Army Research and Development Commands
RIF	Rapid Innovation Fund
RF	Radiofrequency
SIGINT	Signals Intelligence
SERDP	Strategic Environmental Research and Development Program
SOCOM	Special Operations Command

SOF	Special Operations Forces
SPAWAR	Space and Naval Warfare Systems Center
STO	Strategic Technology Office (DARPA)
TARDEC	Tank-Automotive Research and Development Center (Army)
TBI	Traumatic Brain Injury
TTCP	Technical Cooperation Program
TTO	Tactical Technology Office (DARPA)
UARC	University Affiliated Research Center
UCAR	Unmanned Combat Air Rotor
UCAV	Unmanned Combat Air Vehicle
USACE	United States Army Corps of Engineers
USAMRMC	United States Army Medical Research and Materiel Command
UXV	Unmanned (X for ground (G), air (A), sea (S),…) Vehicles
WRAIR	Walter Reed Army Institute of Research

General

AI	Artificial Intelligence
AMNPO	Advanced Manufacturing National Program Office
AMP	Advanced Manufacturing Partnership
ASEE	American Society for Engineering Education
BAA	Broad Agency Announcement
BRAIN	Brain Research through Advancing Innovative Neurotechnologies
CA	Congressional add
CDC	Centers for Disease Control (in DHHS)
CFDA	Catalog of Federal Domestic Assistance Number
CMOS	Complementary Metal Oxide Semiconductor (electronics)
COE	Center of Excellence
CSI	Congressional Special Interest
DHS	Department of Homeland Security
DHHS	Department of Health and Human Services
DNI	Director of National Intelligence
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
DOEd	Department of Education (alternative)
DOI	Department of Interior
DOJ	Department of Justice
DOS	Department of State
DOT	Department of Transportation
ED	Department of Education
EPA	Environmental Protection Agency
EPSCoR	Experimental Program to Stimulate Competitive Research
FAA	Federal Aviation Administration
FBO	Federal Business Opportunity
FDA	Food and Drug Administration
FFO	Federal Funding Opportunity
FFDRC	Federally Funded Research and Development Center
FHWA	Federal Highway Administration
FOA	Funding Opportunity Announcement
FY	Fiscal Year (1 Oct to 30 Sep for Federal government)

GPS	Global Positioning System
HBCU/MI	Historically Black Colleges/Universities and Minority Institutions
IHE	Institutions of Higher Education
IMI	Institute for Manufacturing Innovation
INTEL	The various agencies that gather intelligence
IR	Infra-Red
IT	Information Technology
IWG	Interagency Working Group
MAPS	Mission Agency Program Summary (provided by USC Res. Adv.)
MEMS/NEMS	Micro- Nano-ElectroMechanical Systems
MRL	Manufacturing Readiness Level
NASA	National Aeronautics and Space Administration
NDI/E	Non-Destructive Inspection/Evaluation
NIH	National Institutes of Health
NIST	National Institute for Standards and Technology (in DOC)
NNMI	National Network for Manufacturing Innovation
NOAA	National Oceanic and Atmospheric Administration (in DOC)
NOFO	Notice of Funding Opportunity
NRC	National Research Council
NRI	Nanoelectronics Research Initiative
NRO	National Reconnaissance Office
NSA	National Security Agency
NSF	National Science Foundation
NSTC	National Science and Technology Council
NTIA	National Telecommunications and Information Administration
OMB	Office of Management and Budget
OPM	Office of Personnel Management
ORAU	Oak Ridge Associated Universities
OSD	Office of the Secretary of Defense
OSTP	Office of Science and Technology Policy (White House)
PBR	President's Budget Request (submitted to Congress)
PCAST	President's Council of Advisors on Science and Technology
PECASE	Presidential Early Career Award for Scientists and Engineers
PTSD	Post-traumatic Stress Syndrome
RD&I	Research, Development and Innovation
RDT&E	Research, Development, Test and Evaluation
RF	Radio-frequency
RFA	Request for Application
RFP	Request for Proposal
S&T	Science and Technology
SBIR	Small Business Innovative Research
SME	Subject Matter Expert
SN	Special Notice
STEM	Science, Technology, Engineering and Mathematics (education)
STTR	Small Business Technology Transfer
TBA	To be announced
TBI	Traumatic Brain Injury
TRL	Technology Readiness Level
UARC	University Affiliated Research Center

USDA	US Department of Agriculture
YIP	Young Investigator Program